



**FOUNDATION INVESTIGATION REPORT  
for  
WESTCHESTER BOURNE OVERHEAD SIGNS  
HIGHWAY 401  
STATION 10+457 TO STATION 32+616  
LONDON, ONTARIO  
ASSIGNMENT NO. 3016-E-0009  
WORK ORDER NO. 13  
LATITUDE AND LONGITUDE: 42.948091, -81.103968**

PETO MacCALLUM LTD.  
165 CARTWRIGHT AVENUE  
TORONTO, ONTARIO  
M6A 1V5  
Phone: (416) 785-5110  
Fax: (416) 785-5120  
Email:toronto@petomaccallum.com

**Distribution:**

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**FOUNDATION INVESTIGATION REPORT**

for

Westchester Bourne Overhead Signs, Highway 401

Station 10+457 to Station 32+616

London, Ontario

Assignment No. 3016-E-0009, Work Order No. 13

Latitude and Longitude: 42.948091, -81.103968

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**1. INTRODUCTION**

WSP Canada Group Ltd. (WSP) has retained Peto MacCallum Ltd. (PML) on behalf of the Ministry of Transportation Ontario (MTO) to conduct the geotechnical investigation in support of the Design Build Ready Report for Agreement No. 3016-E-0009, Work Order No. 13. The Design Build Ready package under Agreement No. 3016-E-0009-013 includes foundation investigation reports for the proposed four (4) overhead signs along Highway 401 at Westchester Bourne (formerly Highway 74) and replacement of the underpass located at the interchange of Highway 401 and Westchester Bourne.

A foundation investigation report for the replacement of the underpass, located at the interchange of Highway 401 and Westchester Bourne, will be completed by PML under a separate cover.

This report summarizes the results of the foundation investigation carried out for the proposed four (4) overhead signs, located off-road from approximate Station 10+457 to Station 32+616 along Highway 401 in London, Ontario.

The purpose of the investigation was to explore the subsurface conditions at the proposed locations of the overhead signs.

**2. SITE DESCRIPTION**

The existing Highway 401 roadway is slightly depressed from the natural topography, and accommodates a total of six (6) lanes of vehicular traffic; three (3) westbound lanes and three (3) eastbound lanes. The existing Westchester Bourne accommodates one (1) northbound and one (1) southbound lane of vehicular traffic and oriented at a skewed angle to Highway 401. The site is generally a flat area, with the exception of the highway and bridge embankments. The site is surrounded by long grass and coniferous forestation with mature trees and shrubs.

The surrounding area is mainly used for farming. A Husky fuel station is located in the southwest quadrant of the Highway 401 and Westchester Bourne interchange. Dorchester is the residential

165 Cartwright Avenue, Toronto, Ontario M6A 1V5

Tel: (416) 785-5110 Fax: (416) 785-5120

E-mail: [toronto@petomacallum.com](mailto:toronto@petomacallum.com)

BARRIE, COLLINGWOOD, HAMILTON, KITCHENER, LONDON, TORONTO



and commercial core of the Municipality of Thames Centre and is located approximately 6.0 km northeast of the site.

### **3. FIELD INVESTIGATION PROCEDURES**

The fieldwork for this investigation was carried out on October 9, 2018 and October 10, 2018. A total of four (4) boreholes were advanced to depths varying from 9.8 m to 12.8 m. The Record of Borehole sheets are provided in Appendix A. The borehole location plans are presented on Drawings WBS-1 to WBS-4.

Refer to Table 3.0 for a summary of the proposed location of overhead signs, location and depth of boreholes.

**Table 3.0 – Borehole Information**

<b>STRUCTURE</b>	<b>APPROXIMATE EXISTING STRUCTURE LOCATION</b>	<b>BOREHOLE ID</b>	<b>DEPTH BELOW GROUND LEVEL (m)</b>
Sign 20W	Station 10+444	20-W	12.8
Sign 17W	Station 11+444	17-W	12.8
Sign 23E	Station 31+503	23-E	11.3
Sign 24E	Station 32+503	24-E	9.8

The proposed borehole locations and coordinates were provided by WSP. The coordinates for proposed borehole locations were provided in MTM NAD 83 Northing and Easting. The boreholes were laid out by PML engineering staff, in conformance with the coordinates provided by WSP. During field investigation, some of the boreholes were relocated due to the presence of underground utilities and difficulty to access the planned locations by drill rig. The locations of boreholes, as drilled, were surveyed by WSP. All elevations (El.) reported in this report are referred to Geodetic datum and expressed in meters.

Traffic control services where required were provided by Almon Equipment Ltd. of Toronto, Ontario, in accordance with Ontario Traffic Manual, Book 7-Temporary Conditions (2014).

PML engineering staff arranged for the clearance of underground services and appropriate permit applications. The respective utility companies cleared the underground services at the borehole



locations. Public and private utility authorities were informed and all of the utility clearance documents were obtained before the commencement of drilling work. Fieldwork was supervised on a full-time basis by PML staff operating under the direction of an engineer.

The boreholes were advanced using continuous flight hollow stem augers powered by a truck mounted CME-75 drill rig. The drilling equipment was supplied and operated by Landshark Drilling Inc. (Landshark) of Brantford, Ontario. Landshark is a specialist drilling contractor and the drilling crews worked under the full-time supervision of a member of the PML engineering staff.

Representative soil samples were recovered starting from the ground surface and continued at 0.75 m intervals to a depth of 6.0 m using a conventional 51 mm outer diameter split spoon sampler. Below 6.0 m depth, the samples were recovered at 1.5 m intervals to the termination depth of boreholes. The sampler was driven by an automatic hammer in accordance with the Standard Penetration Test (SPT) procedure. Standard penetration tests were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata.

