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

Memo

TO: Josie Tayse, Final Design Project Manager
Metro District, Waters Edge

FROM: Paul Martin, Assistant Foundations Engineer
Geotechnical Engineering Section

Paul Martin Digitally signed by Paul Martin
DN: cn=Paul Martin
Date: 2017.12.19 07:39:23 -06'00'

Concur: Rich Lamb, Foundations Design Build Engineer
Geotechnical Engineering Section

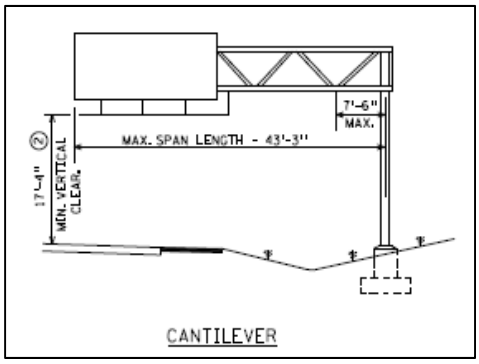
RAL

DATE: December 19, 2017

SUBJECT: SP 8825-652, Metrowide Overhead Sign Structure Replacement
Subsurface Evaluation and Foundation Recommendation REVISED Memo

1.0 Project Summary

This REVISED report is provided in response to a request by the Metro District to provide a subsurface investigation and foundation recommendations for eight proposed new overhead sign structures being constructed along TH 7, TH 36, TH 47, TH 94 (two sites), TH 100 (two sites) and TH 280. The revisions include the removal of X-section sheets showing inaccurate elevations and the inclusion of subsurface information and recommendations from a previous project (SP 8825-562) for two locations on TH 35 that have been rolled into this project. The sign structure types will include both Sign Bridge and Cantilever.



2.0 Subsurface Investigation

With the exception of Site 13, the soils at the proposed sign locations were investigated using Standard Penetration Test Borings (SPT) or Cone Penetration Test Soundings (CPT) conducted in May, June, October, November and December, 2017. Site 13 on TH 280 was explored in 1969.

The CPT soundings were interpreted for general soil behavior type and estimated water table elevation. No soil samples were taken so the interpreted soil behavior type may not exactly match what soil is present, but should indicate how it behaves if compared to standard soils.

Based on the results of the investigations we determined that the foundation soils at the proposed sign locations include loose to very dense sands and layered soft to stiff sandy loam, clay and silt soils. Groundwater was detected in some of the borings and CPT soundings and perched water should also be expected in areas where layered soils exist. Please refer to the attached sounding and boring logs for the most complete description of the foundation soils.

Table 1, below, provides general summaries of the soil and groundwater conditions encountered at/near each sign location.

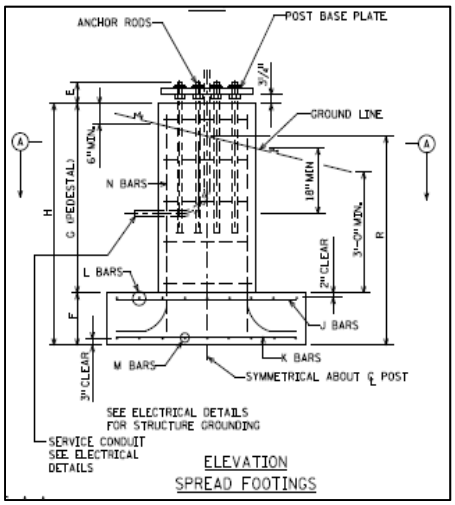
Table 1, Summary of Estimated Soil and Groundwater Conditions

Boring or Sounding	Location	Indicated Groundwater Depth (feet)	Summary of Interpreted Soils (Depths in feet)	Interpreted N-Value
T01	Site 1, TH 7 WB STA 311+26, 36' Lt	6.9	Sandy Loam and Sand to 9' Clays and Silts to 16.5' Sandy Loam and Clay Loam w/Sand & Gravel	25-41 12-19 27-39
T05 (562)	Site 3, I35 NB STA 1683 near Greenhaven Dr	NI-36'	Mostly medium dense to loose Sands	2-15
C07 (562)	Site 5, I35 NB STA 1717+15, near Southcross Dr.	*	Mostly Sands and Sandy Loam with a few Silt and Clay layers	3-50+
C02	Site 7, TH 36 EB Ramp to SB TH 694	*6.5	Frozen soils and Sands to 7' Layered Silts, Clays and Sands to about 25' Sandy Loam and Sands to termination	20-50+ 3-20 14-36
T03	Site 8, TH 47 SB, STA 523+79, 43' Rt	8.5	Fine and very fine grained sands	12-85
T04	Site 8, TH 47 SB, STA 523+81, 20' Lt	11.2	Fine sand, very fine sand and loamy sand	3-66
T05	Site 9, TH 94 WB STA 2118+46, 31 Lt	NI-36'	Plastic Silt Loam to 10' Sands & Gravel to termination.	15-33 21-48
T06	Site 10, TH 94 WB, STA 428+52, 52' Lt	*	Loamy sand to 4, clay loam to 6.5, silt loam to 9, sands to 19, sandy clay to 31.5, sandy loam	23,12 8,7-23 10-13,9-17
T07	Site 10, TH 94 WB, STA 428+55, 28' Rt	*	Sand fill to 11.5, topsoil to 13, sand to 21.5, clay to 31.5, over sandy loam and silty clay	18-41, 14 8-21,6-11 6-22
C08a	Site 11, TH 100 SB STA 183+01, 42'Rt	*	Layered Clays, Sands and Silts to 10.5' Refusal on dense Sand	3-32 50+
C09	Site 12, TH 100 SB STA 227+10, 32'Lt	*	Sands layered with Silt and Clay to 29.5' Refusal on Dense Sand	4-50 30-50+
TC-2 (1969)	Site 13, TH 280 NB near STA 88+60	25	Plastic Sandy Loam to 13' Sand & Gravel to termination.	11-16 20-75

*Perched layers may occur NI- Not Indicated to

3.0 Foundation analysis

As part of the overhead sign standard drawings (revised 11-21-2014), standard foundations were developed to support overhead signs. These standard foundations consist of two spread footing and two drilled shaft designs to be used on the various sign post sizes (see Drawing ST-3, Standard Overhead Sign Supports Interim Design B).



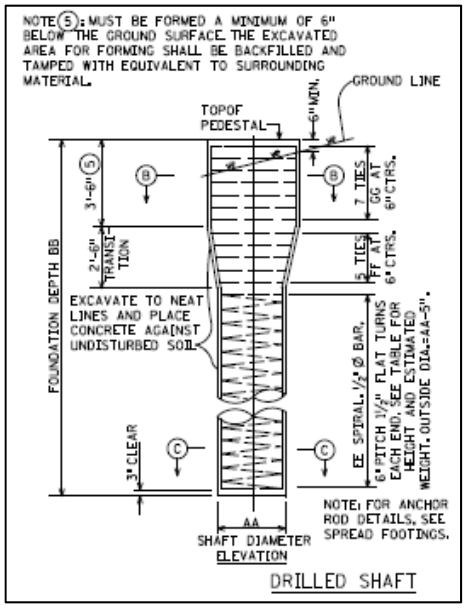
- Spread Footings: 12 ½ ft. x 18 ft. or 9 ft. x 14 ft.
- Drilled Shafts: 3 ft. diameter, 23 ft. deep or 4 ft. diameter, 29 ft. deep

In addition, the standard foundation notes state the following requirements:

- All spread footings shall have an allowable design bearing pressure of 1 ¼ tons per square foot

- The drilled shafts have an allowable design lateral bearing pressure of 250 lbs. per square foot per foot of depth

Based on previous research, these requirements will be met in all but the weakest mineral soils, and therefore represent a very conservative design. In lieu of new foundation designs we checked the foundation soils to see if they met those requirements. The recommendations contained in the paragraphs below are based on our analysis. We recommend the new foundations consist of drilled shafts designed to meet the requirements of the current standard design tables. At many locations the soils in the shaft excavations will require support to prevent caving to prevent loss-of-ground below nearby pavements, utilities or structures.

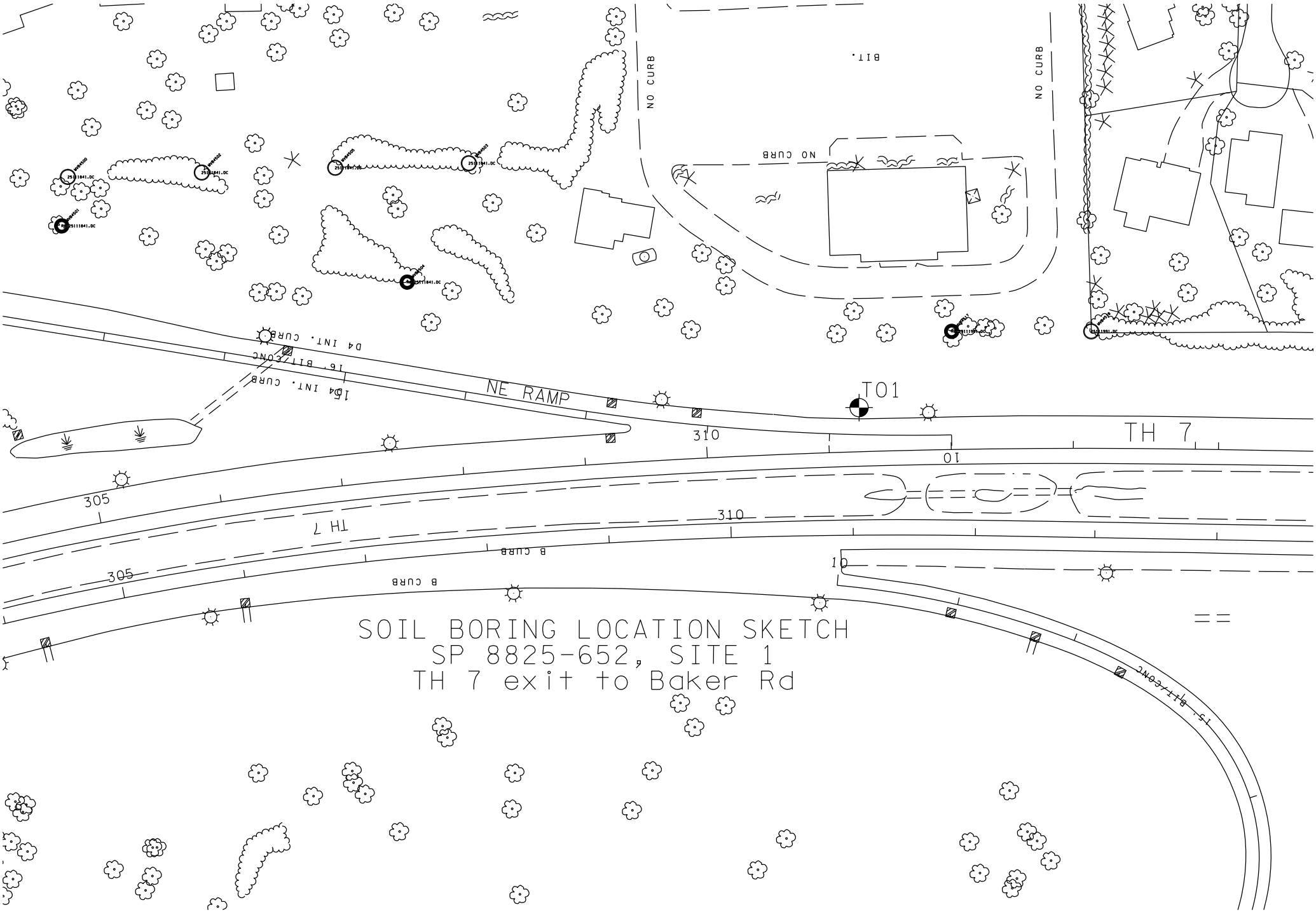


4.0 Foundation Recommendations
Based on review of the existing subsurface conditions and proposed structures, we recommend:

