DEPARTMENT OF TRANSPORTATION

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

# Addendum

**Date:** December 11, 2018

**To:** Eric Peterson, Metro District Signing Engineer
Metro District

**From:** Daniel Freiburger, Graduate Engineer – Trainee
Geotechnical Engineering Section

**Concur:** Rich Lamb, Foundations Engineer
Geotechnical Engineering Section

**Subject:** State Project 8825-682 (Metro District)
Metrowide Overhead Sign Structure Replacement
Foundation Investigation and Recommendations Addendum (Site 9)

## 1.0 Project Information

State Project 8825-682 will replace a number of overhead sign structures on multiple trunk highways throughout the Twin Cities metro area. A Foundation Investigation and Recommendations (FIR) report was sent on December 3 providing subsurface investigation information and recommendations for 13 of the 14 sites requiring new foundations. The initial CPT investigation at Site 9, TH 94 Eastbound at 33rd / 34th Avenues, met refusal as a shallow depth. For this reason, an additional SPT boring was required, but was not finished at the time of the first report. This addendum provides the findings and recommendations with the information from the now complete additional SPT boring.

## 2.0 Subsurface Investigation Summary

The MnDOT Foundations Unit conducted Cone Penetration Test (CPT) Soundings at the Site 9 proposed sign structure location in October of 2018. The Soundings encountered 9.5’ of material that behaved as sand, and then met refusal. To determine the stratigraphy underlying this depth, a Standard Penetration Test (SPT) Boring was made at this site in December of 2018. This boring encountered about 5’ of sand and gravel, followed by deep layer of St. Peter sandstone, beginning at an elevation of 839.0. The sandstone had very high SPT N60 values, and was very poorly cemented, very fine to medium grained, and had well rounded and frosted quartz grains. The water table was estimated to be about 35’ deep. Full details of the subsurface investigation at this site can be found in the drawings and logs attached to this report.

## 3.0 Foundation Analysis

Section 3 in the initial FIR report provided a detailed description of the standard foundation types that MnDOT uses for overhead signs. At Site 9, due to the presence of shallow bedrock, a modified drilled shaft design is recommended. The standard 4’ diameter shaft can be used, but constructing the standard 29’ length shaft at this location is an unnecessary undertaking. To determine an appropriate shaft embedment, a lateral pile analysis was conducted using *LPILE* (Ensoft, Inc.). Using service loads provided by the Bridge Office, different

drilled shaft lengths were investigated to minimize top deflection. It was determined that a drilled shaft extending 5' into the bedrock, with the bottom of the shaft around an elevation of 834.0, would provide a satisfactory foundation while limiting the required amount of bedrock excavation. The shaft excavation is not expected to require temporary casing, due to the estimated depth of groundwater being well below the shaft length. However, perched groundwater above the bedrock may require special attention in the field.