The soil samples were identified in the field in accordance with the MTO Soil Classification procedures and transported to the Toronto PML laboratory for further visual classification and testing. Index tests (water content determination, grain size distribution and Atterberg limits) were carried out on selected representative samples.

The groundwater conditions at the borehole locations were observed during the drilling by visual examination of the soil samples, sampler, and drill rods as the samples were retrieved. In addition, water level measurements were taken in the open boreholes upon completion of drilling.

Upon completion of drilling, the boreholes were backfilled in accordance with the MTO guidelines and O.Reg. 903 for borehole abandonment procedures.

#### **4. LABORATORY TEST PROCEDURES**

##### **4.1 Soil Testing**

Laboratory tests on representative Standard Penetration Test (SPT) samples recovered during the fieldwork were conducted by the laboratory owned by PML, located in Toronto. The laboratory testing program included the following:



- Natural moisture content determinations (47)
- Grain size distribution analysis (9)
- Atterberg limit tests (10)

All laboratory tests to determine the index properties were performed in accordance with the MTO test procedures, which follow the American Society for Testing Materials (ASTM) standards, with the exception of hydrometer test (LS-702). The results of the grain size distribution analyses are presented on Figures GS-1 and GS-2. The results of the Atterberg limit tests are represented on Figure PC-1. All test results are summarized on the attached Record of Borehole sheets provided in Appendix A.

## **5. SITE GEOLOGY AND SUBSURFACE CONDITIONS**

### **5.1 Site Geology**

In general, the project area is located within the Mount Elgin Ridges physiographic region, which consists of a series of ridges and vales, as outlined in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984). The ridges are composed mainly of pale brown calcareous clay or silty clay deposits, and it is common to find alluvium of gravel, sand or silt in the vales. The ridges are well drained, while poor drainage prevails in the hollows.

Based on the Bedrock Geology map (MRD126-REV1, 2011) published by the Ontario Ministry of Northern Development and Mines (MNDM), the project site lies within the Dundee rock formation. The project area consists mainly of middle Devonian limestone, dolostone, and shale. The Bedrock Surface map (Map 3.3, 2004) published by Conservation Ontario based on the Middlesex-Elgin Groundwater Study, suggests that the bedrock surface is expected to be encountered at about El. 230.0 to El. 220.1.

The Quaternary Geology map published by the MNDM, indicates that the sub-surface conditions in the area consist of Port Stanley Till, comprised of strongly calcareous, moderate to low clast silt to sandy silt.

Subsurface conditions near Sign 20W located at the west limit of the project area is expected to consist of Catfish Creek Till; consisting of strongly calcareous sandy silt to silt, and Glaciofluvial Outwash deposits; including gravel and sand, as well as proglacial river and deltaic deposits.



## 5.2 Subsurface Conditions

The subsurface conditions encountered during the course of the investigation, together with the field and laboratory test results are shown on the attached Record of Borehole Sheets. The borehole locations are shown on Drawings WBS-1 to WBS-4.

The extent of the site area covers approximately 3.0 km in length and it is not practical to give detail description for the individual strata. For classification purposes, the soil encountered at this site can be divided into four (4) distinct zones:

- a) Silty Sand, with gravel (Fill)
- b) Clayey Silt, some sand, trace/some gravel (Fill)
- c) Silty Clay to Clayey Silt, trace/some sand, trace/some gravel
- d) Silt

Refer to Table 5.2 for details of subsurface conditions such as type of soil, depth and elevation of soil strata encountered at each borehole location.

**Table 5.2 – Summary of Subsurface Conditions at Borehole Locations**

BOREHOLE	SOIL BOUNDARY DEPTH (m)	SOIL BOUNDARY ELEVATION (m)	SOIL TYPE
20-W	0.0 to 1.4	284.5 to 283.1	Compact Silty Sand (Fill)
	1.4 to 3.0	283.1 to 281.5	Stiff to firm Clayey Silt (Fill)
	3.0 to 12.8	281.5 to 271.7	Very stiff to stiff Clayey Silt
17-W	0.0 to 1.4	278.9 to 277.5	Compact Silty Sand (Fill)
	1.4 to 2.2	277.5 to 276.7	Stiff Clayey Silt (Fill)
	2.2 to 9.4	276.7 to 269.5	Very stiff to stiff Silty Clay to Clayey Silt
	9.4 to 12.8	269.5 to 266.1	Compact Silt
23-E	0.0 to 1.4	277.5 to 276.1	Compact Silty Sand (Fill)
	1.4 to 3.0	276.1 to 274.5	Stiff to soft Clayey Silt (Fill)
	3.0 to 9.0	274.5 to 268.5	Firm Clayey Silt
	9.0 to 11.3	268.5 to 266.2	Dense to compact Silt
24-E	0.0 to 1.8	279.7 to 277.9	Dense Silty Sand (Fill)
	1.8 to 3.0	277.9 to 276.7	Very stiff Clayey Silt (Fill)
	3.0 to 9.0	276.7 to 270.7	Very stiff to stiff Clayey Silt
	9.0 to 9.8	270.7 to 269.9	Dense Silt



### 5.3 Groundwater

Refer to Table 5.3 for groundwater level observed during and upon completing of drilling of boreholes.