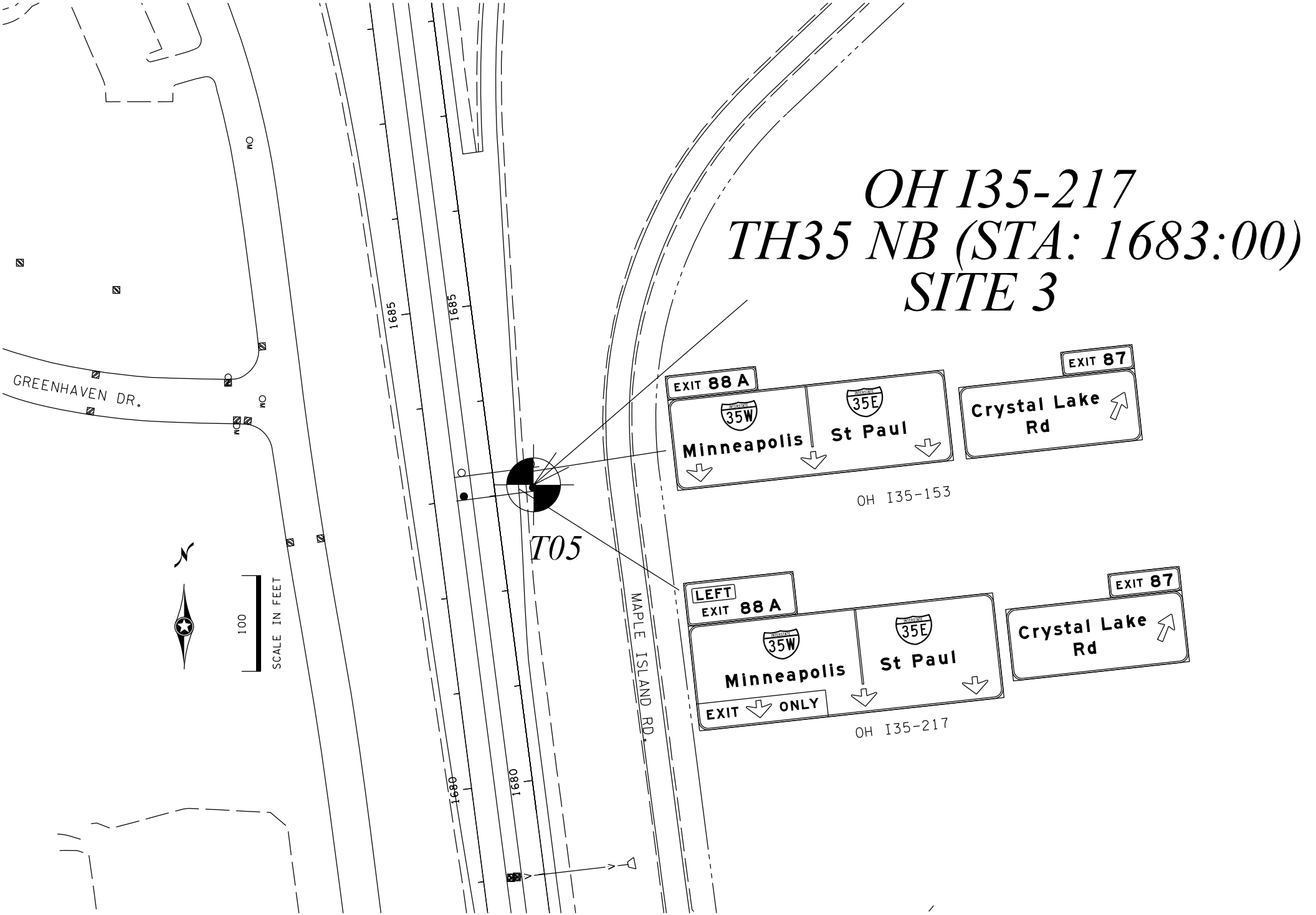
1. The overhead sign structures be supported with drilled shaft foundations as detailed in the typical Foundation Detail Sheet, Drawing ST-3 located on the Traffic Engineering website.
2. Table 1 and the attached Overhead Sign Foundation Recommendations Table, showing the estimated soil and water conditions be forwarded along with a copy of the attached Boring and Sounding Logs to the bidding contractors.
3. That caving conditions be expected where excavations must extend below groundwater and perhaps other areas having very loose sands and gravel layers.
4. And that caving be controlled to protect existing pavements, utilities and structures.

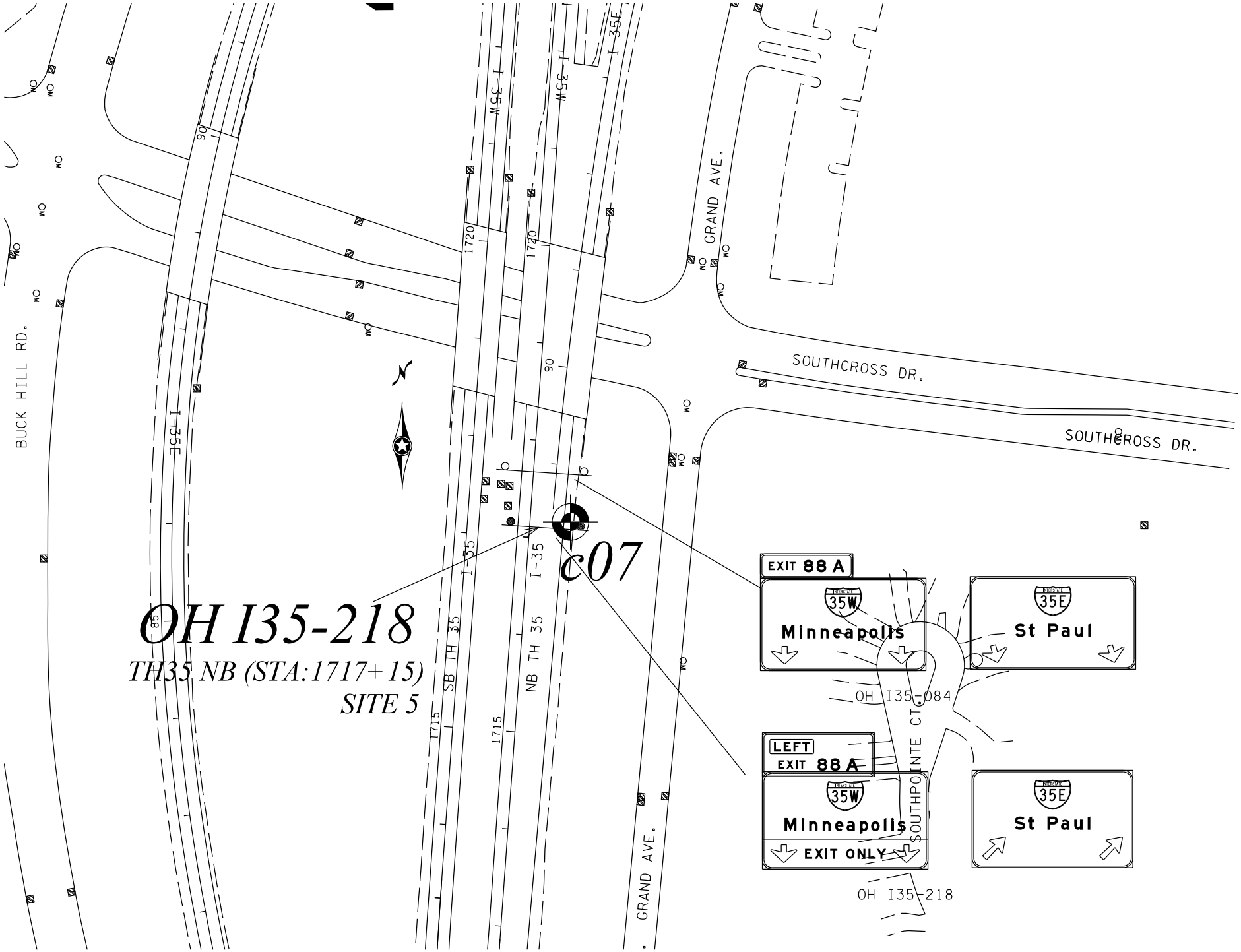
Attachments:
Soil Boring Location Sketches, Sites 1, 3, 5, 7, 8, 9, 10, 11, 12, 13
Overhead Sign Foundation Recommendations Table
Boring Logs T01, T05 (562), T03, T04, T05, T06, T07, TC-2 (1969) Unique Numbers 82770, 82035, 82713, 82714, 82769, 82715, 82716
Sounding Logs C02, C07 (562), C08, C08a, C09, Unique Numbers 82817, 82536, 82796, 82824, 82818
SPT Index
CPT Index

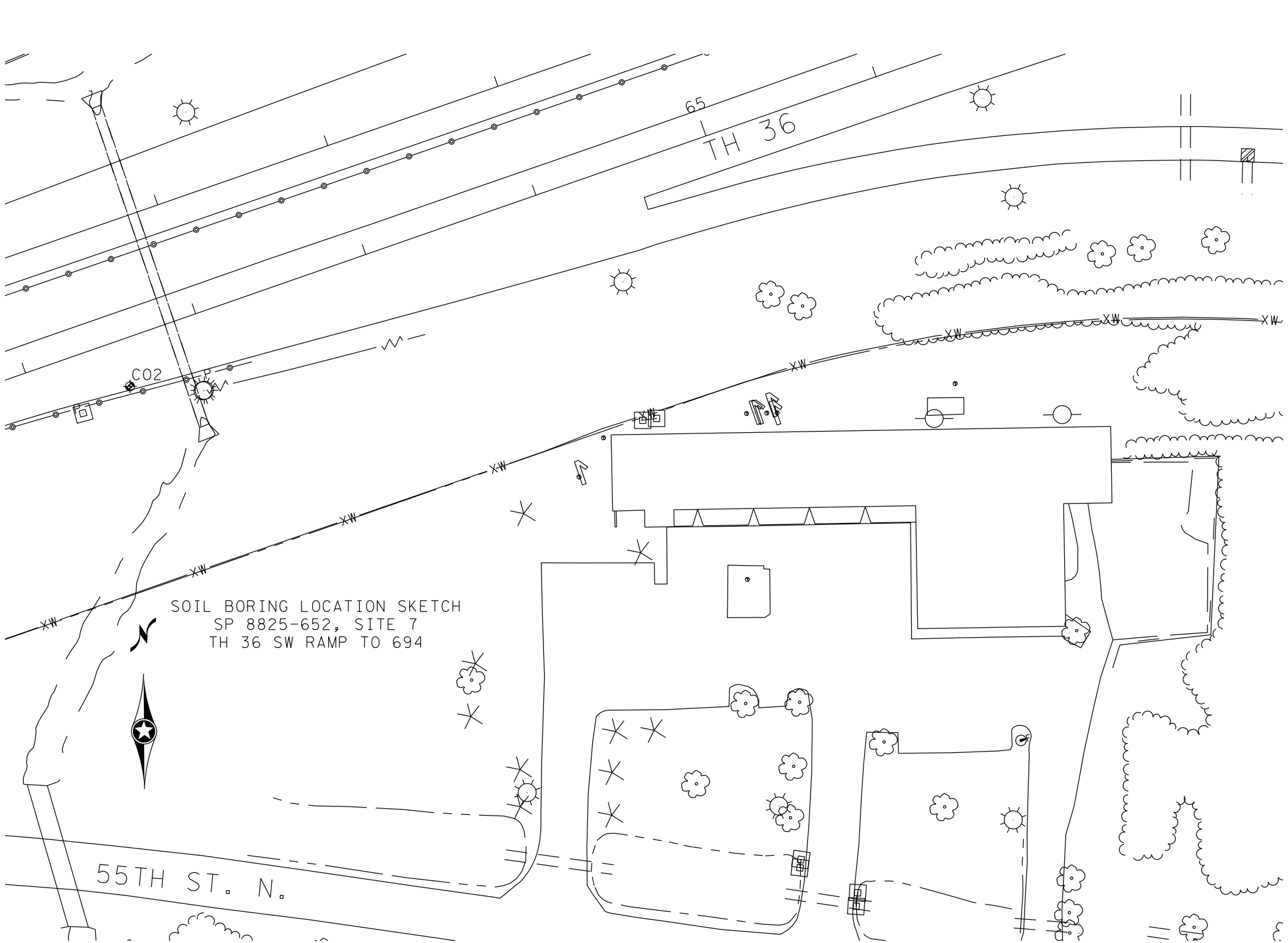
cc: J. Tayse, Signing Engineer
E. Peterson, Metro Signing Design
E. Embacher, Construction Engineer
M. Waters, Environmental Stewardship
B. Skow, Chief Geotechnical Engineer

