



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
CAMERA POLE RELOCATION
HIGHWAY 417 NICHOLAS STREET INTERCHANGE
OTTAWA, ONTARIO**

GWP 4048-11-00

Geocres No.: 31G5-298

Report to:

WSP Canada

Latitude: 45.416477
Longitude: -75.674400

January 2019
Thurber File: 17532

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PART 1. FACTUAL INFORMATION

1 INTRODUCTION

This section of the report presents factual findings obtained from a previous foundation investigation that are pertinent to a proposed camera pole relocation at the location of the proposed new Highway 417 Underpass at Nicholas Street within the City of Ottawa. The investigation was originally carried out by Thurber Engineering Limited (Thurber) for the proposed underpass structure replacement. Thurber carried out this assignment as a sub-consultant to WSP Canada (WSP) under G.W.P. 4048-11-00.

The purpose of this section of the report is to provide a borehole location plan, records of boreholes, laboratory test results and a written description of the subsurface conditions in the vicinity of the camera pole based on the results of the previous investigation. The previous investigation is available in the Geocres library and is identified as follows:

Foundation Investigation Report, Structure Replacement, Highway 417
Nicholas Street Underpass (Site #3-224), Ottawa, Ontario, G.W.P. 4048-11-00,
dated April, 2018. [Geocres 31G5-284]

2 SITE DESCRIPTION

The west side of the existing north approach embankment to the Nicholas Street bridge is presently vegetated with grass with ground surface elevations ranging from about 60 m at the toe of the embankment to about 67 m at Nicholas Street. The embankment has a slope inclination of about 4H:1V.

Nicholas Street currently has two southbound lanes and two northbound lanes divided with a raised median. It is approximately 22 m wide. Highway 417 is a six-lane divided highway. A concrete roadside barrier is present on the north side of the highway in the vicinity of the site. The land adjacent to the site is occupied by apartment buildings, single family dwellings and commercial structures.

3 DESCRIPTION OF SUBSURFACE CONDITIONS

3.1 General

Borehole 17-02 from the previous investigation is located in the vicinity of the proposed camera pole. Please refer to Geocres Report 31G5-284 for a full description of investigation methodology. The location of Borehole 17-02 is shown on the Borehole Location Drawing included in Appendix A. Details of the soil stratigraphy encountered in Borehole 17-02 are presented on the Record of Borehole sheets included in Appendix B. Laboratory test results from the samples collected in Borehole 17-02 are included in Appendix C.

A general description of the stratigraphy based on the conditions encountered in Borehole 17-02 is given in the following sections. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description for interpretation of the site conditions. It must be recognized that the soil and groundwater conditions may vary beyond the borehole location.

In general terms, the subsurface conditions at Borehole 17-02 consist of topsoil and fill that contains waste debris (e.g., brick, coal, organics, wood, ash, and glass) overlying native deposits of silty sand, clay, silt, sandy silt with gravel, and glacial till. The overburden is underlain by shale bedrock.

3.2 Topsoil

A layer of silty sand with organics (topsoil fill) was present at the ground surface of Borehole 17-02. The topsoil was 0.2 m thick with a base elevation of 58.8 m.

3.3 Fill

Fill was present below the topsoil. The fill was composed of sand with silt and gravel and contained waste debris (e.g., brick, coal, organics, wood, ash, and glass). The fill was 4.0 m thick with a base elevation of 55.8 m. The fill was generally brown in colour from 0.2 to 3.0 m depth and was brown-black from 3.0 to 4.2 m depth.

The SPT tests conducted in the fill gave N-values ranging from 1 to 23 blows, indicating a very loose to compact state of packing.

The recorded moisture contents of the fill ranged from 14 to 105%, increasing with depth.

The results of grain size distribution testing conducted on two samples of the fill are summarized below and are illustrated on Figure C1 in Appendix C.

Soil Particle	Percentage (%)
Gravel	24 – 40
Sand	52 – 64
Silt	8 – 12
Clay	

3.4 Silty Sand

A layer of native dark brown silty sand with trace gravel (possibly buried topsoil) was present below the fill. The silty sand was 0.4 m thick with a base elevation of 55.4 m.

The recorded moisture content of the silty sand was 53%.