**Table 5.3 – Summary of Groundwater Levels**

BOREHOLE	GROUND SURFACE ELEVATION	GROUNDWATER LEVEL OBSERVED DURING DRILLING		GROUNDWATER LEVEL MEASURED UPON COMPLETION OF DRILLING	
		DEPTH (m)	ELEVATION (m)	DEPTH (m)	ELEVATION (m)
20-W	284.5	9.1	275.4	10.7	273.8
17-W	278.9	Groundwater not encountered during or upon completion of drilling			
23-E	277.5	2.3	275.2	4.0	273.5
24-E	279.7	9.1	270.6	Groundwater not encountered upon completion of drilling	

Groundwater levels may fluctuate due to the influence of precipitation and seasonal changes. The groundwater measurements were taken prior to backfilling the boreholes. Groundwater levels are shown on the Borehole Logs provided in Appendix A.





## 6. CLOSURE

Mr. A. Hossain and Mr. M. Mohamed carried out the field investigations under the supervision of Mr. N. Rahman, P.Eng., Senior Engineer. Landshark Drilling Inc. of Brantford, Ontario supplied the drilling equipment for the subsurface exploration. Traffic control services were provided by Almon Equipment Inc. of Toronto, Ontario. Surveying of borehole locations were carried out by WSP. The laboratory testing of the selected samples was carried out at the PML laboratory in Toronto.

This report was prepared by Ms. N. Leong-Sem, B.Eng., EIT, Geotechnical Services and reviewed by Mr. N. Rahman, P.Eng., and Mr. M. Vasavithasan, M.Sc.Eng., P.Eng. Senior Engineers, Geotechnical Services. Mr. R. Ng, MBA, PhD, P.Eng., MTO Designated Principal Contact, conducted an independent review of the report.

Yours very truly,

Peto MacCallum Ltd.

Natasha Leong-Sem, B.Eng., EIT  
Geotechnical Services



Nazibur Rahman, P.Eng.  
Senior Engineer, Geotechnical Services



Robert Ng, MBA, PhD, P.Eng.  
Project Manager and  
MTO Designated Principal Contact

NLS/NR/RN:nls-nr-nk



## **APPENDIX A**

Borehole Location Plans – Drawings WBS-1 to WBS-4


Explanation of Terms Used in Report

Record of Borehole Sheets

Results of Grain Size Distribution Analyses – Figures GS-1 and GS-2

Results of Atterberg Limit Tests – Figure PC-1

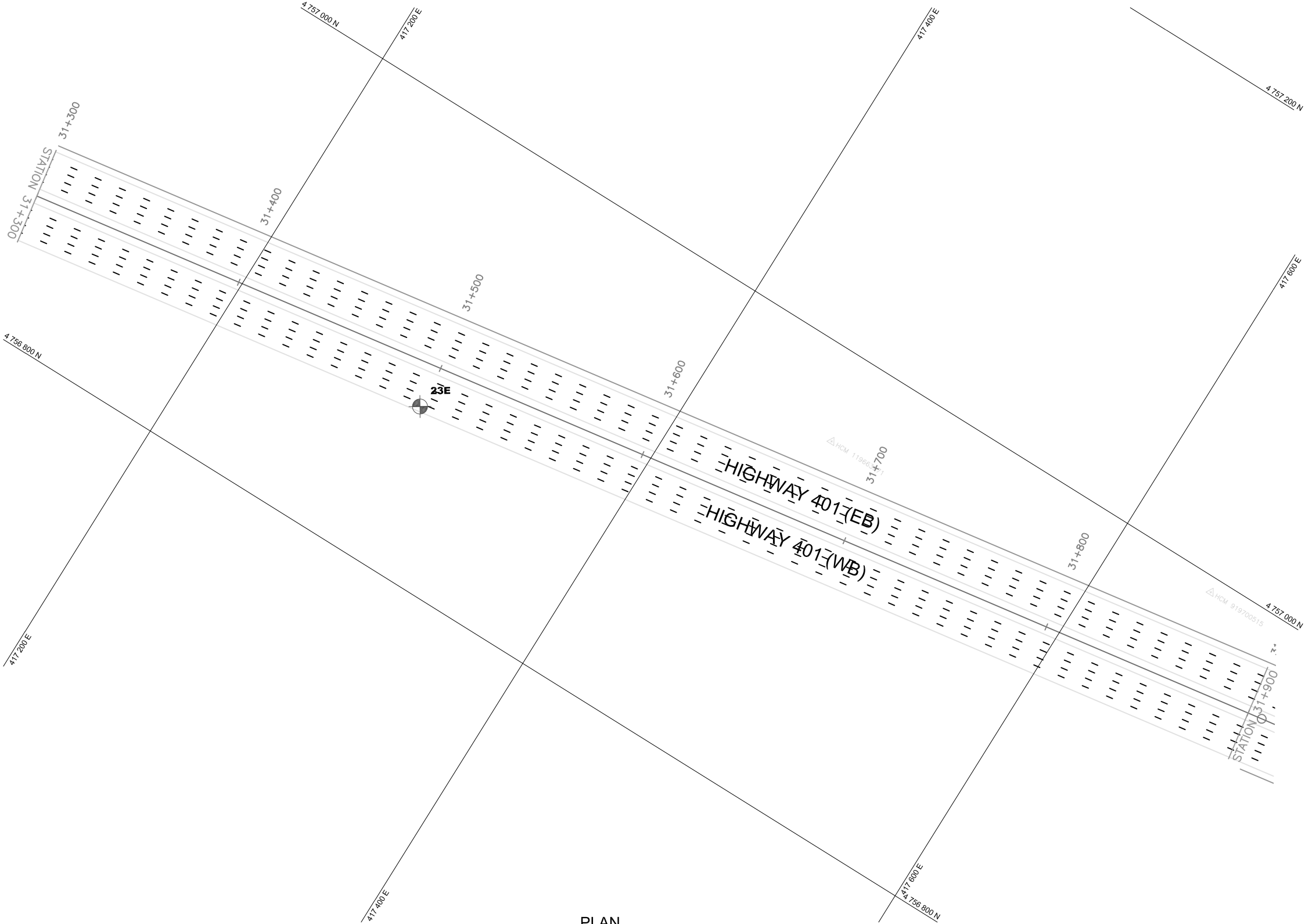


LEGEND			
	23E	Borehole Location	
BH No	ELEVATION	NORTHINGS	EASTINGS
23E	277.5	4 756 874.524	417 298.352