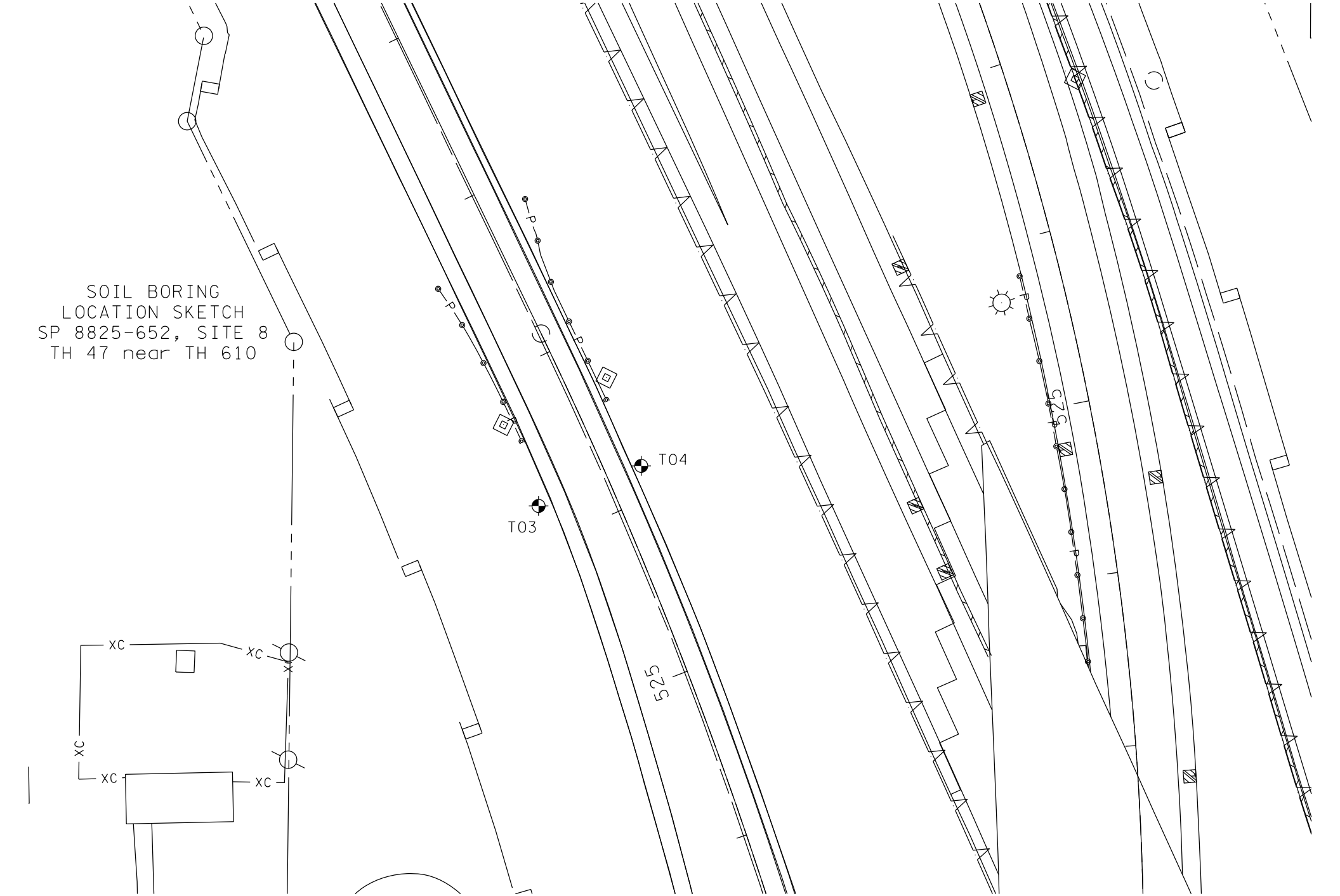


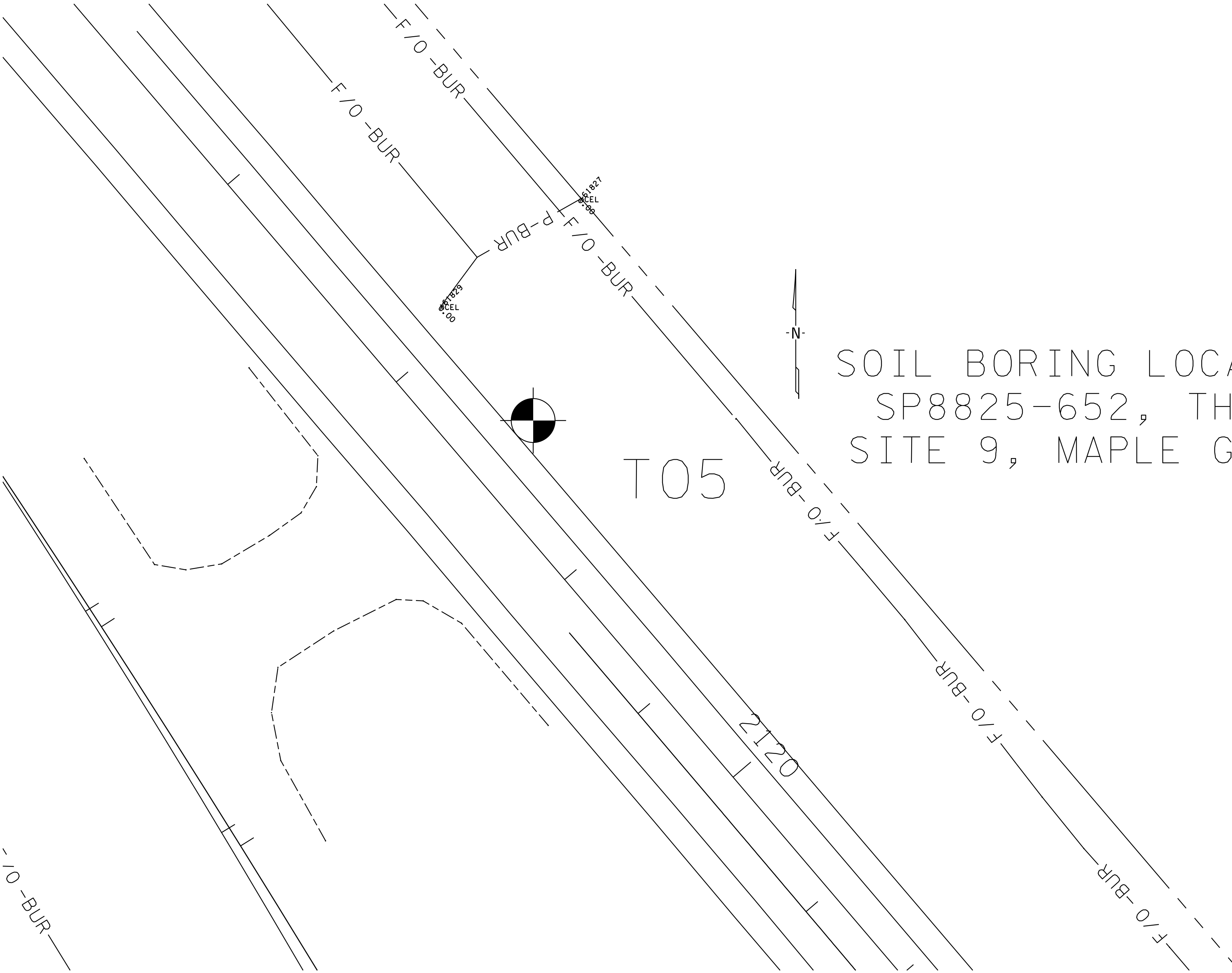
SOIL BORING LOCATION SKETCH
SP 8825-652, SITE 1
TH 7 exit to Baker Rd


OH I35-217
TH35 NB (STA: 1683:00)
SITE 3
GREENHAVEN DR.
MAPLE ISLAND RD.
1685
1685
1681
1681
T05
N
100
SCALE IN FEET
EXIT 88 A
35W
Minneapolis
35E
St Paul
EXIT 87
Crystal Lake Rd
OH I35-153
LEFT
EXIT 88 A
35W
Minneapolis
35E
St Paul
EXIT ONLY
EXIT 87
Crystal Lake Rd
OH I35-217

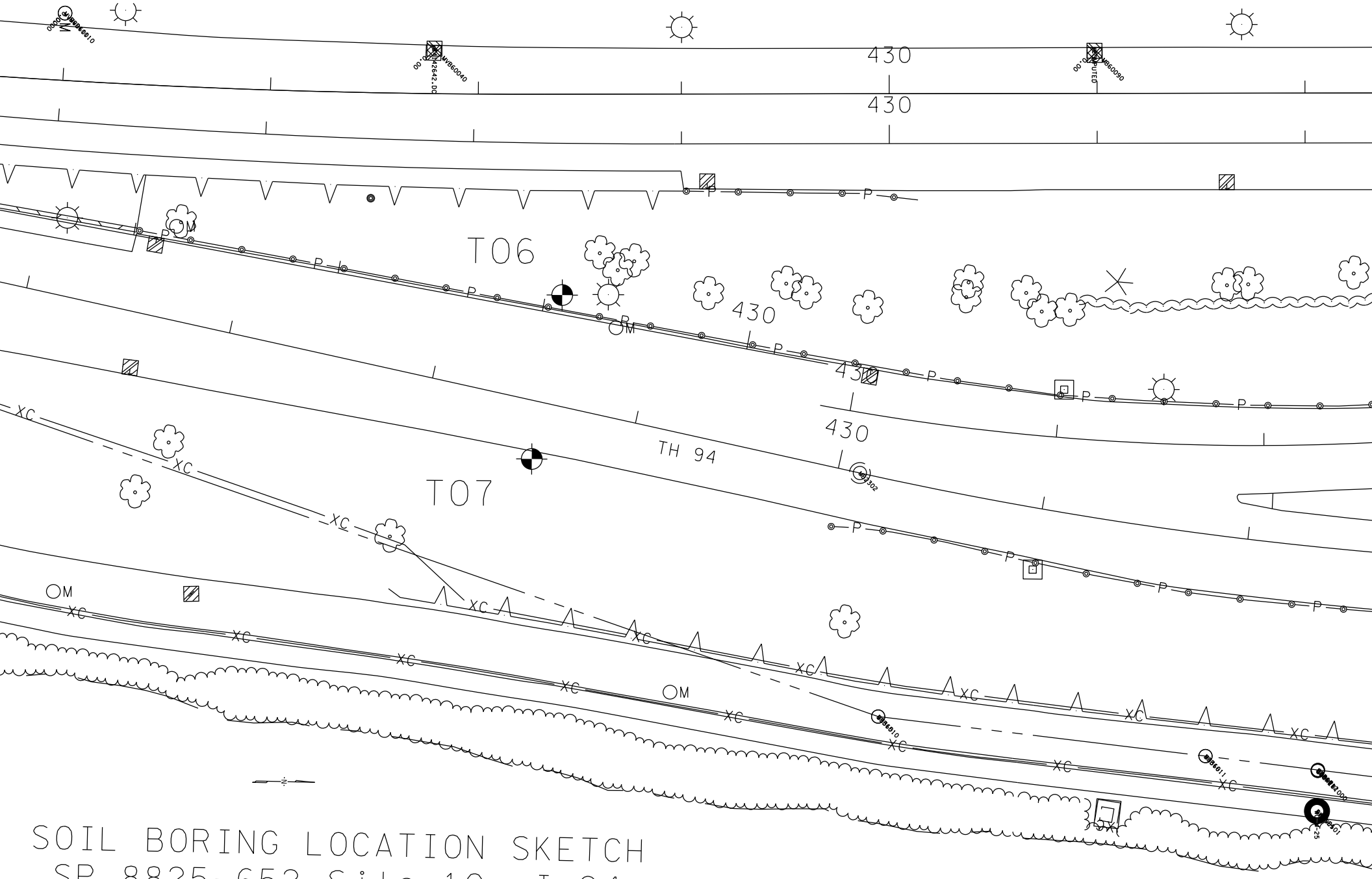

BUCK HILL RD.
I-35E
I-35W
GRAND AVE.
SOUTHCROSS DR.
SOUTHCROSS DR.
SB TH 35
NB TH 35
I-35
1720
1715
90
85
c07
OH I35-218
TH35 NB (STA:1717+15)
SITE 5
EXIT 88 A
35W
Minneapolis
35E
St Paul
OH I35-084
LEFT
EXIT 88 A
35W
Minneapolis
EXIT ONLY
35E
St Paul
SOUTHPOINTE CT.
OH I35-218


SOIL BORING LOCATION SKETCH
SP 8825-652, SITE 7
TH 36 SW RAMP TO 694
N
TH 36
65
CO2
55TH ST. N.