3.5 Marine Clay

A native deposit of sensitive marine clay was present below the silty sand. The clay was grey in colour and was 3.3 m thick with a base elevation of 52.1 m.

One SPT test conducted in the clay gave an N-value of 2 blows. Field vane tests were performed within the deposit and recorded undrained shear strengths ranging from 47 to 87 kPa, indicating a firm to stiff consistency. Remoulded field vane testing in the clay indicates a sensitive to extra-sensitive soil based on criteria provided in the Canadian Foundation Engineering Manual.

The recorded moisture contents of the clay ranged from 46 to 50%.

The results of grain size distribution testing conducted on one sample of the clay are summarized below and are illustrated on Figure C2 in Appendix C.

Soil Particle	Percentage (%)
Gravel	0
Sand	4
Silt	44
Clay	52

Atterberg Limit testing was completed on one sample of the clay. The results are summarized on the Record of Borehole sheets in Appendix B and on Figure C5 in Appendix C. The laboratory results are summarized below and indicate that the clay is of intermediate plasticity (CI).

Parameter	Value
Liquid Limit	42
Plastic Limit	22
Plasticity Index	20

3.6 Silt

A native deposit of silt was present below the marine clay. The silt was 0.8 m thick with a base elevation of 51.3 m.

One SPT test conducted in the silt gave an N-value of 9 blows, indicating a loose state of packing.

The recorded moisture content of the silt was 20%.

3.7 Sandy Silt with Gravel

A native deposit of sandy silt with gravel (a transitional layer between the silt and underlying glacial till) was present below the silt. The sandy silt with gravel was 1.1 m thick with a base elevation of 50.2 m.

One SPT test conducted in the sandy silt with gravel gave an N-value of 'weight of hammer', indicating a very loose state of packing.

The recorded moisture content of the sandy silt with gravel was 7%.

The results of grain size distribution testing conducted on one sample of the sandy silt with gravel are summarized below and are illustrated on Figure C3 in Appendix C.

Soil Particle	Percentage (%)
Gravel	26
Sand	36
Silt	30
Clay	8

Atterberg Limit testing was completed on the fines portion of one sample of the sandy silt. The results of that testing indicate that the sandy silt is non-plastic.

3.8 Silty Sand with Gravel and Shale Fragments (Glacial Till)

A native deposit of silty sand with gravel and shale fragments (glacial till) was present below the sandy silt with gravel. The glacial till was 5.3 m thick with a base elevation of 44.8 m.

SPT tests conducted in the glacial till generally gave N-values ranging from 2 to 29 blows, indicating a very loose to compact state of packing. One SPT test conducted at the base of the deposit gave an N-value of 100 blows for 203 mm of penetration; however, this high blow count is due to the presence of shale bedrock within the sampled interval rather than the state of packing of the soil matrix.

The recorded moisture contents of the glacial till ranged from 6 to 9%.

The results of grain size distribution testing conducted on one sample of the glacial till are summarized below and are illustrated on Figure C4 in Appendix C.

Soil Particle	Percentage (%)
Gravel	27
Sand	54
Silt	19
Clay	

3.9 Shale Bedrock

Shale bedrock was present below the glacial till. The bedrock surface was encountered at a depth of 15.1 m below the existing ground surface (El. 44.8 m). The shale bedrock was cored to a depth of 18.7 m (El. 41.3 m).

The Total Core Recovery (TCR) was consistently 100%, the Solid Core Recovery (SCR) ranged from 98 to 100% and the Rock Quality Designation (RQD) ranged from 78 to 89%. Based on the RQD values, the bedrock is classified as good quality.

3.10 Groundwater

The groundwater level was not monitored within Borehole 17-02 as part of the previous investigation. However, a vibrating wire piezometer was installed in Borehole 17-04 (at the south approach embankment) with its sensor tip at a depth of 16.4 m (elev. 46.2 m) to allow for measurements of the groundwater level. The groundwater level within Borehole 17-04 was measured at approximately 10.4 m depth (elev. 52.2 m) on November 27th, 2017 and on March 22, 2018.