REVISIONS		DATE	BY	DESCRIPTION

Geocres No. 4014-186

HWY No	401	DIST	LONDON
SUBM'D	NL	CHECKED	NR
DATE	FEB. 7, 2019	SITE	
DRAWN	NL	CHECKED	MV
APPROVED	RN	DWG	WBS-1

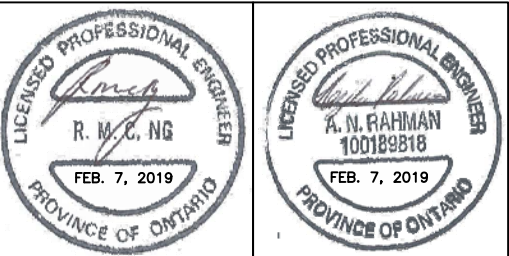


PLAN



NOTES:

- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE LOGS.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
- DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.



Asgmt. No 3016-E-0009



OVERHEAD SIGN REPLACEMENTS  
HIGHWAY 401 AT WESTCHESTER BOURNE  
BOREHOLE LOCATION PLAN

SHEET



LEGEND

**24E**  
Borehole Location

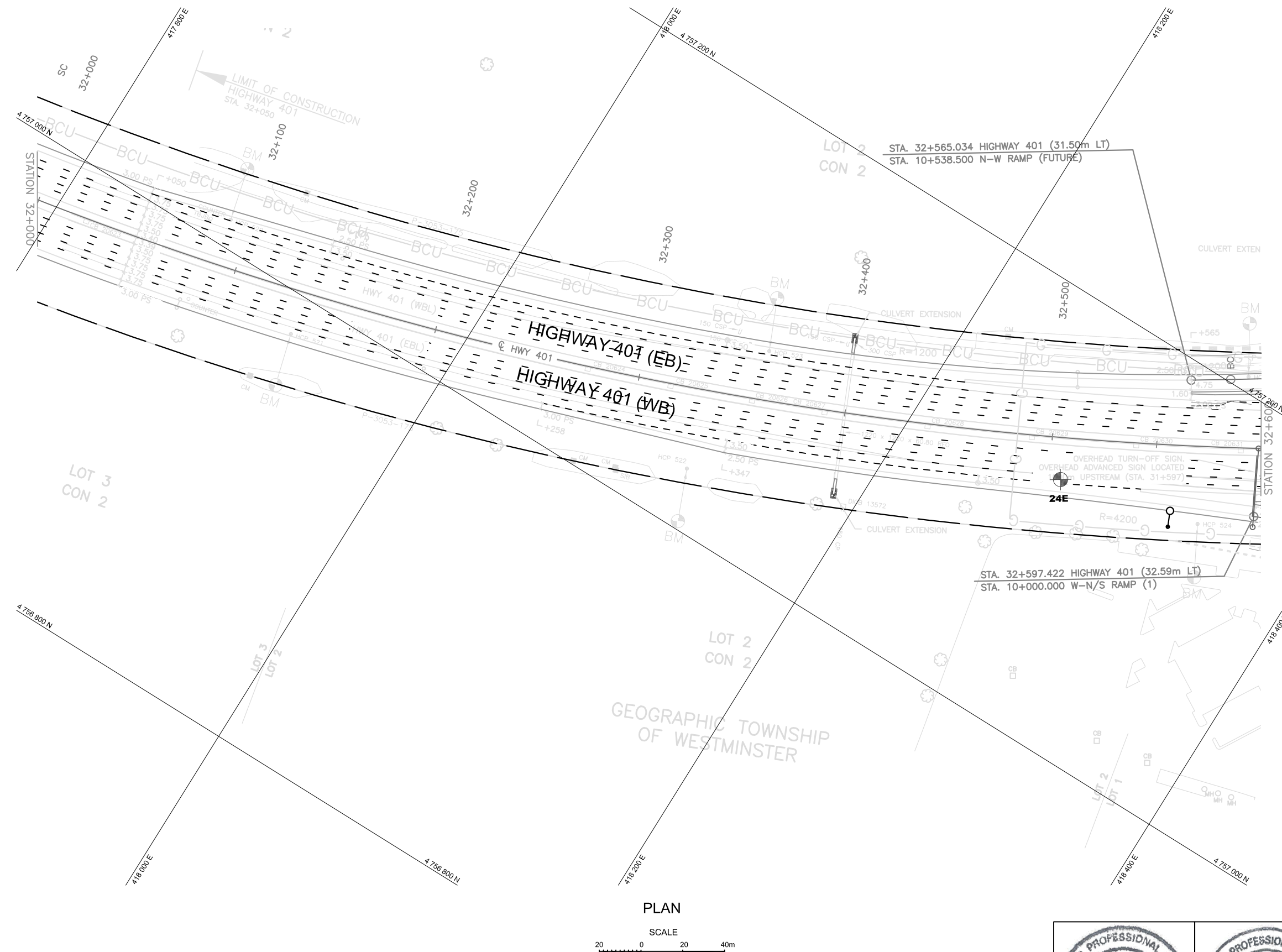
BH No	ELEVATION	NORTHINGS	EASTINGS
24E	279.7	4 757 117.549	418 276.768

