



**THURBER** ENGINEERING LTD.

**FOUNDATION INVESTIGATION AND DESIGN REPORT  
GROUND MOUNTED SIGN SUPPORTS  
HIGHWAY 401/COUNTY ROAD 30  
BRIGHTON, ON  
AGREEMENT 4017-E-0047  
ASSIGNMENT 4**

Geocres No.: 31C-281

Report to:

**Ontario Ministry of Transportation**

Latitude: 44.062620  
Longitude: -77.783679

September 2019  
Thurber File No.: 24731



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**Geocres No.: 31C-281**

**PART 1. FACTUAL INFORMATION**

**1 INTRODUCTION**

This report presents the factual data obtained from a foundation investigation conducted by Thurber Engineering Ltd. (Thurber) for the design of the two ground mounted sign supports at locations along the eastbound Highway 401 west of the County Road 30 Interchange within the County of Northumberland. Thurber carried out the investigation as a consultant to the Ministry of Transportation (MTO) as part of Assignment No. 4 under Retainer Agreement No. 4017-E-0047.

No previous foundation investigation information for the existing signs was available.

The purpose of this investigation was to explore the subsurface conditions at the sites and, based on this data, provide record of boreholes, laboratory test results and a written description of the subsurface conditions.

**2 SITE DESCRIPTION**

The two ground mounted signs are to be located adjacent to the eastbound lanes of Highway 401 approximately 1.8 km and 800 m west of the County Road 30 overpass structure, respectively. Highway 401 near the site locations consist of a four lane freeway with a rural cross-section and vegetated median of variable width. The highway embankment at the sign locations is performing well with no noticeable signs of settlement or erosion. The terrain ranges from flat to gently rolling and the land adjacent to the highway typically consists of farm fields or forests.

Based on published geological information in The Physiography of Southern Ontario by Chapman and Putnam (1984), the signs are located within the physiographic region known as Iroquois Plain. The Iroquois Plain generally consists of glacio-lacustrine sand and silty sand. The soil deposit is underlain by limestone bedrock.

Site photographs showing the general conditions at the sites are presented in Appendix D.



### 3 SITE INVESTIGATION AND FIELD TESTING

The field investigation was carried out on December 3rd, 2018 and included advancing one borehole at each of the two sign locations. The drilling was carried out using a truck mounted CME 55 drill rig.

The northing, easting and elevation of the boreholes are shown on the Borehole Location Drawing No. 1 in Appendix A, the individual Record of Borehole sheets in Appendix B and in Table 3-1. The termination depth of each of the boreholes is also provided in Table 3-1 below. The site is within MTM Zone 9.

**Table 3-1: Borehole Summary**

<b>Borehole</b>	<b>Location</b>	<b>Northing (m) MTM Z9</b>	<b>Easting (m) MTM Z9</b>	<b>Ground Surface Elevation (m)</b>	<b>Borehole Depth (m)</b>
18-4	Outside shoulder of Hwy 401 EB, 1.8 km west of CR30	4881096.1	201956.5	200.7	8.2
18-5	Outside shoulder of Hwy 401 EB, 0.8 km west of CR30	4881854.1	202642.3	202.5	8.1

As a component of our standard procedures and due diligence, Thurber contacted Ontario One Call to provide utility locates/clearances for the intended borehole locations in advance of the investigation.

The subsurface stratigraphy encountered in the boreholes was recorded in the field by Thurber personnel. Split spoon samples were collected at regular depth intervals in all boreholes during the completion of Standard Penetration Tests (SPT), following the methods described in ASTM Standard D1586-11. All soil samples recovered from the boreholes were placed in moisture-proof containers and the samples were transported to Thurber's Ottawa geotechnical laboratory for further examination and testing.

The open-hole groundwater levels were measured upon completion of drilling. The boreholes were backfilled with a low-permeability mixture of auger cuttings and bentonite pellets in general accordance with Ontario MOE Regulation 903.

The as-drilled locations of the boreholes were recorded using a handheld GPS and verified with measurements in the field using a measuring wheel relative to existing highway features (existing signs and edge of asphalt). The measurements were converted to northing and easting grid coordinates (MTM Zone 9) based on the georeferenced CAD drawing provided by the MTO. The ground surface elevations at the borehole locations were



measured by Thurber with a rod and level relative to the highway elevation and confirmed using digital terrain mapping provided by the MTO.

#### **4 LABORATORY TESTING**

The recovered soil samples were subjected to inspection and to natural moisture content determination. Selected samples were also subjected to gradation analysis (hydrometer and/or sieve) and Atterberg Limit testing. The results of these tests are summarized on the Record of Borehole sheets included in Appendix B. One sample of soil recovered from within each of borehole was selected and submitted for analytical testing of corrosivity parameters. All laboratory test results are provided in Appendix C.

#### **5 GENERAL DESCRIPTION OF SUBSURFACE CONDITIONS**

Details of the soil stratigraphy encountered in the boreholes are presented on the Record of Borehole sheets in Appendix B. A Borehole Location Plan is presented on Drawing No. 1 in Appendix A. An overall description of the stratigraphy is given in the following sections; however, the factual data presented on the Borehole Records governs any interpretation of the site conditions.

In general, the stratigraphy in the boreholes is characterized by granular fill, overlying sandy silt and glacial till.

More detailed descriptions of the individual strata are presented below.

##### **5.1 Silty Sand to Sand, Fill**

A layer of embankment fill was encountered from surface in Boreholes 18-4 and 18-5 consisting of sand with gravel to silty sand with gravel. The underside of this fill was at 0.6 and 1.5 m below the existing roadway surface (elev. 200.1 and 201.0 m) in Boreholes 18-4 and 18-5, respectively.

The SPT tests conducted in the silty sand with gravel fill gave N-values ranging from 16 to 20 blows, indicating a compact relative density.

Recorded moisture contents ranged from 5 to 10%. The results of a grain size analysis conducted on one sample of the fill indicated this material to consist of 34% gravel, 54% sand and 12% fines. These results are illustrated on Figure C1 in Appendix C.

##### **5.2 Sandy Silt (ML)**

A native deposit of sandy silt was encountered beneath the embankment fill in Borehole 18-5 with a thickness of 3.1 m. The underside of the sandy silt layer was at elevation 197.9 m. Trace amounts of gravel were noted in this layer and some organics were encountered in the upper 0.5 m.

SPT tests conducted this layer gave N-values ranging from 7 to 13 blows indicating a loose to compact relative density.