## 4.0 Foundation Recommendations

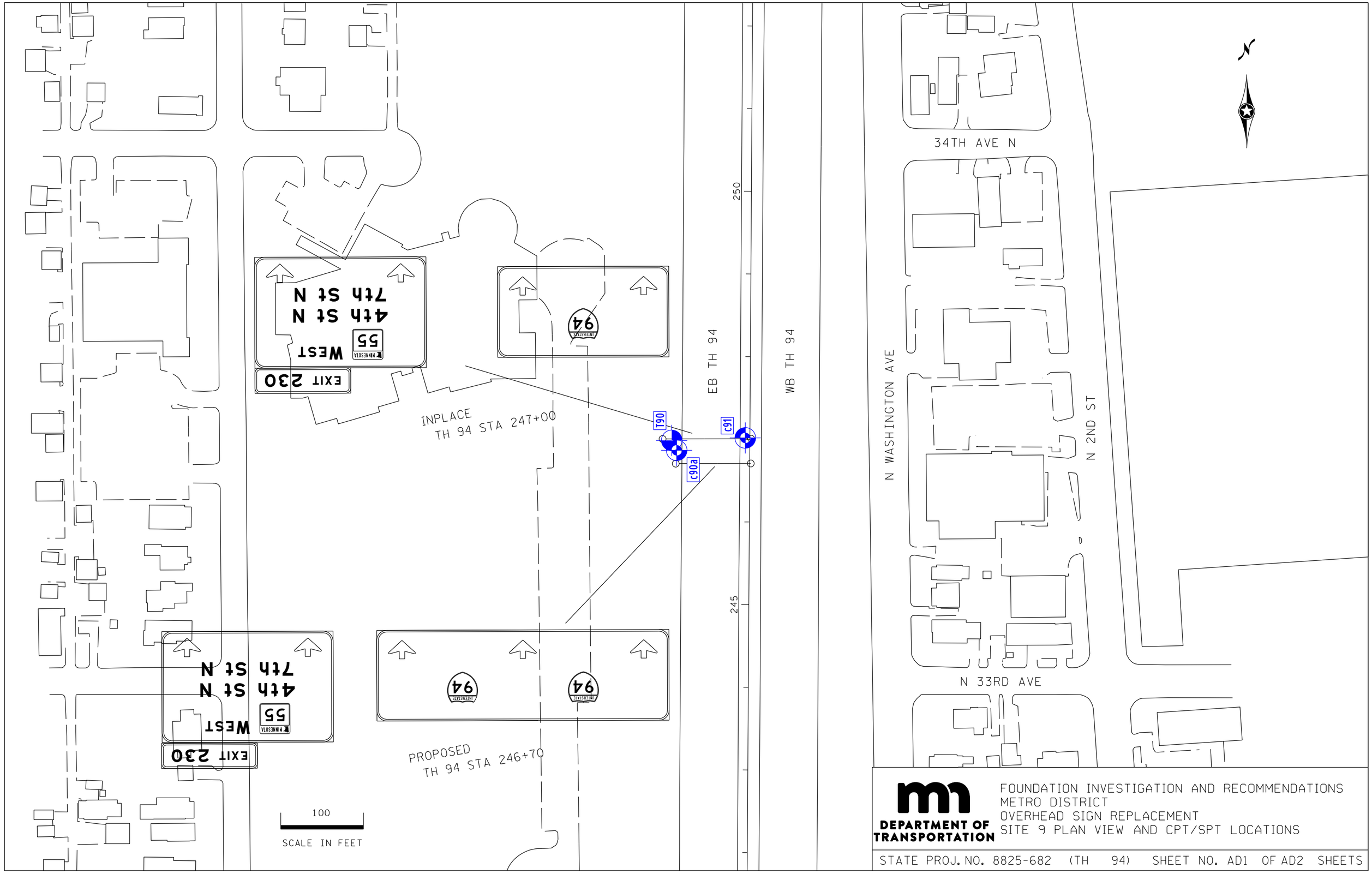
Based on review of the existing subsurface conditions and proposed construction, it is recommended that:

1) The proposed overhead sign structure at Site 9 be supported on modified drilled shaft foundations as detailed in Drawing ST-3 for Standard Overhead Sign Interim Design B and described in Section 3.0 above.
2) Subsurface information from this investigation and report be provided to the bidding contractors so that the scope of foundation construction can be clearly understood prior to project letting.
3) The Foundations Office be contacted if the soils encountered during construction differ significantly from those described in this report.

## 5.0 Attachments

Plan View of Site 9 Sign Location and Subsurface Investigation Sites
Cross Section of Site 9 Sign Structure and CPT/SPT Findings
CPT Index Sheet
CPT Logs for Soundings c90a-c91 (Unique No. 83502-83503)
SPT Index Sheet
SPT Log for Boring T-90 (Unique Number 83616)