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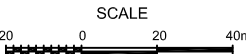
DATE	BY	DESCRIPTION

Geocres No. 4014-186

HWY No	401	DIST	LONDON
SUBM'D	NL	CHECKED	NR
DATE	FEB. 7, 2019	SITE	
DRAWN	NL	CHECKED	MV
APPROVED	RN	DWG	WBS-2



PLAN



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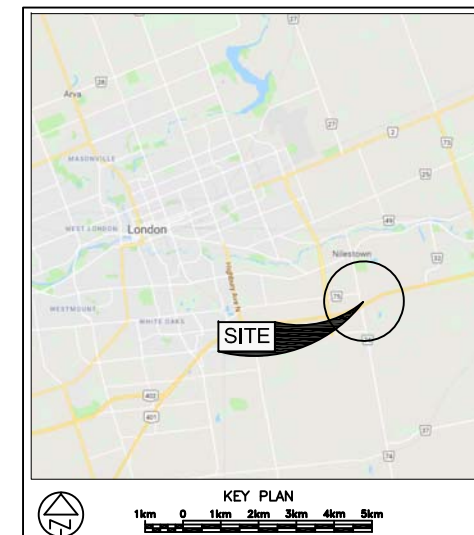


Reference WSP Ltd. Drawing: 3053-New Construction Westchester.dwg, dated April 2018.

SHEET



**Peto MacCallum Ltd**  
CONSULTING ENGINEERS



### LEGEND

**20W**

 Borehole Location

BH No	ELEVATION	NORTHINGS	EASTINGS
20W	284.5	4 757 654.783	419 066.780

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[illegible]

Geocres No. 4014-186

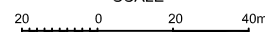
HWY No 401				DIST LONDON	
SUBM'D NL		CHECKED NR	DATE FEB. 7, 2019		SITE
DRAWN NL		CHECKED MV	APPROVED RN		DWG WBS-3

This engineering plan view illustrates the layout of Highway 401, including its eastbound (EB) and westbound (WB) lanes, and associated infrastructure. The drawing is oriented with North at the top. Key features include:

- Highway 401 (EB):** The eastbound lanes are shown with stationing from 10+300 to 10+900. The centerline is marked with a dashed line and the text "HWY 401 (EB)".
- Highway 401 (WB):** The westbound lanes are shown with stationing from 10+300 to 10+900. The centerline is marked with a dashed line and the text "HWY 401 (WB)".
- Ramps and Interchanges:**
  - E-N/S RAMP (1):** Located at station 10+000.000, this ramp connects the highway to the north.
  - S-E RAMP (FUTURE):** Located at station 10+601.386, this future ramp connects the highway to the south.
  - Overhead Turn-off Sign:** Located at station 10+349.616, this sign is for the future S-E ramp.
- Stationing:** The drawing shows stationing from 10+300 to 10+900 along the highway. Key station points include 10+300, 10+349.616, 10+400, 10+500, 10+600, 10+601.386, 10+700, 10+800, and 10+900.
- Easements and Property Lines:**
  - Hydro Easement:** A hydro easement is shown as a dashed line, with a note "HYDRO EASEMENT AS IN INSTRUMENT NE22534".
  - Lot 24 and Lot 23:** The drawing shows Lot 24 and Lot 23, both containing Con 1. The text "GEOGRAPHIC TOWNSHIP OF NORTH DORCHESTER" is also present.
- Other Features:**
  - BCU (Boundary Control Unit):** Several BCU units are shown along the highway.
  - BM (Benchmark):** Several benchmark points are marked with circles and the text "BM".
  - TS (Top of Slope):** A top of slope point is marked with a circle and the text "TS".
  - Limit of Furb Depth Reconstruction:** A line is drawn at station 10+875, with the text "LIMIT OF FURB DEPTH RECONSTRUCTION STA. 10+875".

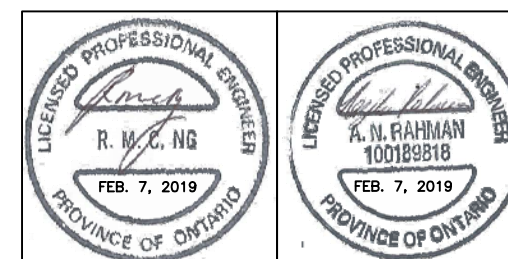
## PLAN

SCALE



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Reference WSP Ltd. Drawing: 3053-New Construction Westchester.dwg, dated April 2018.





LEGEND

**17W**  
 Borehole Location

BH No	ELEVATION	NORTHINGS	EASTINGS
17W	278.9	4 758 120.777	419 961.959


DATE	BY	DESCRIPTION

Geocres No.    4014-186

HWY No	401	DIST	LONDON
SUBM'D	NL	CHECKED	NR
DATE	FEB. 7, 2019	SITE	
DRAWN	NL	CHECKED	MV
APPROVED	RN	DWG	WBS-4

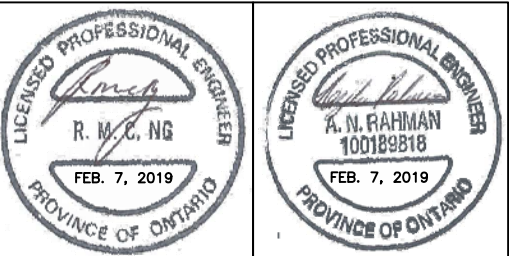


PLAN



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## EXPLANATION OF TERMS USED IN REPORT