Recorded moisture contents of the sandy silt typically ranged from 12 to 15%. A moisture content of 26% was recorded in an upper sample containing organics. The results of grain size analysis conducted on one sample of the sandy silt indicated this material to consist of 7% gravel, 41% sand, 43% silt and 9% clay. These results are illustrated on Figure C2 in Appendix C.

An Atterberg Limit test completed on one sample of the sandy silt indicated that the material is non-plastic.

### **5.3 Silty Sand (SM) Glacial Till**

A deposit of glacial till consisting of silty sand with varying amounts of gravel was encountered below the fill in Borehole 18-4 and below the sandy silt in Borehole 18-5. Occasional cobbles were noted throughout this layer in Borehole 18-5, while occasional to frequent cobbles were noted in the lower portion of this layer in Borehole 18-4. In Borehole 18-4, the silty sand till was noted to be 5.5 m thick with a base elevation of 194.6 m. Borehole 18-5 was terminated within the silty sand till at elevation 194.4 m.

The SPT tests conducted in this layer gave N-values ranging from 13 to 95 blows, indicating a compact to very dense relative density.

Recorded moisture contents ranged from 7 to 13%. The results of grain size analyses conducted on three samples of the silty sand till are summarized in the Table 5-1 below and are illustrated on Figure C3 in Appendix C.

**Table 5-1: Grain Size Summary - Silty Sand (SM) Glacial Till**

Soil Particle	Percentage (%)	
Gravel	9 – 18	
Sand	45 – 51	
Silt	29	38 – 40
Clay	8	

An Atterberg Limit test completed on a sample of the silty sand till indicated that the material is non-plastic.

### **5.4 Sandy Silty Clay (CL-ML) Glacial Till**

A deposit of glacial till consisting of sandy silty clay was encountered below the silty sand till in Borehole 18-4. Borehole 18-4 was terminated 2.1 m into the sandy silty clay till at elevation 192.5 m. Occasional to frequent cobbles were noted in this layer.

The SPT tests conducted in this layer gave N-values ranging from 93 to greater than 100 blows, indicating a very dense (or hard) relative density.

Recorded moisture contents were 6 and 9%. The results of grain size analysis conducted on one sample of the sandy silty clay indicated this material to consist of 6% gravel, 40% sand, 40% silt and 14% clay. These results are illustrated on Figure C4 in Appendix C.

An Atterberg Limit test was completed on a sample of the sandy silty clay and indicated that the fines have a low plasticity (CL-ML). This result is illustrated on Figure C5 in Appendix C.

## 5.5 Groundwater

The open-hole groundwater levels were measured on December 3, 2018 upon completion of drilling. The recorded water at that time were 2.1 m and 2.7 m below the ground surface (elev. 198.6 m and 199.8 m) in Boreholes 18-4 and 18-5, respectively.

These observations are considered short term. It should be noted that the groundwater level at the time of construction may be different and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after periods of significant and/or prolonged precipitation.

## 5.6 Analytical Testing

One sample of the native soil from each borehole was submitted for analysis of pH, water soluble sulphate, sulphide and chloride concentrations, and conductivity and resistivity. The analysis results are summarized in Table 5-2. A copy of the test results is provided in Appendix C.

**Table 5-2: Results of Chemical Analysis**


Borehole (Sample)	Depth (mbgs)	Sulphate (µg/g)	pH ( - )	Resistivity (Ohm-cm)	Conductivity (uS/cm)	Chloride (µg/g)	Sulphide (%)
18-4 (SS5)	3.0 – 3.6	11	7.97	3,350	298	128	< 0.02
18-5 (SS4)	2.3 – 2.9	8	7.78	2,400	417	184	< 0.02



## 6 MISCELLANEOUS

The sign locations were provided in advance of the investigation by the Ministry of Transportation. Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. Thurber surveyed the borehole locations and ground surface elevations based on benchmarks provided by MTO. CCC Geotechnical and Environmental Drilling of Ottawa, Ontario supplied and operated the drilling equipment to carry out the drilling, sampling, and in-situ testing. The drilling, and sampling operations in the field were supervised on a full-time basis by Sean O'Bryan, C.E.T., of Thurber. Laboratory testing was carried out by Thurber in its MTO-approved laboratory in Ottawa.

Overall project management and direction of the field program was provided by Stephen Dunlop, P.Eng. Interpretation of the field data and preparation of this report was completed by Justin Gray P.Eng., and Stephen Dunlop, P.Eng. The report was reviewed by Dr. Fred Griffiths, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

  
For Justin Gray, P.Eng.  
Geotechnical Engineer



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**PART 2. ENGINEERING DISCUSSION AND RECOMMENDATIONS**

**7 INTRODUCTION**

This report presents the interpretation of the factual data obtained from a foundation investigation conducted by Thurber for two ground mounted sign support foundations on Highway 401, west of the County Road 30 Interchange, within the County of Northumberland, Ontario. Geotechnical assessment and recommendations are provided to assist the project team in designing a suitable foundation for the proposed relocated sign foundations.

This foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation and shall not be used or relied upon for any other purposes or by any other parties including the construction or design-build contractor. Contractors must make their own interpretation based on the factual data in Part 1 of the report. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Contractors must make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

One borehole was drilled near each of the sign locations to provide subsurface information for detailed foundation design of the sign supports. The Records of Boreholes are presented in Appendix B.

**8 FOUNDATION DESIGN PARAMETERS**

Design of the sign support foundations should be carried out in accordance with the following document.

- Ministry of Transportation, Ontario (2015) "Sign Support Manual", Engineering Standards Branch, Bridge Office (Reference 1).

Reference should also be made to the following document.

- Canadian Highway Bridge Design Code and Commentary (2014). CAN/CSA-S6-14 and S6.1-14 (Reference 2).

It is expected that each sign support will consist of two or three steel supports embedded within 450 mm diameter concrete caissons as shown in Figure 5.4.3 of the Sign Support Manual. The standard footing detail results in footings ranging from 1600 mm to 2800 mm deep.

The standard design is based on soil providing a minimum passive earth pressure of 68 kPa at SLS, which is based on a cohesive soil with minimum shear strength of 50 kPa. This design method is based on lateral soil resistance for the full caisson (footing) depth without reduction for frost depth. The lateral passive resistance within the frost depth should not be neglected, per the Sign Support Manual.