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

3.11 Analytical Testing

One sample of soil was submitted to Paracel Laboratories in Ottawa, Ontario for analysis of water soluble sulphate and chloride concentrations, pH, and resistivity. The analysis results are included in Appendix C and are summarized in the table below:

Borehole	Sample	Depth (m)	Sulphate (µg/g)	pH	Resistivity (Ohm-cm)	Chloride (µg/g)
17-02	SS3	1.5 – 2.1	487	7.46	1930	23

4 MISCELLANEOUS

Interpretation of the factual data and the preparation of this report were carried out by Mr. Stephen Dunlop, P.Eng. The report was reviewed by Dr. Fred Griffiths, P.Eng., a Designated Principal Contact for MTO Foundation Projects.



Stephen Dunlop, M.A.Sc., P.Eng.
Senior Geotechnical Engineer








Dr. Fred Griffiths, Ph.D., P.Eng.
Senior Associate
Senior Geotechnical Engineer

CAMERA POLE RELOCATION
HIGHWAY 417 NICHOLAS STREET INTERCHANGE

Appendix A.
Borehole Location Plan



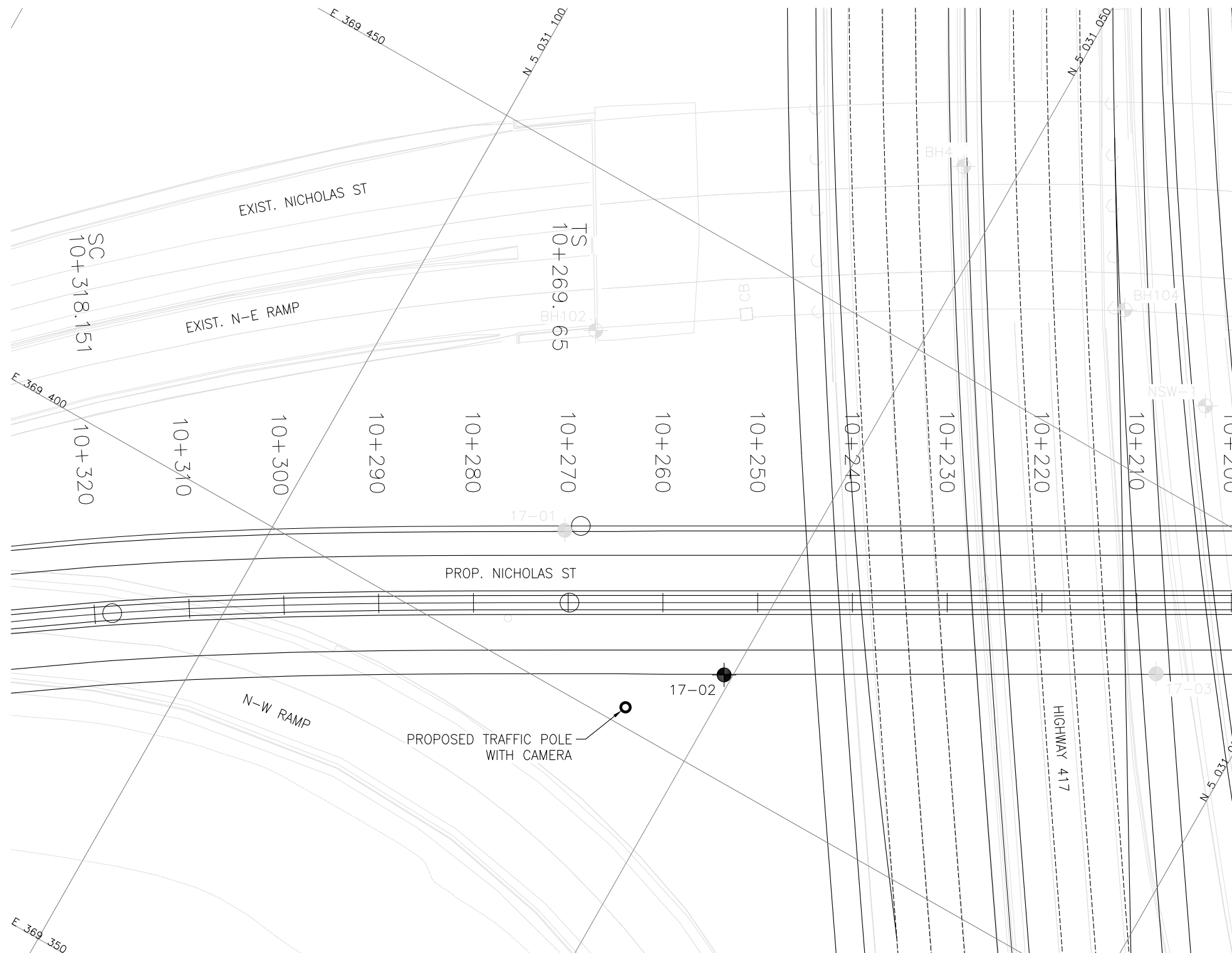
LEGEND

	Borehole (Current Investigation)
	Borehole (Previous Investigation)
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