**N VALUE:** THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS  $\bar{N}$ .

**DYNAMIC CONE PENETRATION TEST:** CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

**COMPOSITION:** SECONDARY SOIL COMPONENTS ARE DESCRIBED ON THE BASIS OF PERCENTAGE BY MASS OF THE WHOLE SAMPLE AS FOLLOWS:

PERCENT BY MASS	0 - 10	10 - 20	20 - 30	30 - 40	> 40
	TRACE	SOME	WITH	ADJECTIVE (SILTY)	AND (AND SILT)

**CONSISTENCY:** COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

$c_u$ (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

**DENSENESS:** COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

**RECOVERY:** SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

**MODIFIED RECOVERY:** SUM OF THOSE INTACT CORE PIECES, 100mm\* IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINTING AND BEDDING:**

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

S S SPLIT SPOON	T P THINWALL PISTON
W S WASH SAMPLE	O S OSTERBERG SAMPLE
S T SLOTTED TUBE SAMPLE	R C ROCK CORE
B S BLOCK SAMPLE	P H T W ADVANCED HYDRAULICALLY
C S CHUNK SAMPLE	P M T W ADVANCED MANUALLY
T W THINWALL OPEN	F S FOIL SAMPLE
F V FIELD VANE	

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{v0}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_i$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	n	1, %	POROSITY	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE
$\gamma_s$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	w	1, %	WATER CONTENT	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER	$S_r$	%	DEGREE OF SATURATION	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\gamma_w$	kN/m <sup>3</sup>	UNIT WEIGHT OF WATER	$w_L$	%	LIQUID LIMIT	D	mm	GRAIN DIAMETER
$\rho$	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_p$	%	PLASTIC LIMIT	$D_n$	mm	n PERCENT - DIAMETER
$\gamma$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_s$	%	SHRINKAGE LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\rho_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	h	m	HYDRAULIC HEAD OR POTENTIAL
$\gamma_d$	kN/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	q	m <sup>3</sup> /s	RATE OF DISCHARGE
$\rho_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	v	m/s	DISCHARGE VELOCITY
$\gamma_{sat}$	kN/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	DTPL		DRIER THAN PLASTIC LIMIT	i	1	HYDRAULIC GRADIENT
$\rho'$	kg/m <sup>3</sup>	DENSITY OF SUBMERGED SOIL	APL		ABOUT PLASTIC LIMIT	k	m/s	HYDRAULIC CONDUCTIVITY
$\gamma'$	kN/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL	WTP		WETTER THAN PLASTIC LIMIT	j	kN/m <sup>3</sup>	SEEPAGE FORCE
e	1, %	VOID RATIO						

# RECORD OF BOREHOLE No 17W

1 OF 1

METRIC

G.W.P. 3016-E-0009-013 LOCATION Coords: 4 758 120.777 N; 419 961.959 E ORIGINATED BY A.H.  
DIST West Region HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY N.L.  
DATUM Geodetic DATE 2018.10.09 LATITUDE 42.954177 LONGITUDE -81.088592 CHECKED BY M.V.

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
278.9 0.0	GROUND SILTY SAND, with gravel Compact, Brown, Moist		1	SS	22		278							
			2	SS	27		277							
	CLAYEY SILT, some sand Stiff, Brown/Grey, Moist (FILL)		3	SS	9		276							
276.7 2.2	SILTY CLAY TO CLAYEY SILT, trace sand, trace gravel Very stiff to stiff, Brown to grey, Moist		4	SS	23		275							0 1 52 47
			5	SS	24		274							
			6	SS	20		273							
			7	SS	14		272							
			8	SS	10		271							
			9	SS	8		270							
			VANE				269							
			10	SS	10		268							
269.5 9.4	SILT Compact, Grey, Wet		11	SS	30		267							0 0 96 4
			12	SS	14									
			13	SS	30									
266.1 12.8	End of borehole													
NOTES: 1. Groundwater was not encountered during or upon completion of drilling. 2. Upon extraction of hollow stem augers, borehole caved in at a depth of 9.8 m.														

ONTARIO MTO 18KF037A.GPJ ONTARIO MTO.GDT 12/17/18



# RECORD OF BOREHOLE No 20W

1 OF 1

METRIC

G.W.P. 3016-E-0009-013 LOCATION Coords: 4 757 654.783 N; 419 066.780 E ORIGINATED BY A.H.  
 DIST West Region HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY N.L.  
 DATUM Geodetic DATE 2018.10.09 LATITUDE 42.950118 LONGITUDE -81.099655 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)			
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE													
284.5 0.0	GROUND SILTY SAND, with gravel  Compact, Brown, Moist		1	SS	21		284											1 12 58 29			
			2	SS	9		283														
	CLAYEY SILT, some sand Stiff to firm, Brown, Moist (FILL)		3	SS	9		282														
			4	SS	6		281														
281.5 3.0	CLAYEY SILT, some sand, trace gravel Very stiff to stiff, Grey, Moist		5	SS	17			280													0 22 57 21
			6	SS	17			279													
			7	SS	12			278													
			8	SS	11			277													
			9	SS	12			276													
								275													
								274													
								273													
								272													
271.7 12.8	End of borehole																				
	Groundwater level measured during drilling Groundwater level measured upon completion of drilling  NOTE: Upon extraction of hollow stem augers, borehole caved in at a depth of 11.0 m.																				