Based on the soils encountered in the investigation it is expected that the standard design method will be applicable. This can be checked by comparing the design lateral loads against the passive soil resistance by using the design parameters presented in Table 1 (Appendix E). The following additional input is provided with respect to assessment of the foundation design:

- The boreholes were drilled at the shoulder rounding through the existing embankment. It is anticipated that the replacement signs may be supported on non-level ground extending down from the shoulder rounding into the adjacent ditch. The geotechnical design parameters to be used for design will need to take into consideration the vertical offset between the ground surface at the borehole location and the ground surface at each footing location. Reference should be made to Section 5.2.3 of the MTO Sign Support Manual.
- The groundwater level is expected to be higher than that observed in the boreholes after periods of prolonged precipitation/snowmelt. The design groundwater level is expected to be governed by the water level within the adjacent ditches. In the absence of detailed cross-sections and drainage data, a design groundwater level 1 m below the top of shoulder is suggested.
- Cohesionless soil meeting the minimum strength assumed for the standard design was encountered in all boreholes.

## **9 CAISSON INSTALLATION**

Caisson installation should generally be carried out in accordance with OPSS.PROV 903 and OPSS.PROV 915. The contract documents should contain an NSSP alerting the contract bidders of the specific aspects relating to caisson construction for the sign support foundations at these sites. Suggested wordings for this NSSP are provided in Appendix F.



Caisson installation equipment must be able to dislodge, handle, remove cobbles and boulders, and penetrate obstructions within the fills or native soils.

Groundwater levels may be encountered at relatively shallow depths below existing ground surface. Soil sloughing and water seepage may also occur in unsupported holes, particularly in the sandy silt layer. Temporary liners must be available to support the caisson sidewalls and provide seepage cut-off where required. The Contractor must be prepared to control the groundwater and surface water flow at the site. The groundwater level for the site at the time of the proposed installation should be taken as the water level in the adjacent ditch. It is recommended that the replacement be conducted during a drier season such as after the spring freshet or prior to the fall season.

## **10 CONSTRUCTION CONSIDERATIONS**

Potential construction concerns include, but are not necessarily limited to, the following:

- Handling and removal of obstructions such as cobbles in the fill or native soils
- Water seepage and soil sloughing into the open caisson excavation

Caisson construction should be monitored by qualified geotechnical personnel as per OPSS.PROV 903 to verify the soil conditions and to confirm that those conditions are consistent with the design assumptions in this report.


It is noted that the information provided on Table 1 in Appendix E is presented for design purposes only. Contractors bidding for the work must review the borehole records and make their own interpretation of the soil and groundwater conditions.



## 11 CLOSURE

Engineering analysis and preparation of this report were carried out by Justin Gray, P.Eng. and Mr. Stephen Dunlop, P.Eng. The report was reviewed by Dr. Fred Griffiths, P.Eng. a Designated Principal Contact for MTO Foundation Projects.

Thurber Engineering Ltd.  
Report Prepared By:

  
FOR Justin Gray, P.Eng.  
Geotechnical Engineer



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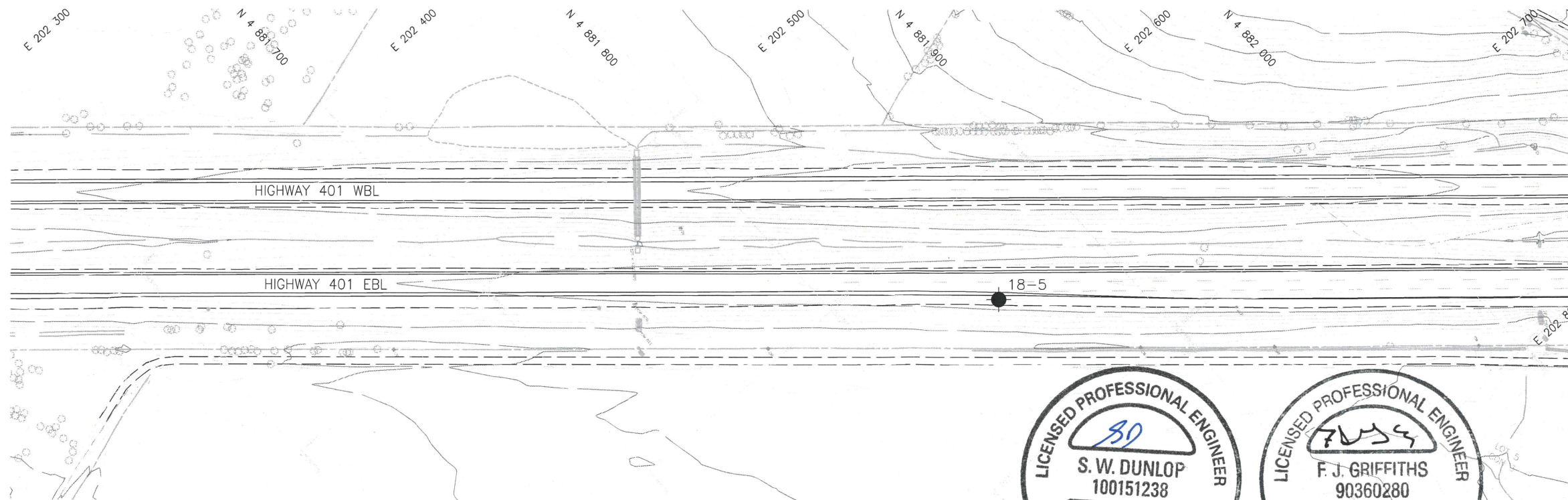
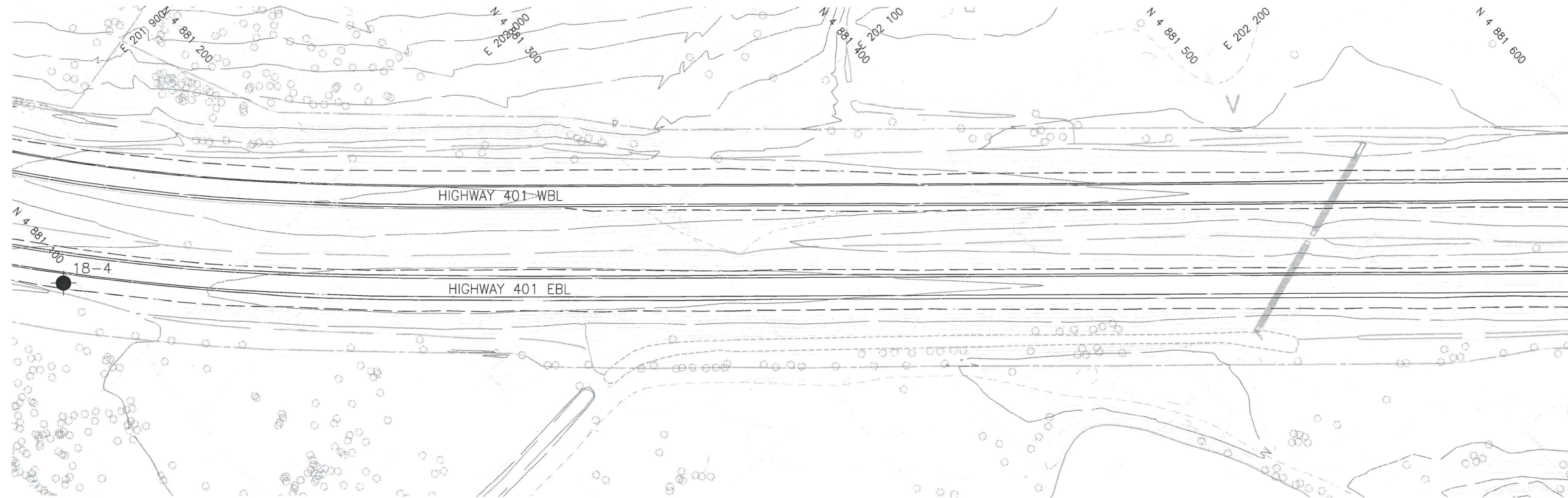
Fred Griffiths, P.Eng., Ph.D.  
MTO Review Principal  
Senior Geotechnical Engineer