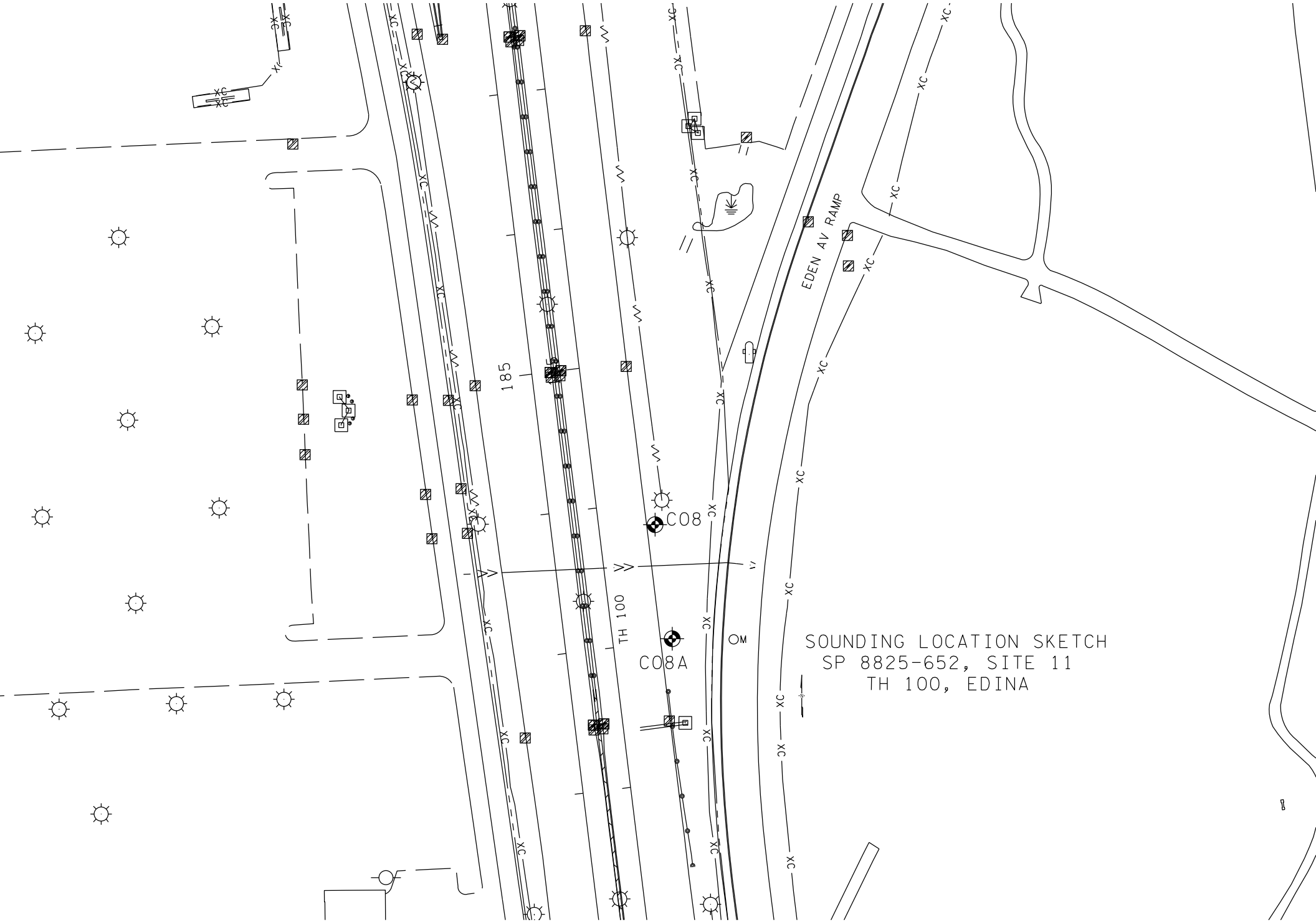

SOIL BORING
LOCATION SKETCH
SP 8825-652, SITE 8
TH 47 near TH 610
T03
T04
525
525
xc
xc
xc
xc
xc



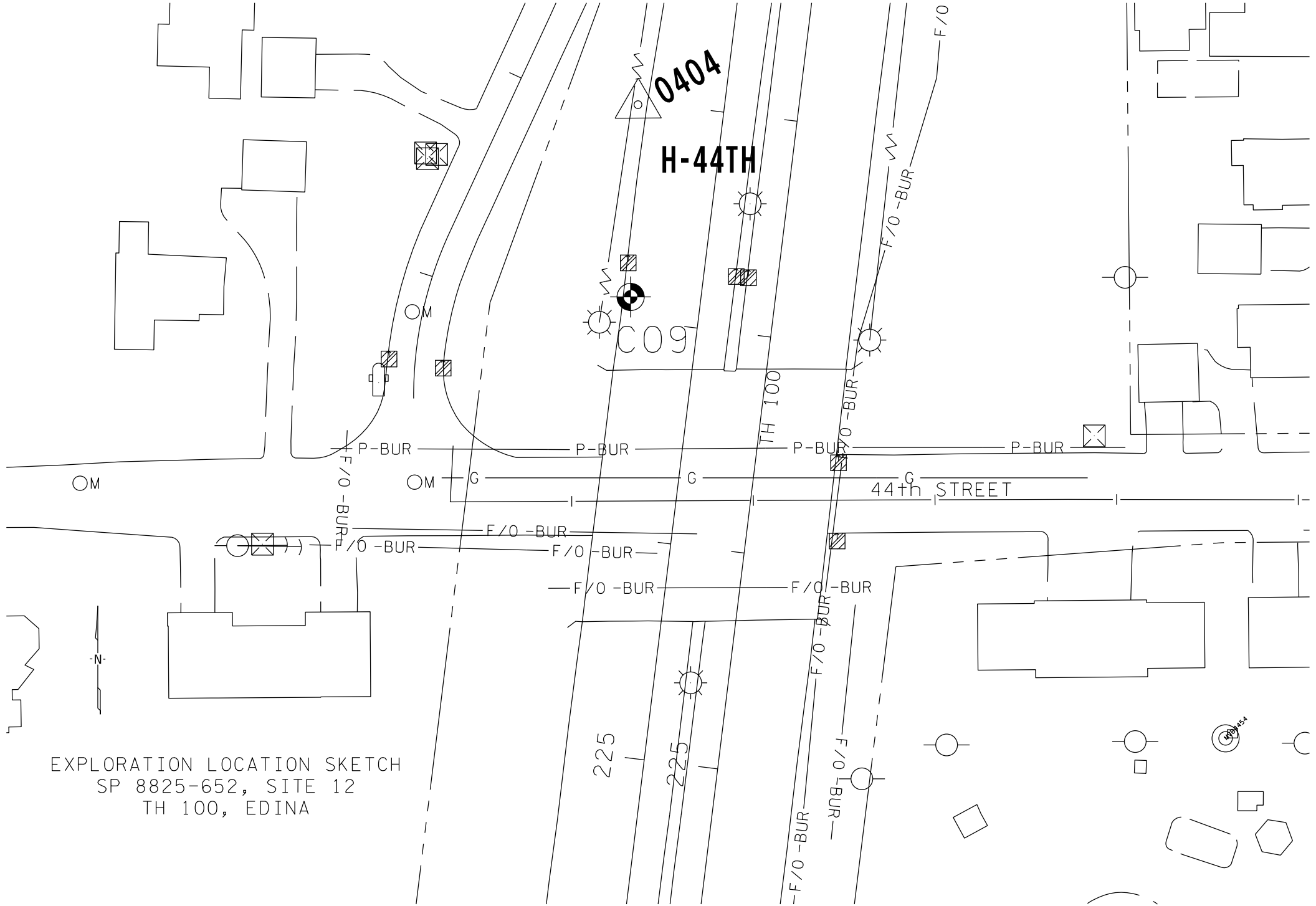
SOIL BORING LOCATION
SP8825-652, TH 94
SITE 9, MAPLE GROVE



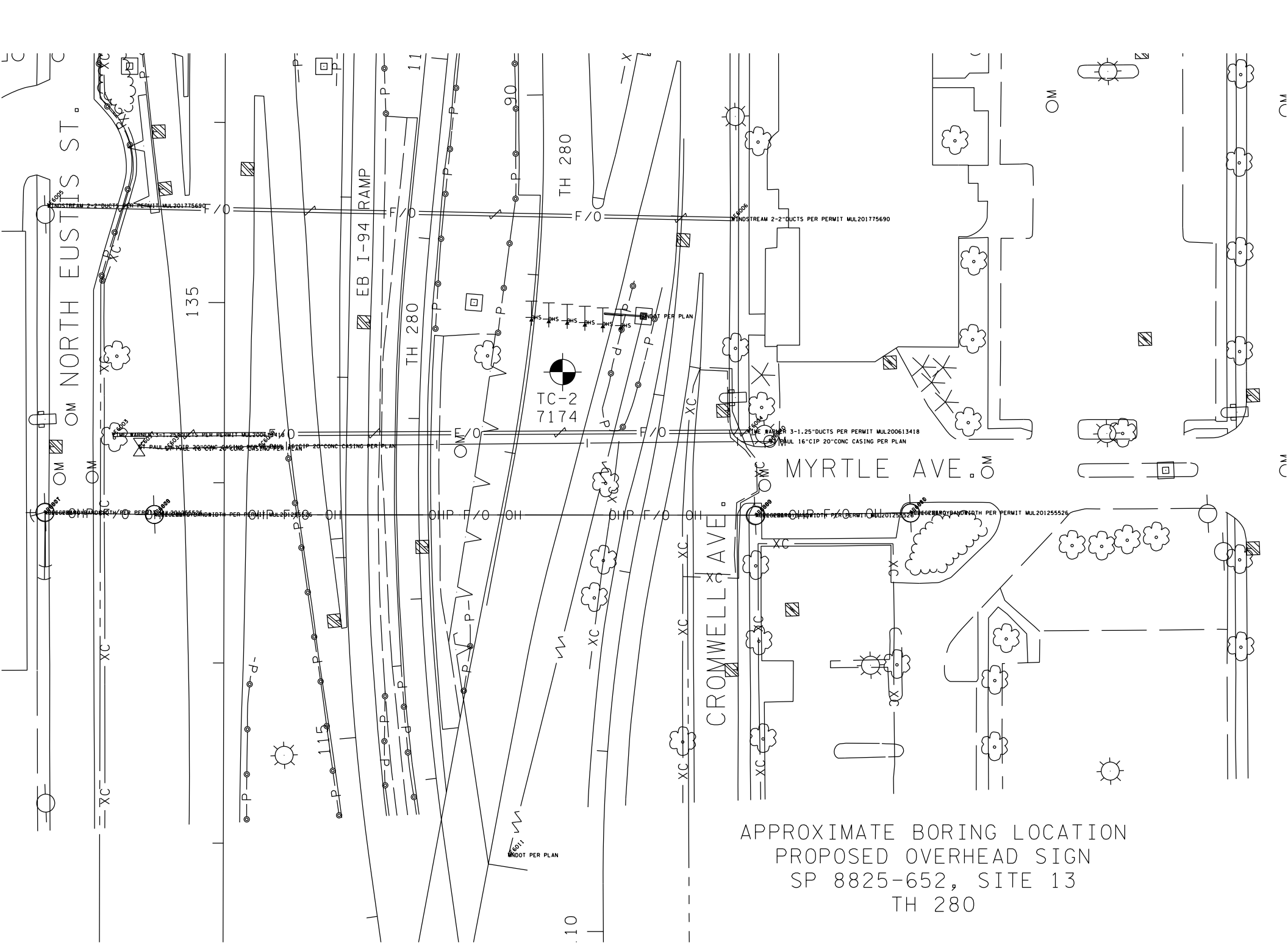
SOIL BORING LOCATION SKETCH
SP 8825-652 Site 10, I-94
Borings T06 and T07