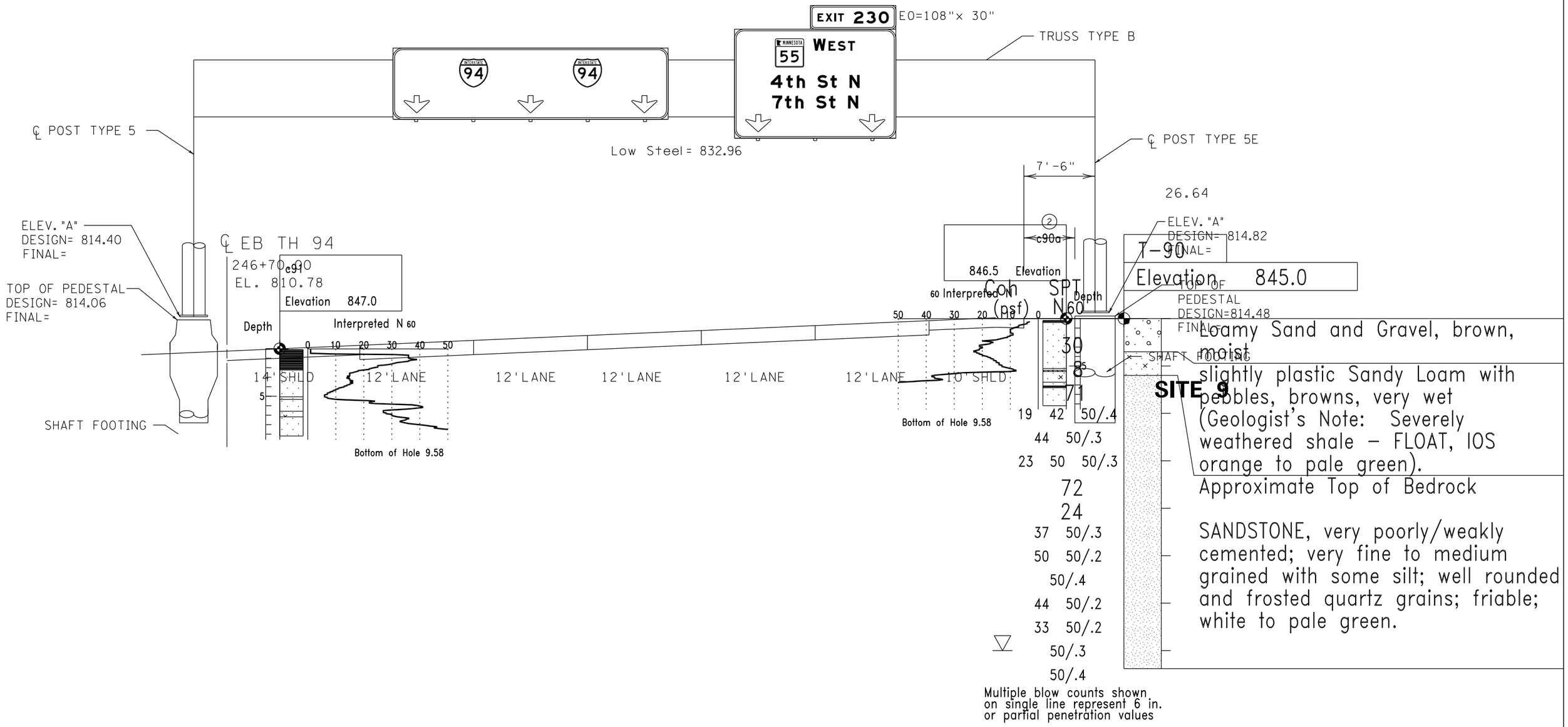
**CC:** Brad Skow, Chief Geotechnical Engineer
Tim Clyne, Metro District Materials Engineer
Michelle Waters, Office of Environmental Stewardship




DEPARTMENT OF TRANSPORTATION

FOUNDATION INVESTIGATION AND RECOMMENDATIONS
METRO DISTRICT
OVERHEAD SIGN REPLACEMENT
SITE 9 PLAN VIEW AND CPT/SPT LOCATIONS

STATE PROJ. NO. 8825-682 (TH 94) SHEET NO. AD1 OF AD2 SHEETS




Multiple blow counts shown on single line represent 6 in. or partial penetration values

10

SCALE IN FEET

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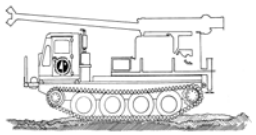
FOUNDATION INVESTIGATION AND RECOMMENDATIONS
METRO DISTRICT
OVERHEAD SIGN REPLACEMENT
SITE 9 CROSS SECTION AND CPT/SPT RESULTS

STATE PROJ. NO. 8825-682 (TH 94) SHEET NO. AD2 OF AD2 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)

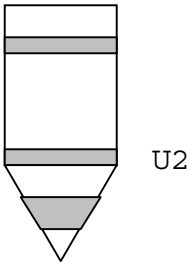
### $q_T$ TIP RESISTANCE
The resistance at the cone corrected for water pressure. Data is from cone with 60 degree apex angle and a 10 $cm^2$ end area.