# RECORD OF BOREHOLE No 23E

1 OF 1

METRIC

G.W.P. 3016-E-0009-013 LOCATION Coords: 4 4 756 874.524 N; 417 298.352 E ORIGINATED BY A.H.  
 DIST West Region HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY N.L.  
 DATUM Geodetic DATE 2018.10.10 LATITUDE 42.943359 LONGITUDE -81.121478 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  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									WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE								
277.5 0.0	GROUND SILTY SAND, with gravel  Compact, Brown, Moist		1	SS	30	 	277										7 20 48 25		
			2	SS	20		276												
	CLAYEY SILT, some sand, trace gravel Stiff to soft, Brown, Moist (FILL)		3	SS	9		275												
			4	SS	3		274												
274.5 3.0	CLAYEY SILT, some sand, trace gravel Firm, Brown, Moist		5	SS	4		273												
			6	SS	5		272												
			7	SS	8		271												
	very stiff to hard grey wet		8	SS	23		270												
			9	SS	37		269												
			10	SS	62/25cm		268												
							267												
268.5 9.0	SILT, trace sand Dense to compact, Grey, Wet		11	SS	44														
			12	SS	28														
266.2 11.3	End of borehole																		
<div> Groundwater level observed during drilling</div> <div> Groundwater level measured upon completion of drilling</div> <div>NOTE: Upon extraction of hollow stem augers, borehole caved-in at a depth of 9.4 m.</div>																			



Groundwater level observed during drilling



Groundwater level measured upon completion of drilling

NOTE: Upon extraction of hollow stem augers, borehole caved-in at a depth of 9.4 m.