SOUNDING LOCATION SKETCH
SP 8825-652, SITE 11
TH 100, EDINA



EXPLORATION LOCATION SKETCH
SP 8825-652, SITE 12
TH 100, EDINA


NORTH EUSTIS ST.
EB I-94 RAMP
TH 280
MYRTLE AVE.
CROMWELL AVE.
WINDSTREAM 2-2"DUCTS PER PERMIT MUL201775690
PRIME WARNER 3-1.25"DUCTS PER PERMIT MUL200613418
ST PAUL 16"CIP 20"CONC CASING PER PLAN
MNDOT PER PLAN
TC-2
7174
APPROXIMATE BORING LOCATION
PROPOSED OVERHEAD SIGN
SP 8825-652, SITE 13
TH 280

SP 8825-652, Various Metro State Highways, Overhead Sign Foundation Recommendations

Current Plan	ID	Roadway Type	Direction	New Structure Station	Exploration Points	Exploration Locations	Post Locations	Soils	Ground Water	Recommendations
NEW CANTILEVER , SITE 1, TH 7	MN7-001	RAMP	WB	Ramp to NB US Baker Road, STA 311+25, 110' west of existing sign	T01	311+26, 36'Lt	SHOULDER	Sandy Loam and Sand to 9', Clays and Silts to 16.5', then Sandy Loam and Clay Loam with layers of Sand & Gravel.	6.9'	Suitable for Standard Design, but excavations extending below the groundwater surface will likely require support, such as casing and/or drilling fluid.
NEW SIGN BRIDGE SITE 3, TH35	OH I35217	MAINLINE	NB	1683+00 NEAR GREENHAVEN DR.	T05, SP8825-562	1683+06, 41' Rt	SHOULDER MEDIAN	Sands and Sandy Loam with Clay and Silt layers.	Below 979	Suitable for Standard Design
NEW SIGN BRIDGE SITE 5, TH 35	OH I35-218	MAINLINE	NB	1717+15 NEAR SOUTHCROSS DR.	C07, SP8825-562	1717+19, 41' Rt	SHOULDER MEDIAN	Sands with layers of Sandy Loam, Clay and Silt.	- - *	Suitable for Standard Design, but excavations extending below the groundwater surface will likely require support, such as casing and/or drilling fluid.
NEW CANTILEVER, SITE 7, TH 36	MN36-090	RAMP	EB	Ramp to SB TH 694, STA 61+45, 25' east of existing sign	C02	61+52, 26' Rt	SHOULDER	Frozen soils and Sands to 7', layered Silts, Clays and Sands to about 25', Sandy Loam and Sands to 36'	*6.5	Suitable for Standard Design, but excavations extending below the groundwater surface will likely require support, such as casing and/or drilling fluid.
NEW SIGN BRIDGE, SITE 8 TH 47	MN47-004	MAINLINE	SB	TH 47 STA 523+75, 50' south of existing sign	T03 T04	523+79, 43'Rt 523+81, 20'Lt	SHOULDER MEDIAN	Fine and very fine Sands	8.5 11.2	Suitable for Standard Design, but excavations extending below the groundwater surface will likely require support, such as casing and/or drilling fluid.
NEW CANTILEVER, SITE 9, TH 94	I94-688	MAINLINE	WB	2118+30, 30' southeast of existing sign	T05	2118+46, 31' Lt	SHOULDER	Silt Loam to 10', Sandy Loam to 11.5' and Sand & Gravel to 36'	- -	Suitable for Standard Design
NEW SIGN BRIDGE, SITE 10, TH 94	I94-689	MAINLINE	WB	428+50, 250' south of existing sign	T06 T07	428+52, 52'Lt 428+55, 28' Rt	MEDIAN SHOULDER	Sands with Clay and Silt layers.	Below 810	Suitable for Standard Design
NEW CANTILEVER, SITE 11, TH 100	MN100-142	MAINLINE	NB	182+80, 30' north of existing sign	C08a C08	183+01, 42'Rt 183+83, 40'Rt	SHOULDER	Layered Clays, Sands and Silts to 10.5'. Refusal on dense Sand	- -*	Suitable for Standard Design, but excavations extending below the groundwater surface will likely require support, such as casing and/or drilling fluid.
NEW CANTILEVER, SITE 12, TH 100	MN100-143	MAINLINE	SB	227+13, 25' South of existing sign bridge	C09	227+10, 32'Lt	SHOULDER	Sands with Clay and Silt layers to 29.5'. Refusal on dense Sand	- - *	Suitable for Standard Design, but excavations extending below the groundwater surface will likely require support, such as casing and/or drilling fluid.
NEW CANTILEVER, SITE 13, TH 280	MN280-023	MAINLINE	NB	88+60, 25' south of existing sign	TC-2 (1969)	NEAR 88+60	SHOULDER	Sandy Loam to 13', then Sand & Gravel to 34'	25	Suitable for Standard Design, but excavations extending below the groundwater surface will likely require support, such as casing and/or drilling fluid.
								- - Groundwater not indicated	* Perched groundwater layers may occur and may require excavation sidewall support.	

DEPARTMENT OF TRANSPORTATION

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 82770

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8825-652	**OH SIGN MN7-001**	**Various Metro**	**T01**	**1004.4** *(DTM)*

Location Ramsey County Coordinate System
X=484330 Y=149353 *'TH 7 WB, STA 311+26, 36' Lt*
Latitude (North)=44°55'35.22" Longitude (West)=93°26'37.79"

Drill Machine **211304 CME Fat Tire**
Hammer **CME Automatic Calibrated**

SHEET 1 of 1
Drilling Completed **11/15/17**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60}	MC (%)	REC (%)	RQD (%)	COH (psf)	ACL (ft)	γ (pcf)	Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			slightly plastic Sandy Loam with pebbles, brown, moist, medium dense to dense		25	11								a little rough drilling 3.5', 7'
5					41	8								
	6.5 / 997.9		Loamy Sand, gray-brown, saturated, medium dense		25	15								
	9.0 / 995.4													
10			Clay, brown, wet, stiff		13	42								
				PD	12	34								
				PD										
15	15.0 / 989.4		Sandy Clay Loam, browns with IOS, wet, very stiff		19	19								rough drilling at 15.8'
	16.5 / 987.9		Silty Clay Loam, browns with IOS, wet, very stiff	PD										
	17.5 / 986.9		Loamy Sand and Gravel, browns with IOS, moist, medium dense		25	33 / 10								
	19.0 / 985.4			PD										
20			Sandy Clay Loam with pebbles, brown, wet, very stiff		27	20								
	21.5 / 982.9			PD										rough drilling at 21.5'
					39	17								
				PD										
25					37	11								
				PD										
			slightly plastic Sandy Loam with a few pebbles and a seam of Loamy Sand and Gravel at 23.5', browns, wet, dense		34	14								
				PD										
30					35	13								
				PD										
					34	10								
				PD										
35	36.0 / 968.4		Bottom of Hole - 36.0'		31	11								
			Water measured at 6.9' with auger											

Field Crew Chief: O'Donnel, Pat Soil Class:JAH Rock Class: Edit: Date: 12/12/17

G:\GINT\PROJECTS-ACTIVE\8825-652-METRO DISTRICT-OVERHEAD SIGNS.GPJ

DEPARTMENT OF TRANSPORTATION

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 82035

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8825-562	**OH I35-217**	**Interstate Highway TH 10 & 35 & 94**	**T05**	**1011.0** *(DTM)*

Location Dakota County Coordinate System
X=508973 Y=193060 *I35 NB STA 1683+06, 41' Rt*
Latitude (North)=44°43'37.85" Longitude (West)=93°16'55.72"

Drill Machine **209332 GeoProbe**
Hammer **GeoProbe Automatic**

SHEET 1 of 1
Drilling Completed **5/17/17**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	0.5 1010.5		Topsoil with roots, dark-brown, moist		15	33				
			Medium-Grained Sand, brown, damp, medium dense to loose		14	3				
5					8	4				
	7.0 1004.0				6	4				
10					10	9				
			Fine-Grained Sand, brown, damp, loose to very loose		2	8				
15					12	9				
					14	7				
20					10	6				
	22.0 989.0				12	5				rough drilling 22.0'-27.0'
25			Medium-Grained Sand with some Gravel, brown, damp, loose to medium dense		7	4				
					9	3				
30					11	8				
	31.5 979.5		Bottom of Hole -31.5' No water encountered or measured during drilling							

Field Crew Chief: Buhl, Dylan Soil Class:JAH Rock Class: Edit: Date: 12/18/17
G:\GINT\PROJECTS-ACTIVE\8825-562- OVERHEAD SIGN (TH 10 & 35W & 94).GPJ

DEPARTMENT OF TRANSPORTATION

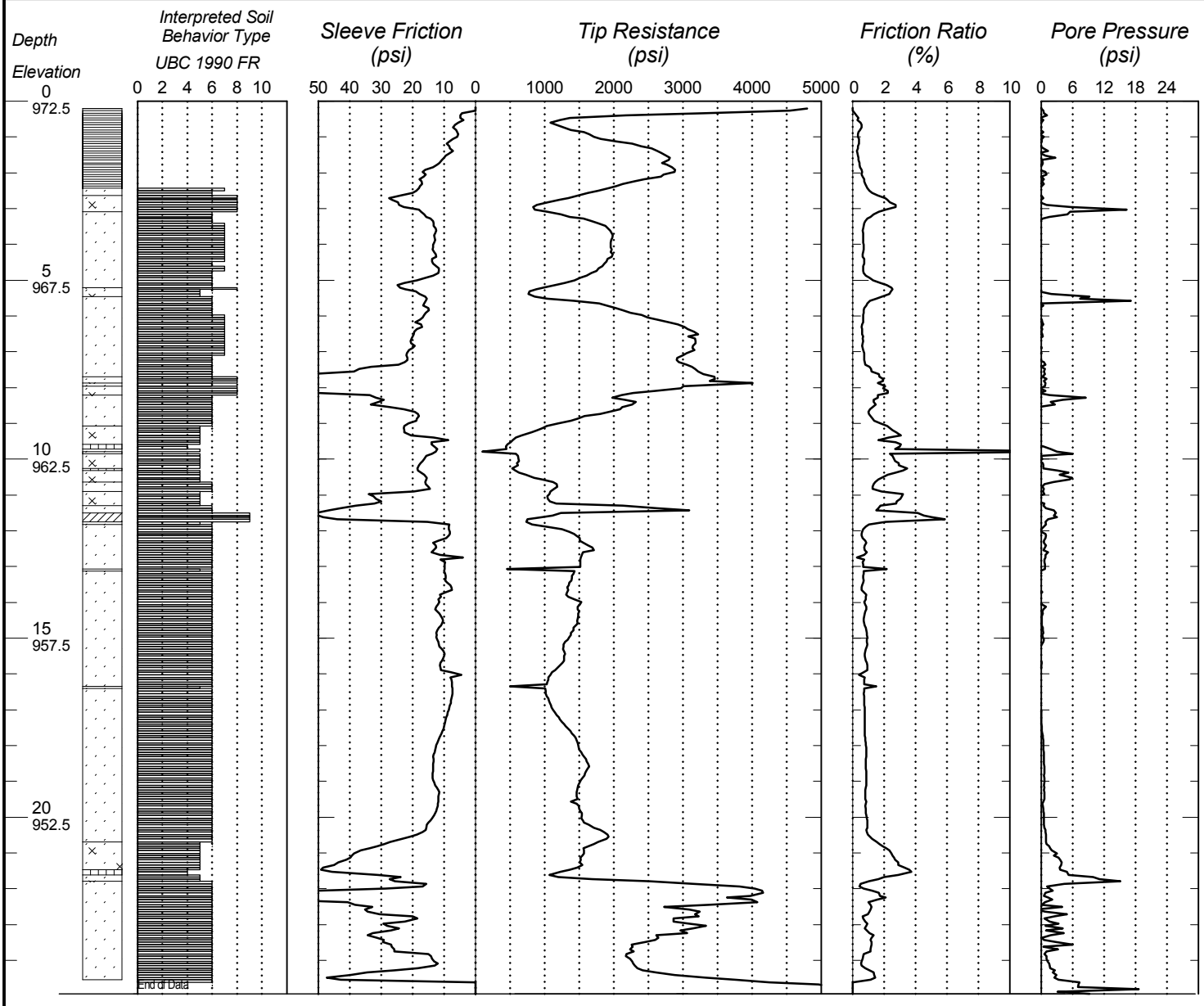
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 82536