### $f_s$ 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.

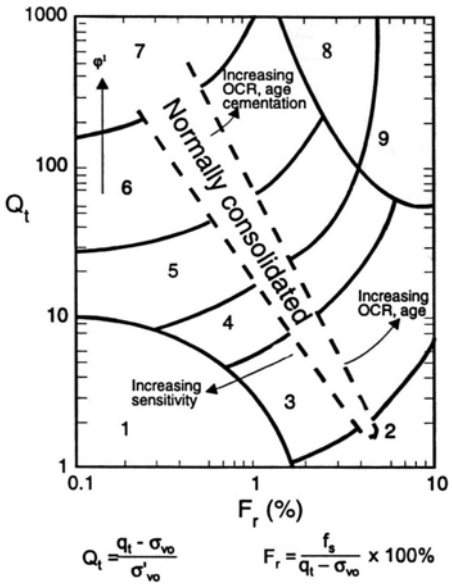
The numbers corresponding to different regions on the charts represent the following soil behavior types:

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

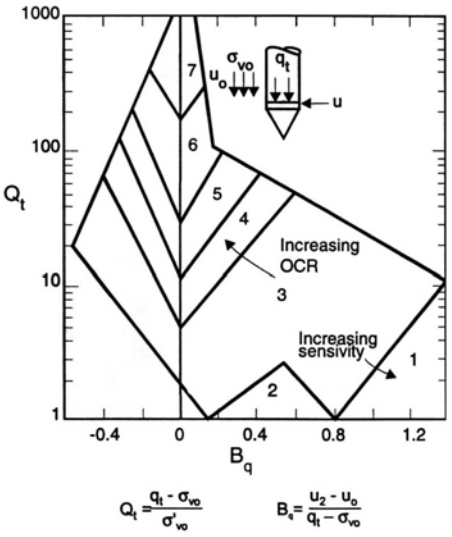
Note that engineering judgment, and comparison with conventional borings is especially important in the proper interpretation of CPT data in certain geo-materials.

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
$\sigma_{vo}$ ..... overburden pressure
$\sigma'_{vo}$ ..... effective over burden pressure
$u_2$ ..... measured pore pressure
$u_0$ ..... equilibrium pore pressure