[illegible]

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

REVISIONS									
	DATE	BY	DESCRIPTION						
DESIGN	SD	CHK	—	CODE	LOAD		DATE	JAN 2019	
DRAWN	MFA	CHK	SD	SITE	STRUCT		DWG	1	



PLAN



CAMERA POLE RELOCATION
HIGHWAY 417 NICHOLAS STREET INTERCHANGE

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).

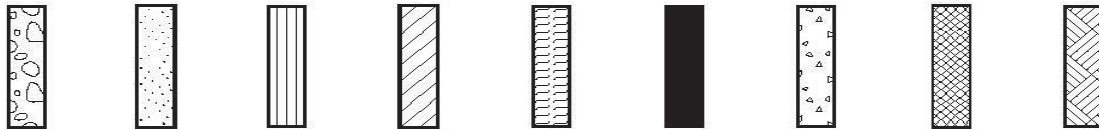
DYNAMIC CONE PENETRATION TEST (DCPT):

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 17-02

1 OF 2

METRIC

GWP# 4048-11-00 LOCATION Nicholas Street Interchange - MTM z10: N 369 410.0 E 5 031 050.8 ORIGINATED BY KE
HWY 417 BOREHOLE TYPE Hollow Stem Augers / NW Casing / NQ Core COMPILED BY KE
DATUM Geodetic DATE 2017.10.19 - 2017.10.23 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
							WATER CONTENT (%)						
							20 40 60						
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT						
							W P W W L						
60.0													
0.0													
0.2	<div><div>SILTY SAND with organics</div><div>Compact</div><div>Brown</div><div>FILL</div></div>		1	SS	23								40 52 8 (SI+CL)
	<div><div>SAND with silt and gravel</div><div>with WASTE: brick, coal, organics, wood fragments, ash, glass</div><div>Very loose to compact</div><div>Brown</div><div>FILL</div></div>		2	SS	7		59						
			3	SS	6		58						
			4	SS	8		57						
	becoming brown-black at 3.0 m		5	SS	1		56						24 64 12 (SI+CL)
55.8			6	SS	5		55						
4.2	<div><div>SILTY SAND trace gravel</div><div>Loose</div></div>						54						
55.4	Dark brown						53						
4.6	<div><div>CLAY (Cl)</div><div>Stiff</div><div>Grey</div></div>		7	SS	2		52						0 4 44 52
			8	ST	Push		51						
							50						
52.1			9	SS	9		49						
7.9	<div><div>SILT</div><div>Loose</div><div>Grey</div></div>						48						
51.3							47						
8.7	<div><div>SANDY SILT with gravel</div><div>Very loose</div><div>Grey</div></div>						46						
			10	SS	WH		45						26 36 30 8 non-plastic
50.2							44						
9.8	<div><div>SILTY SAND (SM) (Glacial Till)</div></div>						43						

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
20
15
10
(%) STRAIN AT FAILURE