## **Appendix A.**

### **Borehole Locations**



METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN



CONT No  
WP No

HIGHWAY 401  
COUNTY ROAD 30  
GROUND MOUNTED SIGN SUPPORTS  
BOREHOLE LOCATIONS PLAN



### KEYPLAN

### LEGEND

- Borehole
- Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
18-4	200.7	4 881 096.1	201 956.5
18-5	202.5	4 881 854.1	202 642.3

### NOTES

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Coordinate system is MTM NAD 83 Zone 9.

GEOCREs No. 31C-281

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	JG	CHK -	CODE
DRAWN	MFA	CHK JG	SITE
			LOAD
			STRUCT
			DWG 1
			DATE SEP 2019

**Appendix B.**

**Record of Borehole Sheets**



## SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

### TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in sizes from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services)

### TERMINOLOGY DESCRIBING SOIL STRUCTURE:

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	> 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	< 2 mm in thickness

### RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

### N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, the number of blows are reported over the sampler penetration in millimetres (e.g. 50/75).

### DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an "A" size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.





### STRATA PLOT:

Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders  
Cobbles  
Gravel      Sand      Silt      Clay      Organics      Asphalt      Concrete      Fill      Bedrock

### TEXTURING CLASSIFICATION OF SOILS

Classification	Particle Size
Boulders	Greater than 200 mm
Cobbles	75 – 200 mm
Gravel	4.75 – 75 mm
Sand	0.075 – 4.75 mm
Silt	0.002 – 0.075 mm
Clay	Less than 0.002 mm

### TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	12 or less
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

### SAMPLE TYPES

SS	Split spoon samples
ST	Shelby tube or thin wall tube
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ etc.	Rock core sample obtained with the use of standard size diamond coring equipment

### TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

Descriptive Term	SPT “N” Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50

### MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note -  $W_L$  = Liquid Limit



## EXPLANATION OF ROCK LOGGING TERMS

### ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock materials.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structures are preserved.

### TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1 m in length or larger, as a percentage of total core length
Unconfined Compressive Strength: (UCS)	Axial stress required to break the specimen.
Fracture Index: (FI)	Frequency of natural fractures per 0.3 m of core run.

### DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 to 2 m
Medium bedded	0.2 to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 to 60 mm
Laminated	6 to 20 mm
Thinly laminated	Less than 6 mm

### STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)
Extremely Strong	Greater than 250
Very Strong	100 – 250
Strong	50 – 100
Medium Strong	25 – 50
Weak	5 – 25
Very Weak	1 – 5
Extremely Weak	0.25 – 1

# RECORD OF BOREHOLE No 18-4

1 OF 1

METRIC

GWP# 4012-18-00 LOCATION Lat: 44.062641°, Long: -77.783711° ORIGINATED BY SOB  
 HWY 401/CR 30 BOREHOLE TYPE HSA COMPILED BY AC  
 DATUM Geodetic DATE 2018.12.03 - 2018.12.03 CHECKED BY SD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20   40   60   80   100	W <sub>P</sub> W   W <sub>L</sub>	WATER CONTENT (%)						
								SHEAR STRENGTH kPa ○ UNCONFINED   + FIELD VANE ● QUICK TRIAXIAL   × LAB VANE								
200.7	Gravel Shoulder						20   40   60   80   100	20   40   60							GR   SA   SI   CL	
0.0	SAND with gravel compact brown FILL		1	SS	16										11   51   38 (SI+CL)	
200.1																
0.6	SILTY SAND (SM) some gravel TILL compact brown		2	SS	13											
			3	SS	17										18   45   29   8 non-plastic	
			4	SS	17											
197.7																
3.0	SILTY SAND (SM) with gravel TILL occasional to frequent cobbles compact to very dense brown		5	SS	25										6   40   40   14	
			6	SS	41											
			7	SS	63											
194.6																
6.1	SANDY SILTY CLAY (CL-ML) trace gravel TILL occasional to frequent cobbles very dense brown		8	SS	100/ 200 mm											
			9	SS	93											
192.5																
8.2	End of Borehole Open hole water level at 2.1 m upon completion of drilling															

DOUBLE LINE 24731 - HWY 401 CR 30 SIGNS.GPJ 2012TEMPLATE(MTO).GDT 13/9/19

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 18-5

1 OF 1

METRIC

GWP# 4012-18-00 LOCATION Lat: 44.069561° Long: -77.775303° MTM z9: N 4 881 854.1 E 202 642.3 ORIGINATED BY SOB  
 HWY 401/CR 30 BOREHOLE TYPE HSA COMPILED BY AC  
 DATUM Geodetic DATE 2018.12.03 - 2018.12.03 CHECKED BY SD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
202.5	Gravel Shoulder													
0.0	SILTY SAND with gravel compact brown FILL		1	SS	20		202							
			2	SS	16									
201.0							201							
1.5	SANDY SILT (ML) trace gravel loose to compact dark brown to light brown -some organics from 1.5 to 2.0 m		3	SS	7									
			4	SS	7		200							
			5	SS	9		199							
			6	SS	13									
197.9							198							
4.6	SILTY SAND trace gravel TILL occasional cobbles very dense brown		7	SS	50		197							
			8	SS	59		196							
							195							
			9	SS	95									
194.4														
8.1	End of Borehole Open hole water level at 2.7 m upon completion of drilling													