DEPARTMENT OF TRANSPORTATION

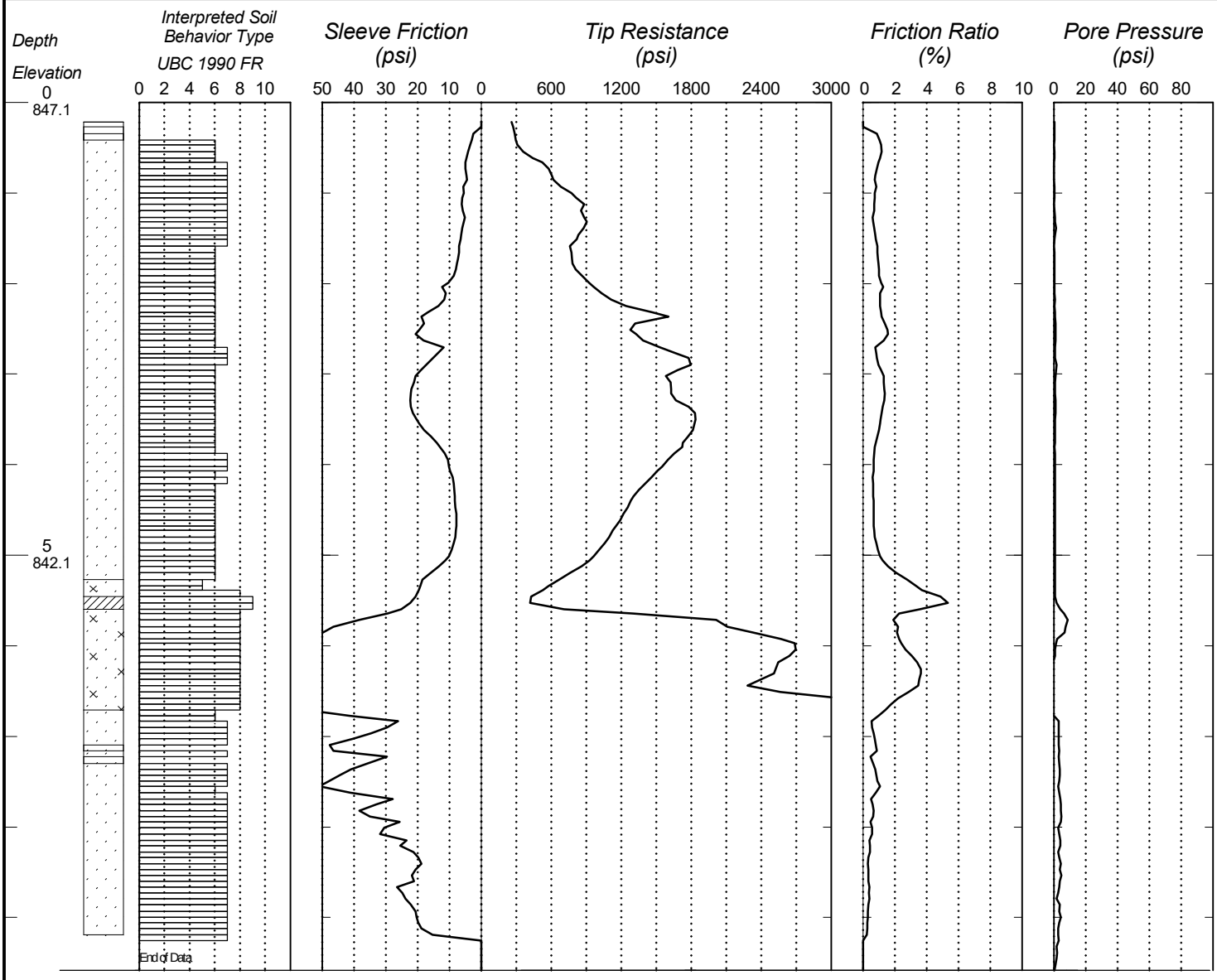
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

**CONE PENETRATION TEST RESULTS**

# UNIQUE NUMBER 83502

| State Project | Bridge No. or Job Desc. | Trunk Highway/Location | Sounding No. | Ground Elevation |
|---|---|---|---|---|
| **8825-682** | **Overhead Signs** | | **c90a** | **847.1** *(DTM)* |

| Location | CPT Machine | SHEET 1 of 1 |
|---|---|---|
| Hennepin County Coordinate System | **203094 CPT Truck** | |
| **X=525979 Y=181893** | CPT Operator **Dusbabek** | Date Completed |
| *Latitude (North)=45°00'56.41"* *Longitude (West)=93°16'58.38"* | Hole Type **CPT-STD** | **10/30/18** |




Bottom of Hole 9.58

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DEPARTMENT OF TRANSPORTATION