ONTMT4S_17532_NICHOLASINTERCHANGE.GPJ 2012TEMPLATE(MTO).GDT 9/4/18

METRIC

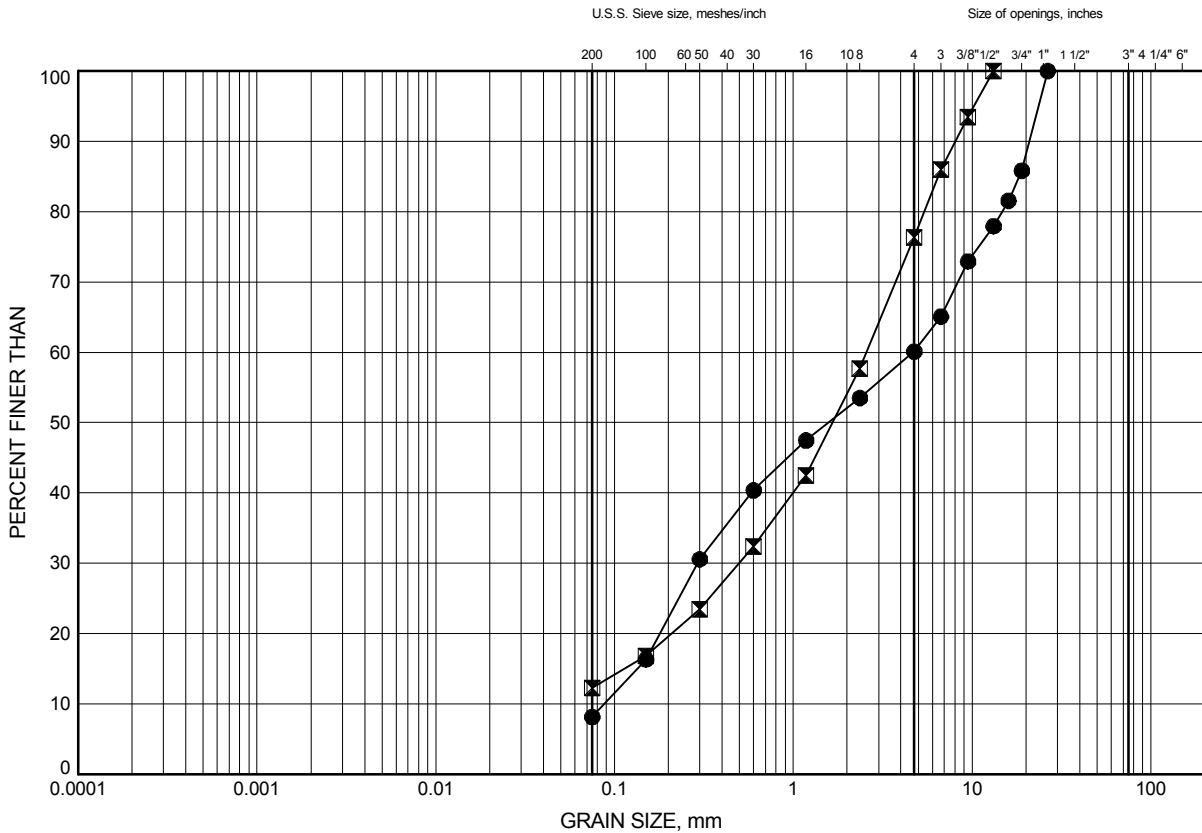
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+³, ×³: Numbers refer to Sensitivity

Appendix C.
Laboratory Testing

GRAIN SIZE DISTRIBUTION

FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-02	0.53	59.44
⊠	17-02	3.35	56.62