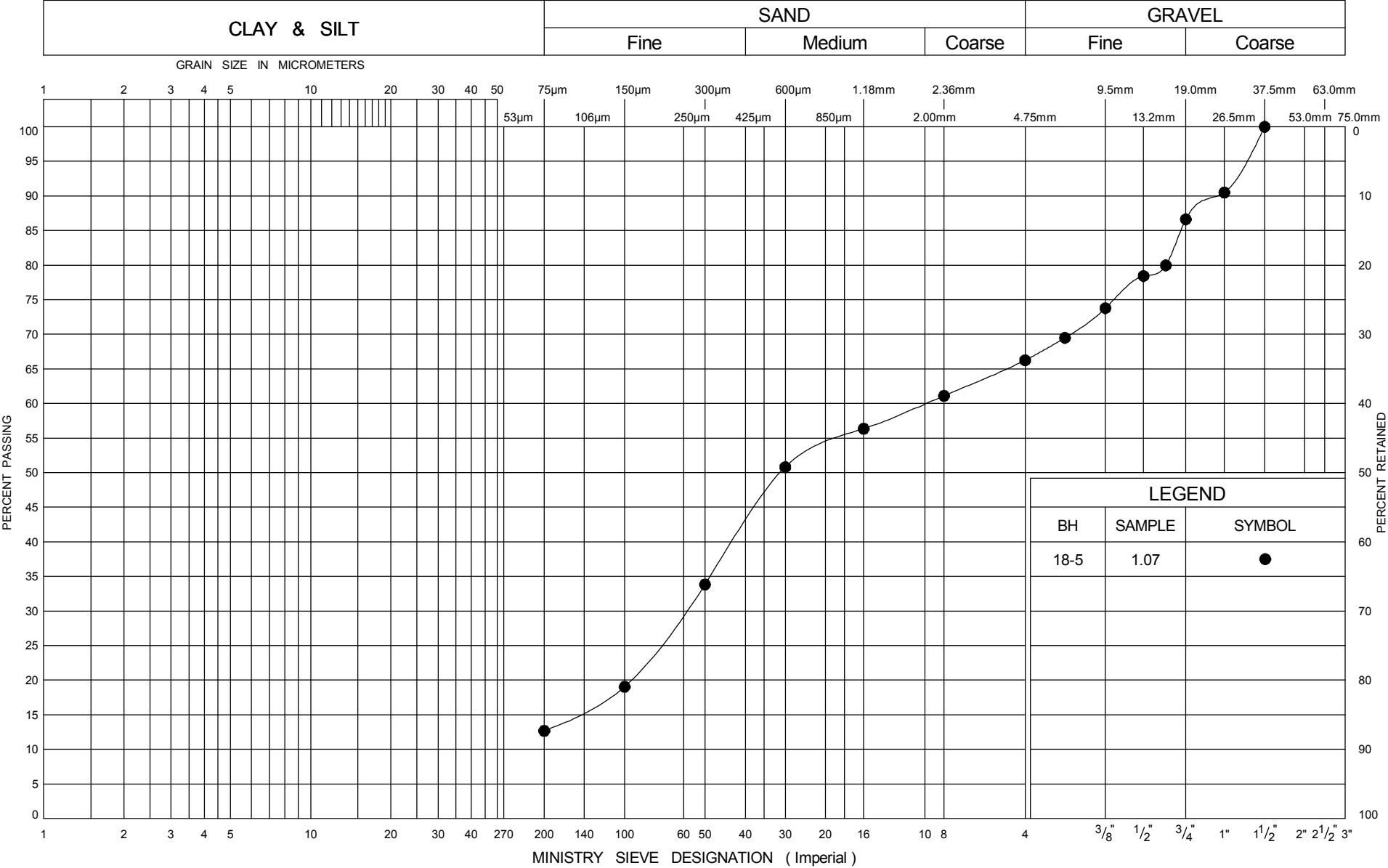
DOUBLE LINE 24731 - HWY 401 CR 30 SIGNS.GPJ 2012TEMPLATE(MTO).GDT 13/9/19