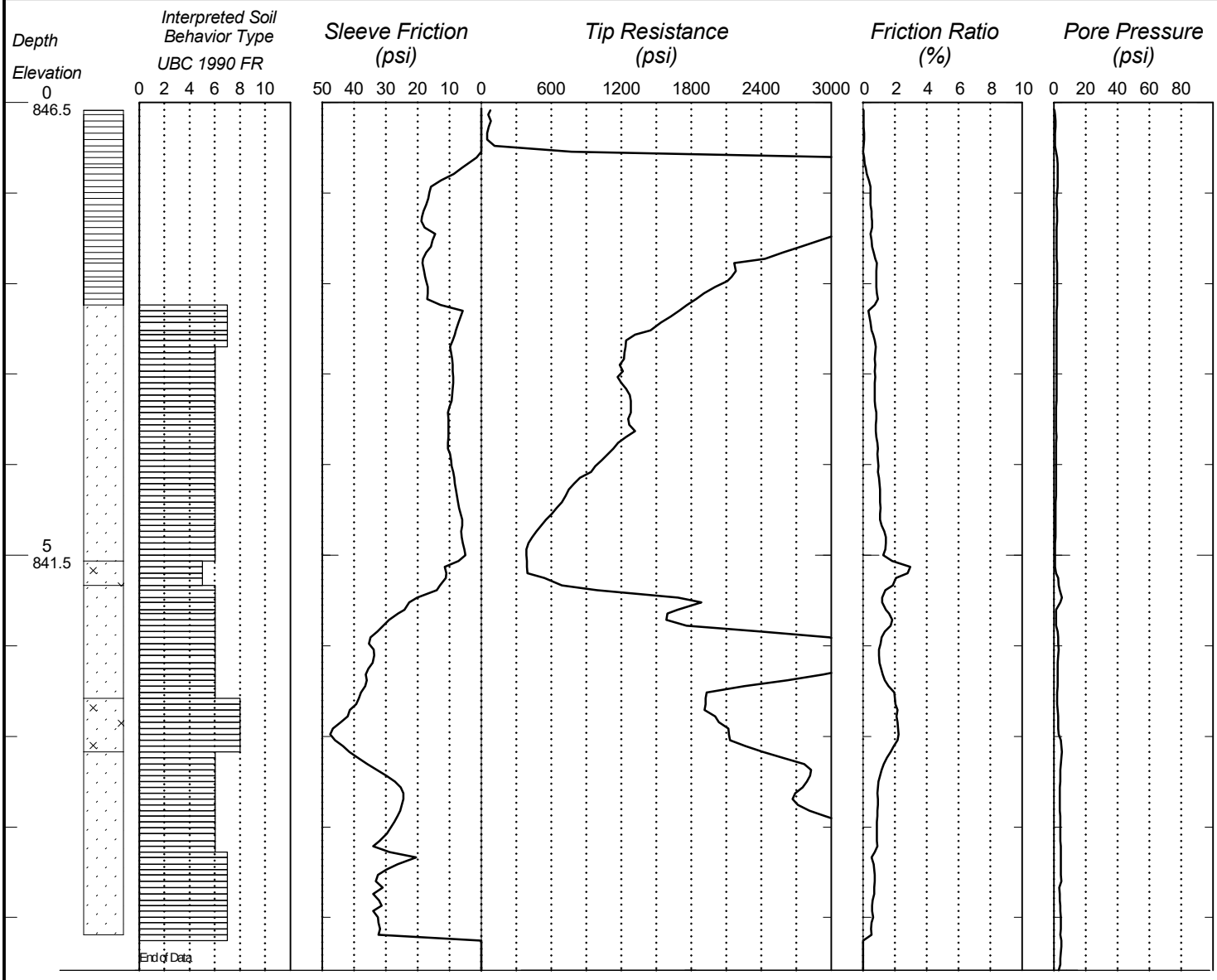
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

**CONE PENETRATION TEST RESULTS**

# UNIQUE NUMBER 83503

| State Project | Bridge No. or Job Desc. | Trunk Highway/Location | Sounding No. | Ground Elevation |
|---|---|---|---|---|
| **8825-682** | **Overhead Signs** | | **c91** | **846.5** *(DTM)* |

| Location | CPT Machine | SHEET 1 of 1 |
|---|---|---|
| Hennepin County Coordinate System | **203094 CPT Truck** | |
| **X=526062 Y=181908** | CPT Operator **Dusbabek** | Date Completed |
| *Latitude (North)=45°00'56.55"* *Longitude (West)=93°16'57.22"* | Hole Type **CPT-STD** | **10/30/18** |

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# 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.