Date May 2018

GWP# 4048-11-00

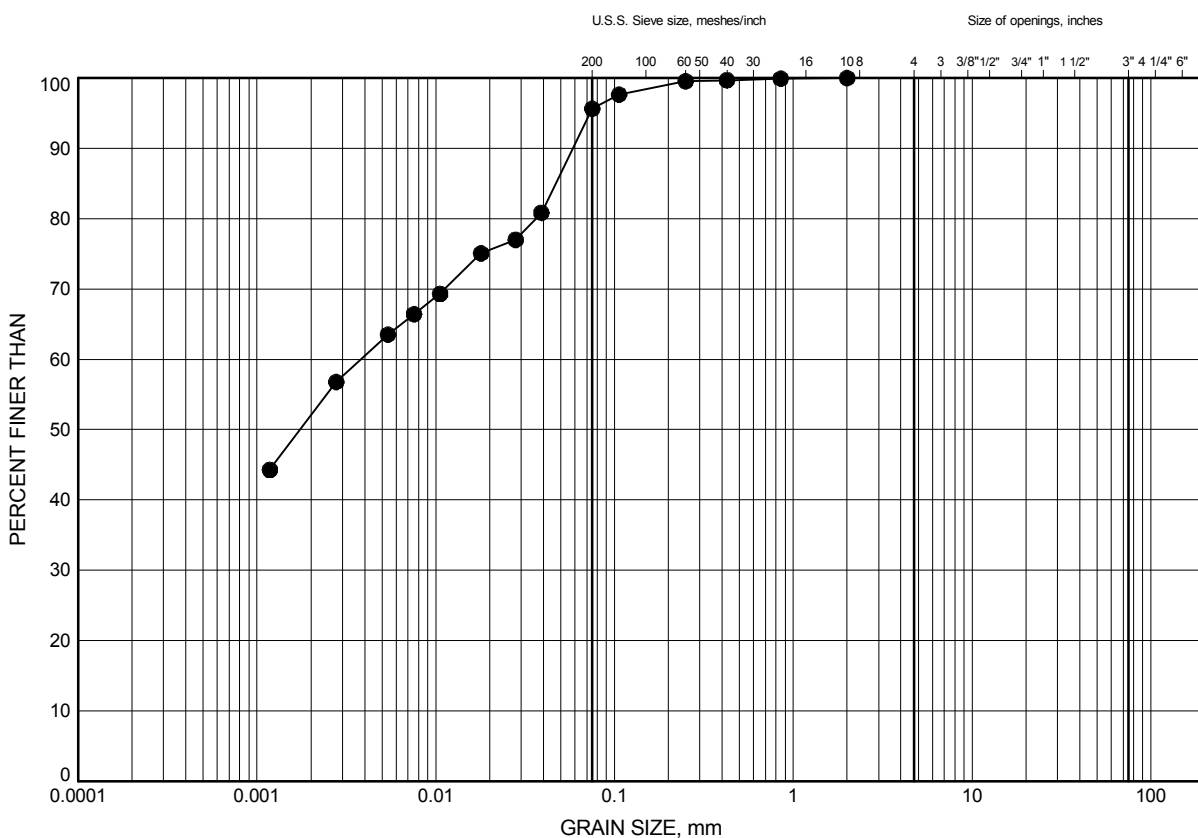


Prep'd KE

Chkd. SD

GRAIN SIZE DISTRIBUTION

CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-02	4.88	55.09

Date May 2018

GWP# 4048-11-00

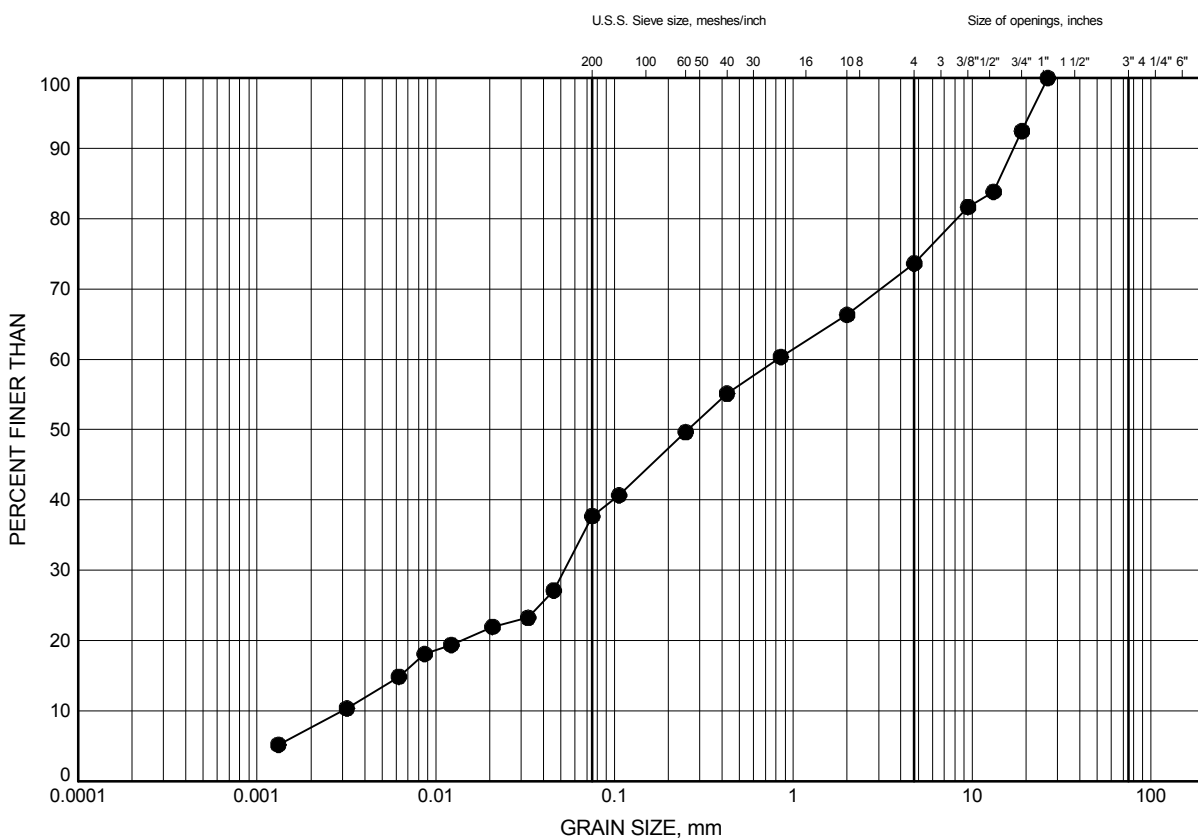


Prep'd KE

Chkd. SD

GRAIN SIZE DISTRIBUTION

SANDY SILT WITH GRAVEL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-02	9.45	50.52