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

**Appendix C.**  
**Laboratory Testing**

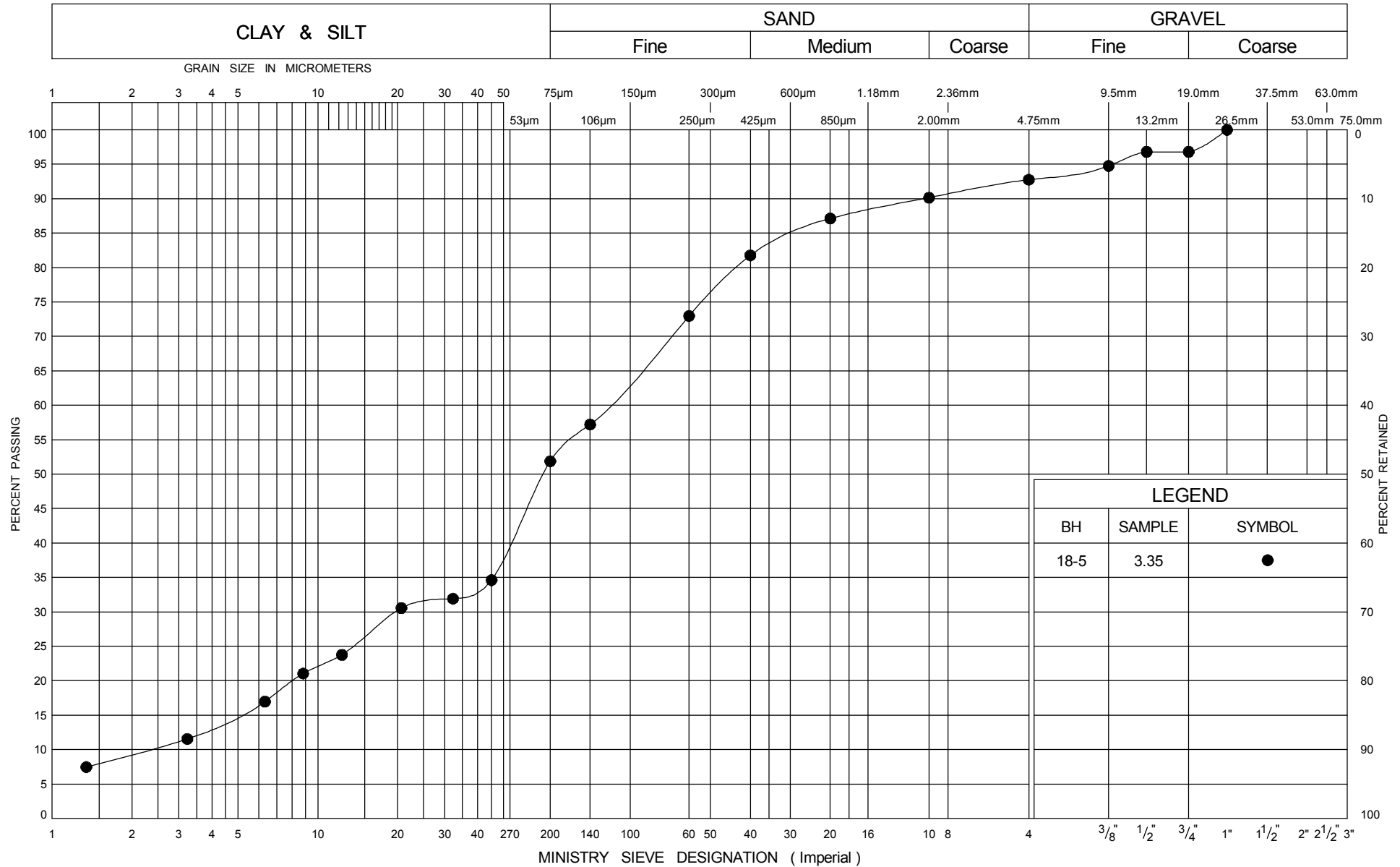
**Appendix C.1**  
**Particle Size Analysis Figures**  
**Atterberg Limit Testing**

UNIFIED SOIL CLASSIFICATION SYSTEM





## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

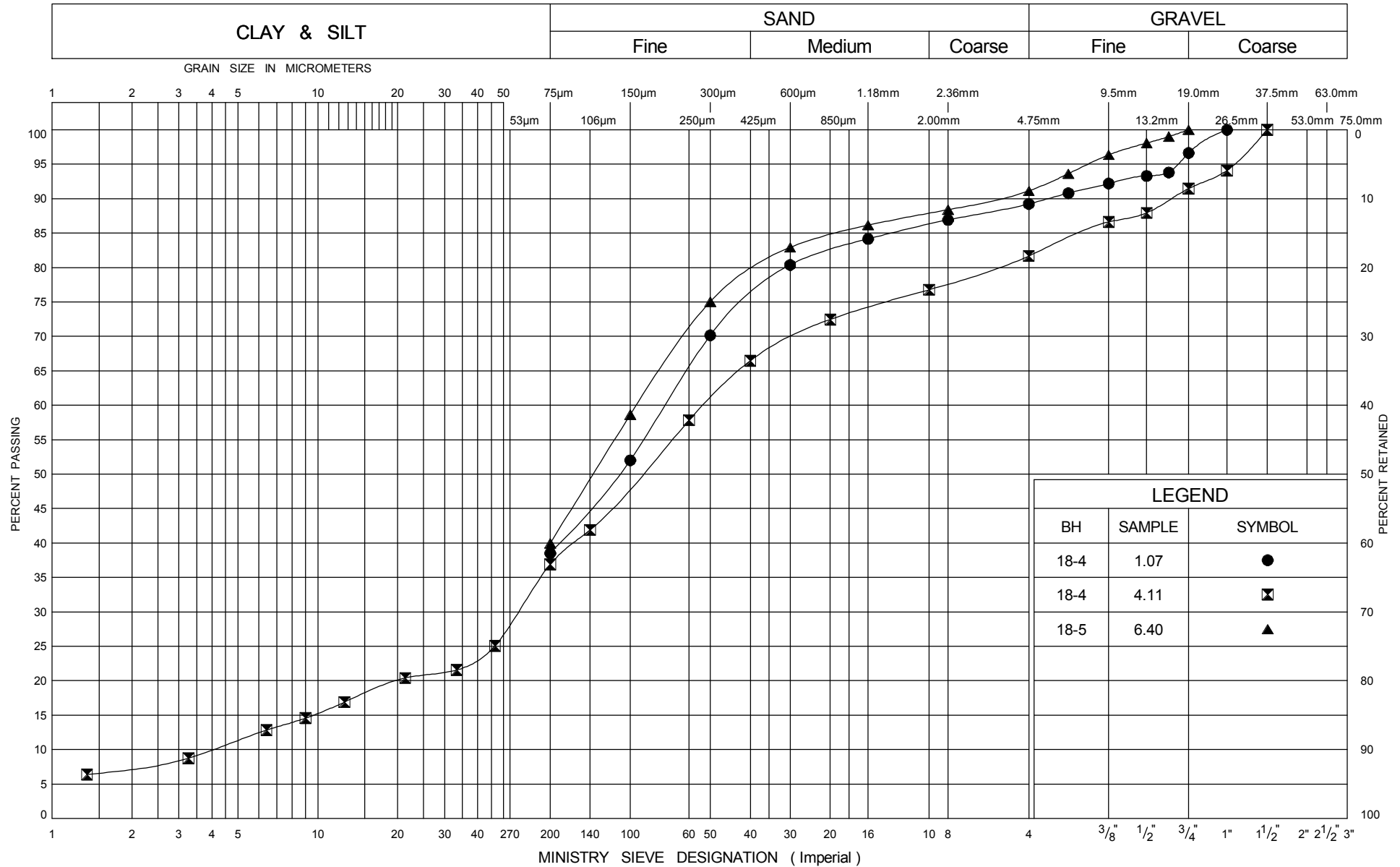
Sandy Silt (ML)