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-562	**OH I35-218**	**TH 10 & 35 & 94**	**c07**	**972.5** *(DTM)*

Location	CPT Machine	SHEET 1 of 1
Dakota County Coordinate System	**203094 CPT Truck**	
X=508728 Y=196508 *I35 NB STA 1717+19, 41' Rt*	*CPT Operator* **Buhl, Dylan**	*Date Completed*
Latitude (North)=44°44'11.90" *Longitude (West)=93°16'59.10"*	*Hole Type* **CPT-STD**	**6/13/17**



Bottom of Hole 24.94

G:\GINT\PROJECTS-ACTIVE\8825-562- OVERHEAD SIGN (TH 10 & 35W & 94).GPJ

DEPARTMENT OF TRANSPORTATION

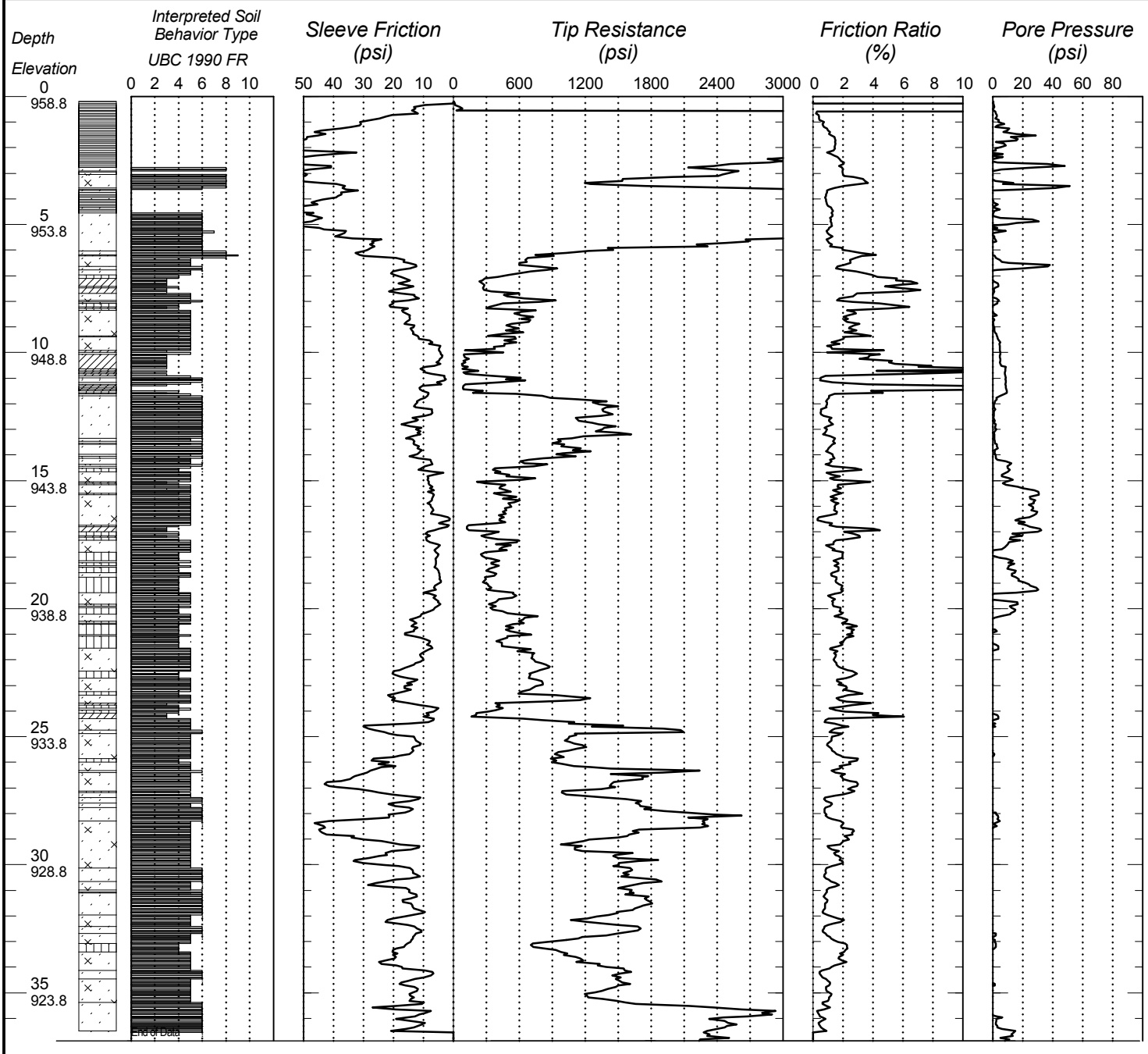
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 82817

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-652	**OH SIGN MN36-090**	**Various Metro**	**C02**	**958.8** *(GeoXH (DC))*

Location Ramsey County Coordinate System	*CPT Machine* **203094 CPT Truck**	*SHEET 1 of 1*
X=607466 Y=186737 *'TH 36, STA 61+52, 26' Rt*	*CPT Operator* **ODonnel**	*Date Completed*
Latitude (North)=45°01'41.67" Longitude (West)=92°58'03.75"	*Hole Type* **CPT-STD**	**12/7/17**



Bottom of Hole 36.88

G:\GINT\PROJECTS-ACTIVE\8825-652-METRO DISTRICT-OVERHEAD SIGNS.GPJ

DEPARTMENT OF TRANSPORTATION

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 82713

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8825-652	**OH SIGN MN47-004 SB**	**Various Metro**	**T03**	**894.3** *(DTM)*

Location Ramsey County Coordinate System
X=528915 Y=229792 *'TH 47 SB, STA 523+79, 43'Rt*
Latitude (North)=45°08'49.28" Longitude (West)=93°16'16.59"

Drill Machine **211304 CME Fat Tire**
Hammer **CME Automatic Calibrated**

SHEET 1 of 1
Drilling Completed **10/24/17**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} (%)	MC (%)	COH (psf)	γ (pcf)	Soil / Rock	Other Tests Or Remarks / Formation or Member
					REC (%)	RQD (%)	ACL (ft)	Core Breaks		
5			Fine Sand, brown with IOS at 8', moist to saturated, medium dense to dense		18	9				
					12	17				
					13	21				
10					27	20				
				PD	41	19				
	14.0 / 880.3			PD	33	25				
15			Very Fine Sand, brown, saturated, dense	PD	29	24				
	16.5 / 877.8			PD	15	24				
20				PD	22	17				
				PD	67	22				
25			Fine Sand, browns, saturated, medium dense to very dense	PD	85	21				
				PD	77	21				
30				PD	72	20				
				PD	73	22				
35	36.0 / 858.3		Bottom of Hole - 36.0'							

Water measured at 8.5' with auger

Field Crew Chief: O'Donnel, Pat Soil Class:JAH Rock Class: Edit: Date: 12/12/17

G:\GINT\PROJECTS-ACTIVE\8825-652-METRO DISTRICT-OVERHEAD SIGNS.GPJ

DEPARTMENT OF TRANSPORTATION

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 82714

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8825-652	**OH SIGN MN47-004 NB**	**Various Metro**	**T04**	**896.9** *(DTM)*

Location Ramsey County Coordinate System
X=528974 Y=229815 *'TH 47 SB, STA 523+81, 20'Lt*
Latitude (North)=45°08'49.51" Longitude (West)=93°16'15.76"

Drill Machine **211304 CME Fat Tire**
Hammer **CME Automatic Calibrated**

SHEET 1 of 1
Drilling Completed **10/25/17**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	4.0 / 892.9		Fine Sand, brown, moist, loose		7	7				
5	6.5 / 890.4		Loamy Fine Sand, dark-brown, moist, very loose		3	12				
			Fine Sand, browns, moist to saturated, medium dense to dense		24	11				
10 ▼	11.5 / 885.4				31	17				
			Very Fine Sand, gray-brown, saturated, medium dense		19	26				
15	16.5 / 880.4				25	24				
				PD	22	24				
20				PD	29	24				
				PD	29	25				
25			Fine Sand, browns, saturated, medium dense to very dense	PD	15	24				
				PD	42	22				
30				PD	56	23				
				PD	50	22				
35	36.0 / 860.9		Bottom of Hole - 36.0'	PD	66	23				

Water measured at 11.2' with auger

Field Crew Chief: O'Donnel, Pat Soil Class:JAH Rock Class: Edit: Date: 12/12/17

G:\GINT\PROJECTS-ACTIVE\8825-652-METRO DISTRICT-OVERHEAD SIGNS.GPJ

DEPARTMENT OF TRANSPORTATION

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 82769

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8825-652	**OH SIGN I-94-688**	**Various Metro**	**T05**	**935.3** *(DTM)*

Location Ramsey County Coordinate System
X=482615 Y=211587 *'TH 94 EB STA 2118+46, 31' Lt*
Latitude (North)=45°05'49.67" Longitude (West)=93°27'02.34"

Drill Machine **211304 CME Fat Tire**
Hammer **CME Automatic Calibrated**

SHEET 1 of 1
Drilling Completed **11/14/17**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
5			slightly plastic Silt Loam, browns, moist, stiff to very stiff		15	18				
					25	19				
					33	15				
10	10.0 / 925.3				31	13				
	11.5 / 923.8		slightly plastic Sandy Loam with some Gravel, brown, moist, very stiff		40	8				a little rougher drilling 11.5' to 36'
15			Loamy Sand and Gravel, dark-browns, moist, dense		35	6				
					48	4				
	19.0 / 916.3				20	2				
20					24	2				
25					29	1				
			Sand and Gravel, brown, damp to dry, dense		31	1				
30					30	1				
					39	1				
35	36.0 / 899.3		Bottom of Hole - 36.0'		39	1				

No water encountered or measured during drilling

Field Crew Chief: O'Donnel, Pat Soil Class:JAH Rock Class: Edit: Date: 12/12/17

G:\GINT\PROJECTS-ACTIVE\8825-652-METRO DISTRICT-OVERHEAD SIGNS.GPJ

DEPARTMENT OF TRANSPORTATION

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 82715

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8825-652	**OH SIGN I94-689**	**Various Metro**	**T06**	**841.2** *(DTM)*

Location Ramsey County Coordinate System
X=525191 Y=199719 *'TH 94 WB, STA 428+52, 52'Lt*
Latitude (North)=45°03'52.41" Longitude (West)=93°17'09.05"

Drill Machine **211304 CME Fat Tire**
Hammer **CME Automatic Calibrated**

SHEET 1 of 1
Drilling Completed **10/26/17**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			Loamy Sand with a little Gravel, dark-brown, moist, medium dense		23	7				
	4.0 / 837.2									
5			Clay Loam, brown with IOS, moist, stiff		12	15				
	6.5 / 834.7									
			slightly organic slightly plastic Silt Loam, dark-brown, moist, firm		8	19				
	9.0 / 832.2									
10			Medium-Grained Sand with a little Gravel, brown, moist, medium dense		13	6				
	11.5 / 829.7									
					23	5				a little rough drilling 11.5' - 19'
15			Sand and Gravel, browns, moist to wet, medium dense to loose		14	7				
					7	8				
	19.0 / 822.2									
20					11	17				
					13	17				
25			Sandy Clay with a few pebbles, gray, moist, stiff		11	17				
					10	15				
30					10	16				
	31.5 / 809.7									
			plastic Sandy Loam, brown, wet, stiff to very stiff		9	14				
35					17	16				
	36.0 / 805.2		Bottom of Hole - 36.0'							