Date May 2018

GWP# 4048-11-00

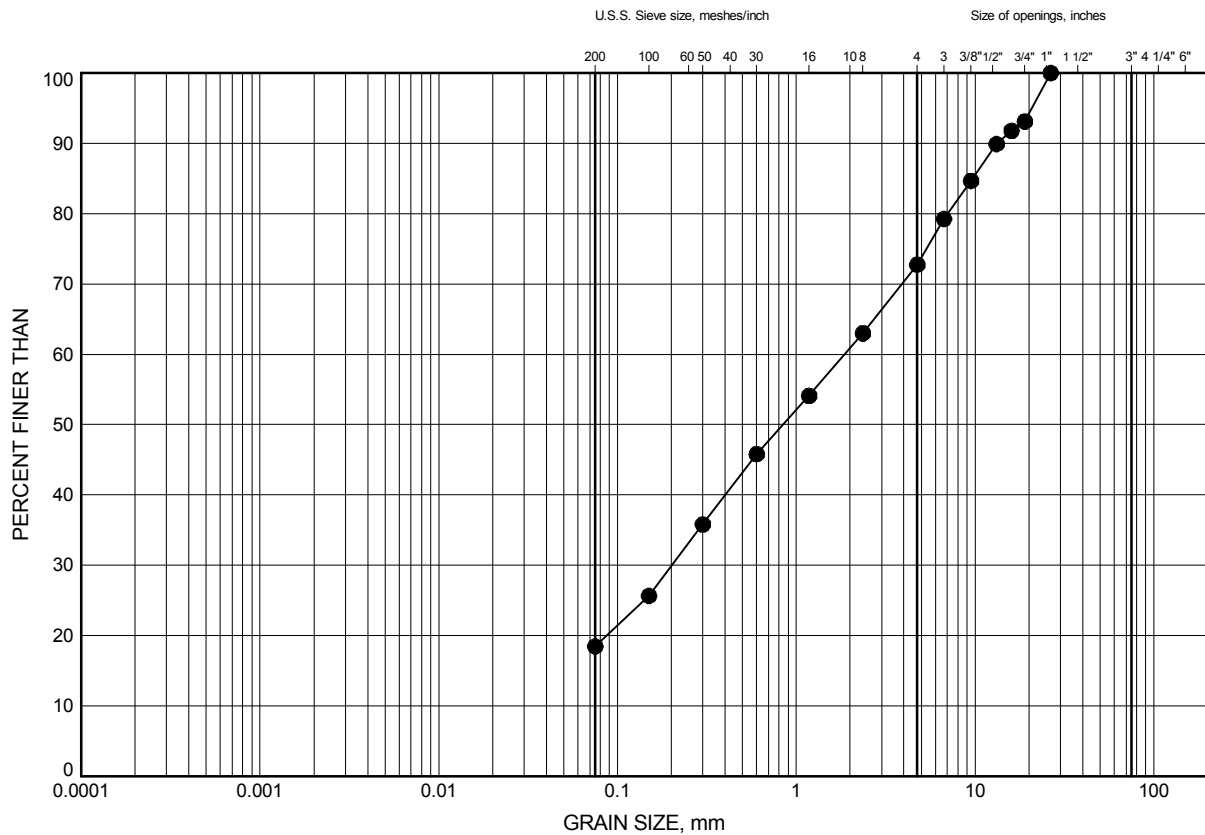


Prep'd KE

Chkd. SD

GRAIN SIZE DISTRIBUTION

GLACIAL TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-02	13.72	46.25

Date May 2018

GWP# 4048-11-00