FIG No C2

W P -

Hwy 401/CR30 Signs

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

# GRAIN SIZE DISTRIBUTION

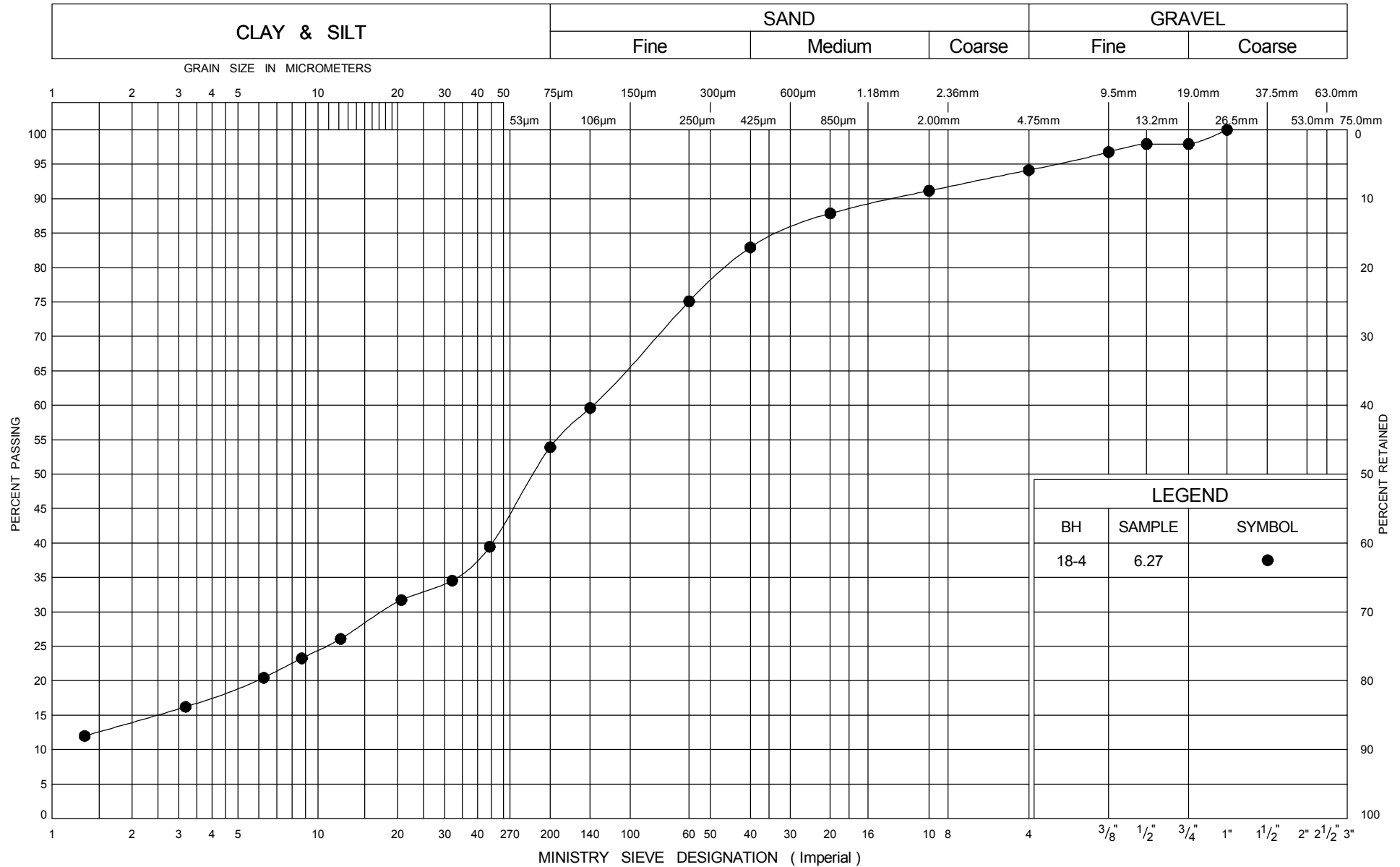
## Silty Sand TILL

FIG No C3

W P -

Hwy 401/CR30 Signs

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

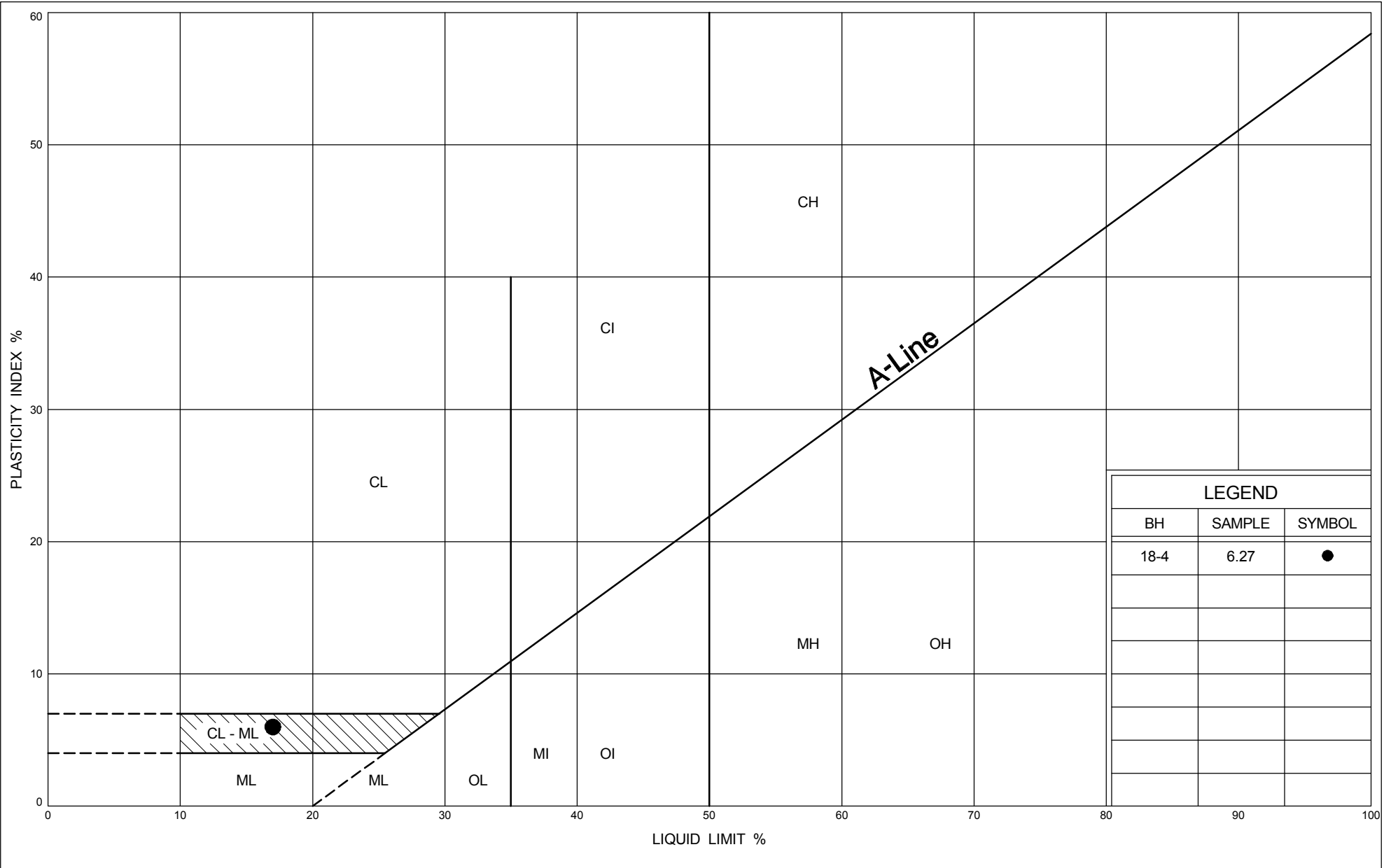
## GRAIN SIZE DISTRIBUTION

### Sandy Silty Clay TILL

FIG No C4

W P -

Hwy 401/CR30 Signs



**Appendix C.2**  
**Analytical Testing Results**

Certificate of Analysis  
Client: Thurber Engineering Ltd.  
Client PO: 24731

Report Date: 12-Dec-2018

Order Date: 6-Dec-2018

Project Description: HWY 401/CR30

		Client ID:	18-3, SS4, 5'9"-7'9"	18-4, SS5, 10'-12'	18-5, SS4, 7'6"-9'6"	-
		Sample Date:	12/03/2018 09:00	12/03/2018 09:00	12/03/2018 09:00	-
		Sample ID:	1849437-01	1849437-02	1849437-03	-
		MDL/Units	Soil	Soil	Soil	-
<b>Physical Characteristics</b>						
% Solids	0.1 % by Wt.		89.9	93.4	88.3	-
<b>General Inorganics</b>						
Conductivity	5 uS/cm		235	298	417	-
pH	0.05 pH Units		7.70	7.97	7.78	-
Resistivity	0.10 Ohm.m		42.6	33.5	24.0	-
<b>Anions</b>						
Chloride	5 ug/g dry		52	128	184	-
Sulphate	5 ug/g dry		9	11	8	-
<b>Subcontract</b>						
Sulphide	0.02 %		<0.02 [1]	<0.02 [1]	<0.02 [1]	-

**Appendix D.**

**Site Photographs**



**Photo 1. Looking at Sign Location #1 at approximately Sta. 11+600 (2018/12/07)**



**Photo 2. Looking at Sign Location #2 at approximately Sta. 12+600 (2018/12/07)**



## **Appendix E.**

### **Table 1 – Geotechnical Parameters**

**TABLE 1**  
**GEOTECHNICAL DESIGN PARAMETERS**  
**GROUND MOUNTED SIGN SUPPORTS**  
**HIGHWAY 401/COUNTY ROAD 30 INTERCHANGE**

Sign	Borehole Details		Reference Simplified Subsurface Stratigraphy for Design	Depth Below Existing Grade (m)	Foundation Design Parameters					Observed Groundwater Depth (m)
	Borehole	Depth (m)			$S_u$ (kPa)	$\phi'$ (deg.)	$\gamma$ (kN/m <sup>3</sup> )	$\gamma'$ (kN/m <sup>3</sup> )	Kp	
EB EXIT 509 Sign #1 (Advance)	18-4	8.2	Fill: Sand with gravel, compact Till: Silty Sand, compact to very dense, brown Till: Sandy Silty Clay, very dense, brown	0.0 - 0.6 0.6 - 6.1 6.1 - 8.2	- - 150	32 32 32	20 20 20	10 10 10	3.3 3.3 3.3	2.1
EB EXIT 509 Sign #2 (Turn off)	18-5	8.1	Fill: Silty Sand with gravel, compact Sandy Silt, loose to compact, brown Till: Silty Sand, dense to very dense, brown	0.0 - 1.5 1.5 - 4.6 4.6 - 8.1	- - -	32 30 32	20 19 20	10 9 10	3.3 3.0 3.3	2.7