No water encountered or measured during drilling

Field Crew Chief: O'Donnel, Pat Soil Class:JAH Rock Class: Edit: Date: 12/12/17

G:\GINT\PROJECTS-ACTIVE\8825-652-METRO DISTRICT-OVERHEAD SIGNS.GPJ

DEPARTMENT OF TRANSPORTATION

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 82716

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8825-652	**OH SIGN I94-689**	**Various Metro**	**T07**	**842.3** *(DTM)*

Location Ramsey County Coordinate System
X=525270 Y=199704 *'TH 94 WB, STA 428+55, 28'Rt*
Latitude (North)=45°03'52.27" Longitude (West)=93°17'07.94"

Drill Machine **211304 CME Fat Tire**
Hammer **CME Automatic Calibrated**

SHEET 1 of 1
Drilling Completed **10/26/17**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
5	6.5 / 835.8		Loamy Sand with a little Gravel, browns, moist, dense		31	6				
					41	7				
10	11.5 / 830.8		slightly plastic Sandy Loam with a few pebbles, brown, moist, very stiff		22	12				
					18	13				
	13.0 / 829.3		organic Loam, black, moist, stiff		14	13				
15	14.0 / 828.3		Sand with a seam of organic Loam, brown, moist, medium dense Loamy Fine Sand, dark-brown, moist, loose		8	14				
	16.5 / 825.8				11	4				
20	21.5 / 820.8		Medium-Grained Sand, brown, moist, medium dense		21	5				
					11	18				
25			Sandy Clay with a few pebbles, gray, moist, firm to stiff		11	17				
					10	17				
30	31.5 / 810.8				6	18				
					6	16				
35	36.5 / 805.8		plastic Sandy Loam, brown, wet, firm		7	16				
					10	19				
40	41.0 / 801.3		Silty Clay, brown, moist, stiff to very stiff Bottom of Hole - 41.0' No water encountered or measured during drilling		22	20				

Field Crew Chief: O'Donnel, Pat Soil Class:JAH Rock Class: Edit: Date: 12/12/17
G:\GINT\PROJECTS-ACTIVE\8825-652-METRO DISTRICT-OVERHEAD SIGNS.GPJ

DEPARTMENT OF TRANSPORTATION

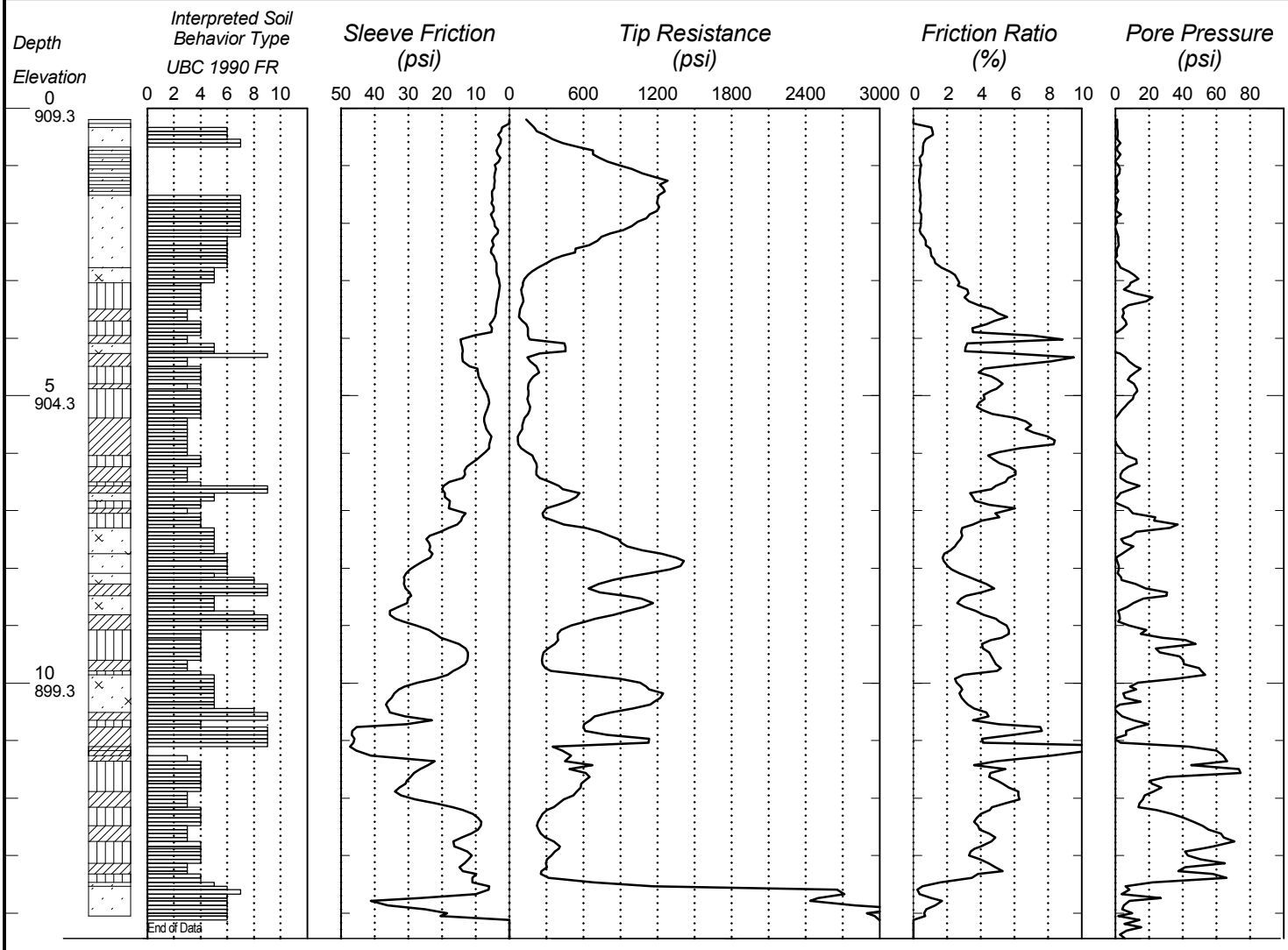
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 82796

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-652	**OH SIGN MN100-142**	**Various Metro**	**C08**	**909.3** *(DTM)*

Location		CPT Machine	SHEET 1 of 1
Ramsey County Coordinate System		**203094 CPT Truck**	
X=508631 Y=142329 *'TH 100 NB, STA 183+83, 40' Rt*		CPT Operator **ODonnel**	Date Completed
Latitude (North)=44°54'25.92" *Longitude (West)=93°21'00.08"*		Hole Type **CPT-STD**	**11/29/17**



Bottom of Hole 14.44

DEPARTMENT OF TRANSPORTATION

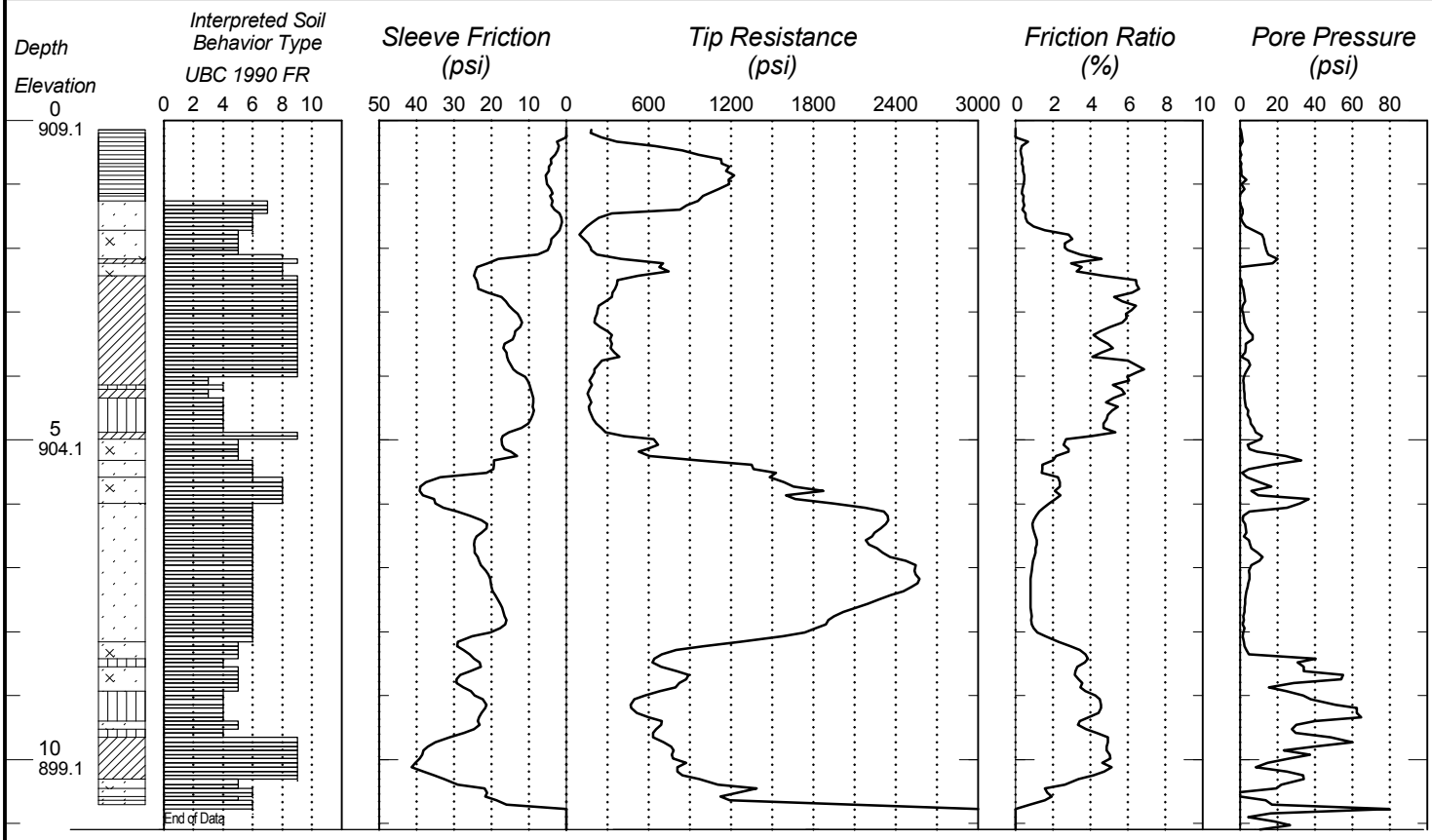
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 82824

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-652	**OH SIGN MN100-142**	**Various Metro**	**C08a**	**909.1** *(DTM)*

Location	CPT Machine	SHEET 1 of 1
Ramsey County Coordinate System	**203094 CPT Truck**	
X=508644 Y=142248 *'TH 100 NB, STA 183+01, 42' Rt*	*CPT Operator* **ODonnel**	*Date Completed*
Latitude (North)=44°54'25.12" *Longitude (West)=93°20'59.91"*	*Hole Type* **CPT-STD**	**11/29/17**