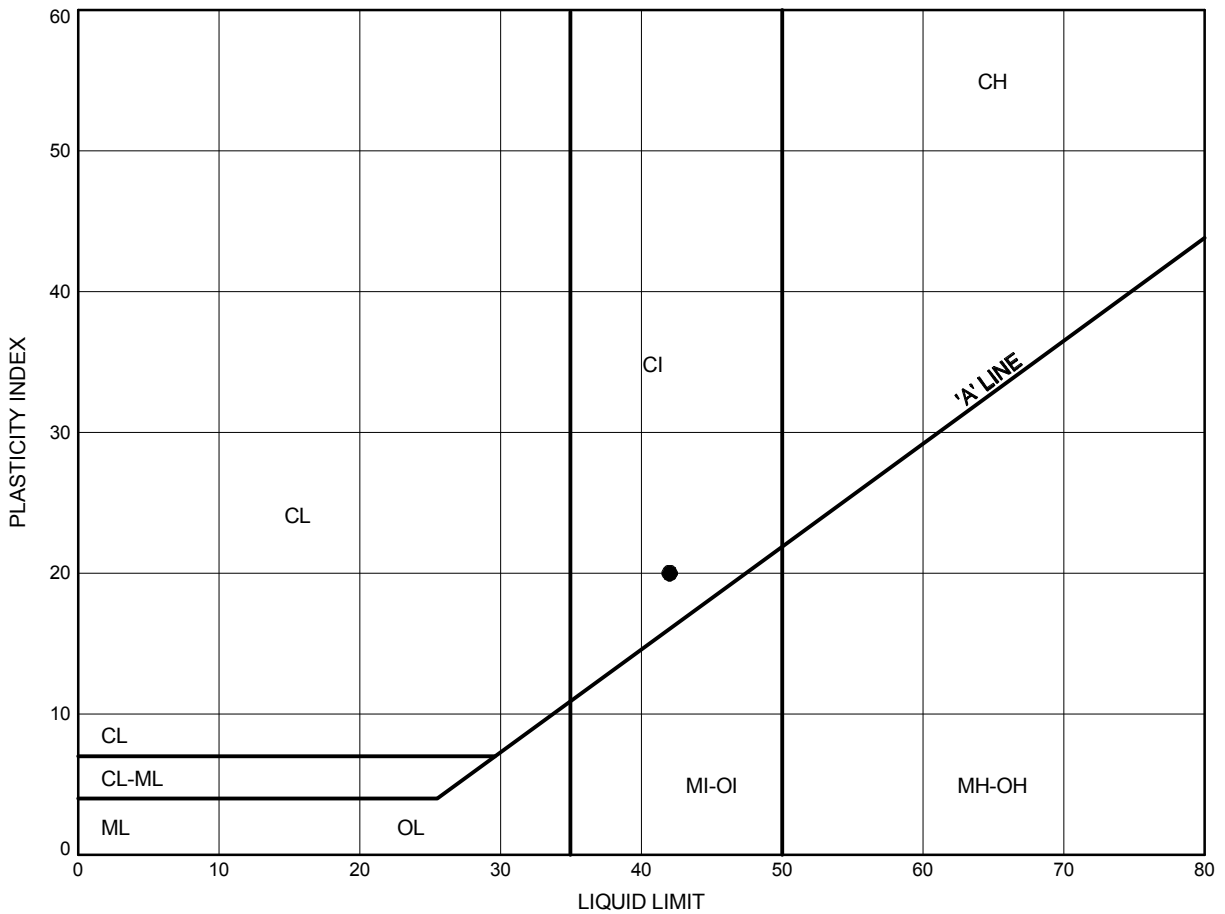
Prep'd KE

Chkd. SD

Nicholas Street Interchange Camera Replacement
ATTERBERG LIMITS TEST RESULTS

FIGURE C5

CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-02	4.88	55.09

Date May 2018
 GWP# 4048-11-00



Prep'd KE
 Chkd. SD