Definitions:

$S_u$  = Undrained shear strength

$\phi'$  = Effective friction angle

$\gamma$  = Total unit weight

$\gamma'$  = Effective unit weight

Kp = Passive earth pressure coefficient

The information provided herein is presented for design purposes only.

Groundwater levels will vary. In the absence of additional information, a design groundwater level could be assumed to be 1m below the top of the shoulder.  
Effective unit weight values should be used for soils below the water table.

## **Appendix F.**

### **List of Referenced Specifications Suggested Text for NSSP**

## **1. LIST OF REFERENCED SPECIFICATIONS**

OPSS.PROV 903      Construction Specifications for Deep Foundations

OPSS.PROV 915      Construction Specifications for Sign Support Structures

## **2. SUGGESTED TEXT FOR NSSP “CAISSON CONSTRUCTION FOR GROUND MOUNTED SIGN FOUNDATIONS”**

The Contractor is advised that variable types of subsurface materials may be encountered at the ground mounted sign locations. For additional information regarding soil conditions, the Contractor is referred to the Foundation Investigation Report.

For bidding purposes, the Contractor shall assume the following:

- i. The subsurface conditions at a ground mounted sign foundation location are the same as those encountered in the borehole closest to the subject sign location, taking into account the vertical offset between the borehole location and the foundation location.
- ii. Cobbles and boulders may be encountered within fill or underlying native deposits. Caisson installation equipment must be able to dislodge, handle, remove or otherwise penetrate these obstructions.
- iii. Water seepage and/or soil sloughing into the caisson hole may occur from existing fill or underlying native deposits. A test boring shall be carried out prior to drilling the caisson foundation to establish the groundwater level and to determine if soil sloughing will be an issue. Temporary liners shall be available on site, or be made available on very short notice, to support the caisson sidewalls and provide seepage cut-off where required.

The Contractor is responsible for constructing the ground mounted sign foundations without disturbing the material at the sides or bases of the foundations.