Bottom of Hole 11.09

DEPARTMENT OF TRANSPORTATION

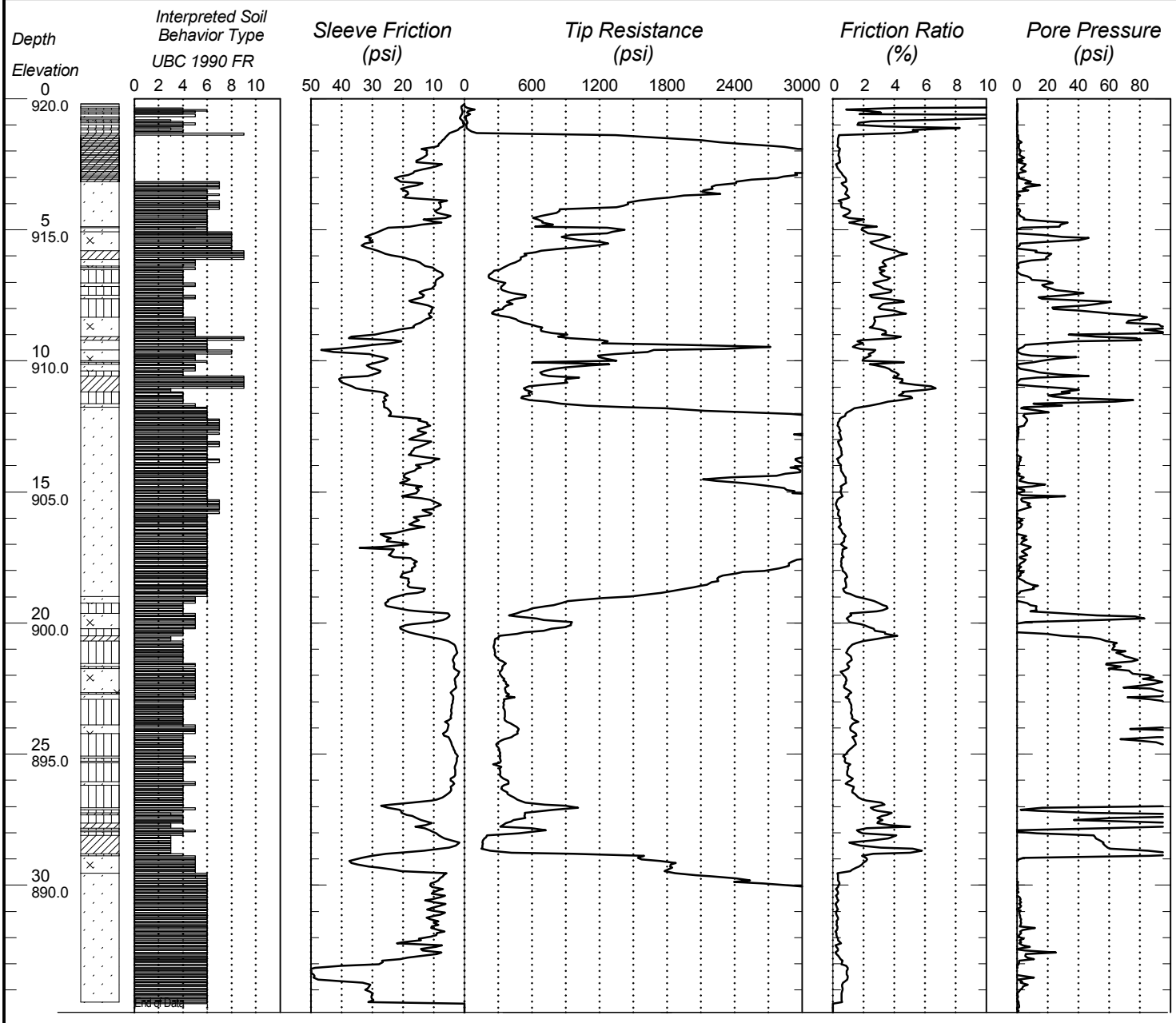
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 82818

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-652	**OH SIGN MN 100-143**	**Various Metro**	**C09**	**920.0** *(DTM)*

Location		CPT Machine	SHEET 1 of 1
Ramsey County Coordinate System		**203094 CPT Truck**	
X=508661 Y=146637 *'TH 100 SB, STA 227+10, 32' Lt*		CPT Operator **ODonnel**	Date Completed
Latitude (North)=44°55'08.45" *Longitude (West)=93°20'59.65"*		Hole Type **CPT-STD**	**12/7/17**



Bottom of Hole 34.85

G:\GINT\PROJECTS-ACTIVE\8825-652-METRO DISTRICT-OVERHEAD SIGNS.GPJ

DEPARTMENT OF TRANSPORTATION

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 7174

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8825-652	**OH SIGN MN280-023**	**Various Metro**	**TC-2 (1969)**	**877.0** *(from Plan)*

Location: Ramsey County Coordinate System
X= Y= *'SP 6242-41, STA 135+25, 20' Lt*
Latitude (North)= Longitude (West)=

Drill Machine: **Soil Sampler**
Hammer: **Rope & Cathead**

SHEET 1 of 1
Drilling Completed: **4/9/69**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} (%) REC	MC (%) RQD	COH (psf) ACL	γ (pcf) Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	2.0 / 875.0		organic Loam, black, moist		11					
5			plastic Sandy Loam, brown, moist, stiff to very stiff		11					
					16					
10					16					
					32					
	13.0 / 864.0				24					
15					20					
					21					
20					22					
			Sand & Gravel, light brown, moist to saturated, medium dense to dense		36					
▼25					27					
					39					
30					30					
	34.0 / 843.0		Bottom of Hole - 34' Water measured at 25' with auger		75					Stone in sampler tip.

Field Crew Chief: C. Thomsen Soil Class:Thomsen Rock Class: Edit: Date: 12/13/17

G:\GINT\PROJECTS-ACTIVE\8825-652-METRO DISTRICT-OVERHEAD SIGNS.GPJ

Minnesota Department of Transportation
Geotechnical Section
BORING LOG DESCRIPTIVE TERMINOLOGY

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.

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

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 (3" Shelby Tube)
WS ..... Wash Sample
AB ..... After Bailing
NSR ..... No Sample Retrieved
WH ..... Weight of Hammer
WR ..... Weight of Rod
Mud ..... Drilling Fluids in Sample
CS ..... Continuous Sample

MISCELLANEOUS

NA ..... Not Applicable
w/ ..... with
w/o ..... with out
sat ..... saturated

SOIL CORE TESTS

SPT N_{60} .....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 (equivalent to 1/2 Unconfined Compression Strength)
γ ..... Sample Unit Weight
LL ..... Liquid Limit
PI ..... Plasticity Index
ϕ ..... Angle of Internal Friction
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.

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

RELATIVE DENSITY

Compactness – Granular Soils	BPF
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
brn ..... Brown
orng ... Orange
grn ..... Green
IOS .... Iron Oxide Stained
wht .... White
yel ..... Yellow
lt ..... Light
dk ..... dark
gr ..... Grey

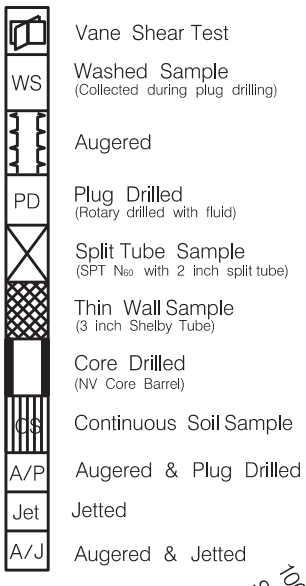
GRAIN SIZE /PLASTICITY

VF ... Very Fine
F ..... Fine
Cr. .... Coarse
pl ..... Plastic
slpl ... Slightly Plastic

SOIL /ROCK TERMS

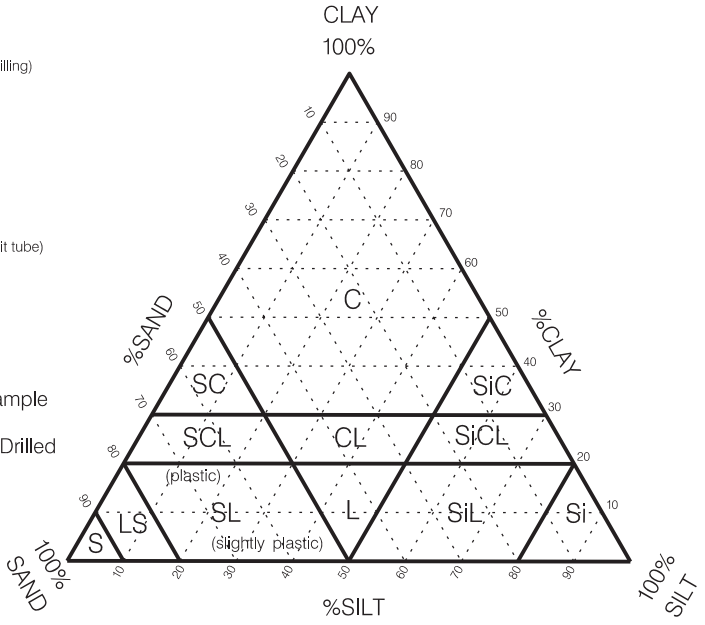
C ... Clay
L ..... Loam
S .... Sand
Si ..... Silt
Lmst ... Limestone
Sst ..... Sandstone
Dolo ... Dolostone
wx ..... weathered
G ... Gravel (No. 10 Sieve to 3 in.)
Bldr ... Boulder (over 3 inches dia.)
T ... till (unsorted, nonstratified glacial deposits)

DRILLING SYMBOLS

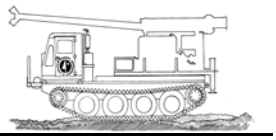


Vane Shear Test
Washed Sample (Collected during plug drilling)
Augered
Plug Drilled (Rotary drilled with fluid)
Split Tube Sample (SPT N_{60} with 2 inch split tube)
Thin Wall Sample (3 inch Shelby Tube)
Core Drilled (NV Core Barrel)
Continuous Soil Sample
Augered & Plug Drilled
Jetted
Augered & Jetted

MnDOT Triangular Textural Classification System



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)

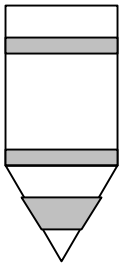
q_T TIP RESISTANCE
The resistance at the cone corrected for water pressure. Data is from cone with 60 degree apex angle and a 10 cm^2 end area.

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.

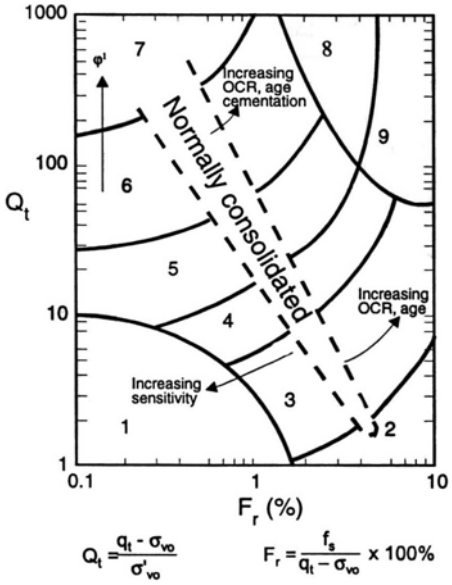
The numbers corresponding to different regions on the charts represent the following soil behavior types:

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.

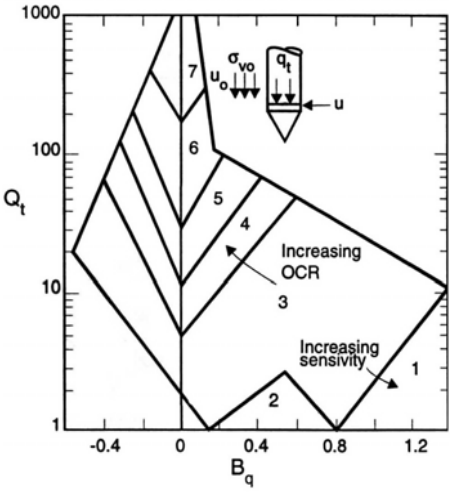
The following charts are used to provide a Soil Behavior Type for the CPT Data.

Robertson CPT 1990
Soil Behavior type based on friction ratio



$$Q_t = \frac{q_t - \sigma_{vo}}{\sigma'_{vo}} \qquad F_r = \frac{f_s}{q_t - \sigma_{vo}} \times 100\%$$

Robertson CPTU 1990
Soil Behavior type based on pore pressure



$$Q_t = \frac{q_t - \sigma_{vo}}{\sigma'_{vo}} \qquad B_q = \frac{u_2 - u_o}{q_t - \sigma_{vo}}$$

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