# RECORD OF BOREHOLE No 24E

1 OF 1

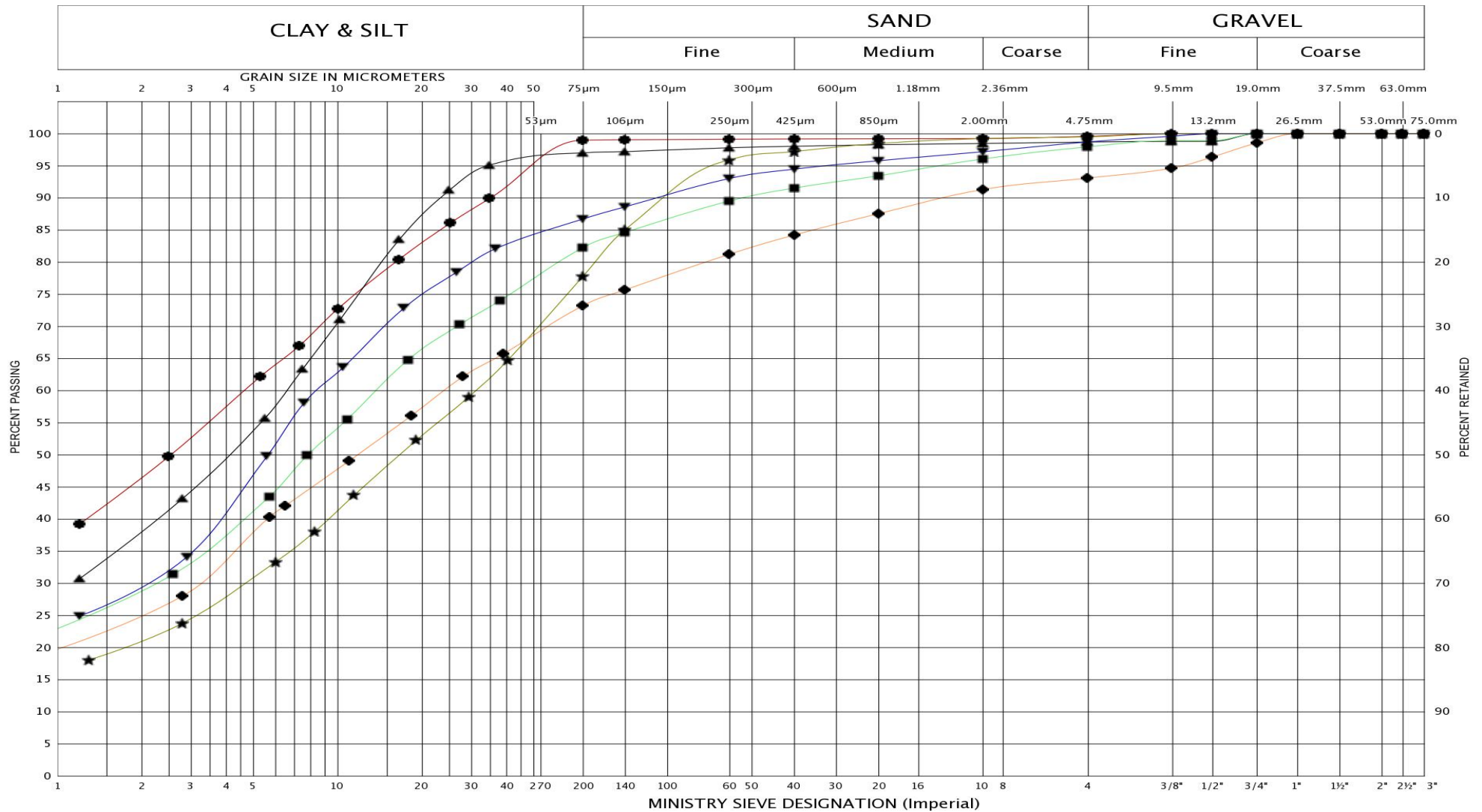
METRIC

G.W.P. 3016-E-0009-013 LOCATION Coords: 4 757 117.549 N; 418 276.768 E ORIGINATED BY A.H.  
 DIST West Region HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY N.L.  
 DATUM Geodetic DATE 2018.10.10 LATITUDE 42.945401 LONGITUDE -81.109443 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT $w_p$	NATURAL MOISTURE CONTENT $w$	LIQUID LIMIT $w_L$	UNIT WEIGHT $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			GR	SA	SI	CL
279.7 0.0	GROUND SILTY SAND, with gravel  Dense, Brown, Moist		1	SS	33		279																
			2	SS	44																		
	CLAYEY SILT, some sand, some gravel Very stiff, Brown, Moist (FILL)		3	SS	25																		
			4	SS	29																		
276.7 3.0	CLAYEY SILT, some sand, trace/some gravel  Very stiff to stiff, Grey, Moist		5	SS	19				276														
			6	SS	10																		
			7	SS	8					275													
				VANE																			
			8	SS	10																		
			9	SS	11					274													
						273																	
						272																	
270.7 9.0	SILT Dense, Grey, Wet		11	SS	43		271																
269.9 9.8	End of borehole																						
	Groundwater level observed during drilling																						
	NOTES: 1. Groundwater was not encountered upon completion of augering. 2. Upon extraction of hollow stem augers, borehole caved in at a depth of 8.5 m.																						

ONTARIO MTO 18KF037A.GPJ ONTARIO MTO.GDT 12/17/18

# UNIFIED SOIL CLASSIFICATION SYSTEM



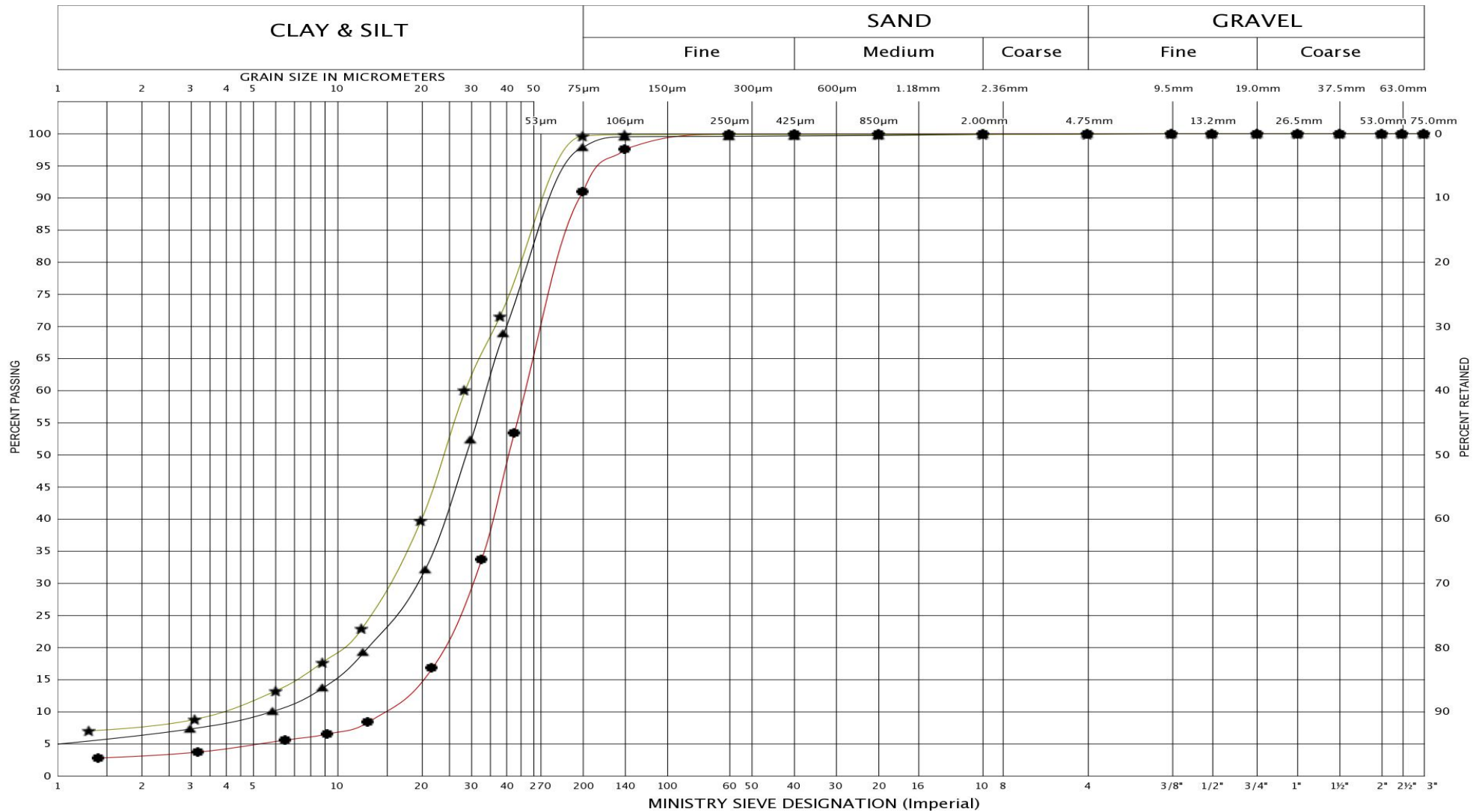
**GRAIN SIZE DISTRIBUTION**  
CLAYEY SILT

FIG No.: GS-1

HWY : 401

GWP 3016-E-0009-013

# UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	17W	23E	24E
	SAMPLE	12	11	11
	SYMBOL	●	▲	★



## GRAIN SIZE DISTRIBUTION

SILT

FIG No.: GS-2

HWY : 401

GWP 3016-E-0009-013