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### 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)
$\gamma$ ..... Sample Unit Weight
LL ..... Liquid Limit
PI ..... Plasticity Index
$\phi$ ..... 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

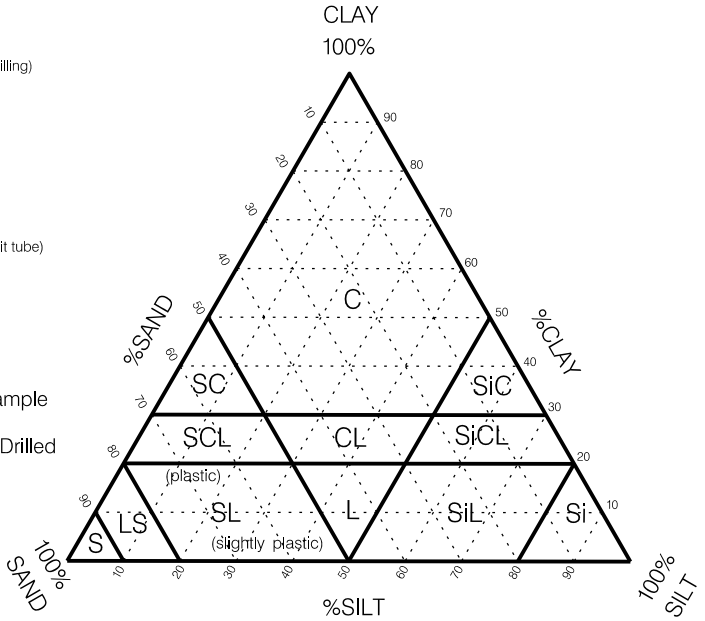
### SOIL /ROCK TERMS

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



DEPARTMENT OF TRANSPORTATION

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

# UNIQUE NUMBER 83616

| State Project | Bridge No. or Job Desc. | Trunk Highway/Location | Boring No. | Ground Elevation |
|---|---|---|---|---|
| 8825-682 | Overhead Signs | Interstate Highway | T-90 | 845.0 (GeoXH (DC)) |

Location: Hennepin County Coordinate System
X=525977 Y=181902
Latitude (North)=45°00'56.491408329" Longitude (West)=93°16'58.400096665"

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

SHEET 1 of 1
Drilling Completed: 12/5/18

| DEPTH | Depth / Elev. | Lithology | Classification | Drilling Operation | SPT N60 | MC (%) | COH (psf) | γ (pcf) | Soil / Rock | Other Tests Or Remarks / Formation or Member |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | REC (%) | RQD (%) | ACL (ft) | Core Breaks | | |
| | | | Loamy Sand and Gravel, brown, moist | | 30 | 5 | | | | |
| | 3.5 / 841.5 | | slightly plastic Sandy Loam with pebbles, browns, very wet (Geologist's Note: Severely weathered shale - FLOAT, IOS orange to pale green). | | 8 | 16 | | | | |
| 5 | 6.0 / 839.0 | | Approximate Top of Bedrock | | 71 | 5 | | | | ST PETER SANDSTONE |
| | | | | | 19<br>42<br>50/.4 | 4 | | | | |
| 10 | | | | | 44<br>50/.3 | 3 | | | | |
| | | | | | 23<br>50<br>50/.3 | 3 | | | | |
| 15 | | | | | 72 | 2 | | | | |
| | | | | | 24 | 3 | | | | |
| 20 | | | SANDSTONE, very poorly/weakly cemented; very fine to medium grained with some silt; well rounded and frosted quartz grains; friable; white to pale green. | | 37<br>50/.3 | 1 | | | | |
| | | | | | 50<br>50/.2 | 3 | | | | |
| 25 | | | | | 50/.4 | 1 | | | | |
| | | | | | 44<br>50/.2 | 39 | | | | |
| 30 | | | | | 33<br>50/.2 | 12 | | | | |
| | | | | | 50/.3 | 16 | | | | |
| ▼35 | | | | | | | | | | |
| | 36.9 / 808.1 | | Bottom of Hole -36.9' | | 50/.4 | 17 | | | | |
| | | | Water measured at 35.0' with auger | | | | | | | |

Field Crew Chief: Dols Soil Class:JAH Rock Class: JNH Edit: Date: 12/11/18

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