

**DRAFT REPORT**

**Foundation Investigation  
New Staging Area  
Booth Street and Rochester Street  
Rapid Bridge Replacements  
Ottawa, Ontario**

*G.W.P. 4173-15-00*

Submitted to:

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GEOCREs No. -

1655214-1150

Latitude: 45.404334°

Longitude: -75.708168°

August 2020



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**PART A**

Foundation Investigation  
New Staging Area  
Booth Street and Rochester Street  
Rapid Bridge Replacements  
Ottawa, Ontario

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## 1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by WSP Canada Group Limited (WSP) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out foundation investigations associated with the detailed design of numerous bridge replacements, overhead signs, noise barrier walls, retaining walls, temporary roadway protection systems, replacement of storm sewers (including trenchless crossings), and a high fill embankment on Highway 417 between Island Park Drive and Kent Street in Ottawa, Ontario (Assignment number 4016-E-0001).

This report presents the results of the foundation investigation carried out for a second proposed staging area for the Booth Street and Rochester Street Rapid Bridge Replacements in Ottawa, Ontario.

The work described herein was not included in the original Terms of Reference for this assignment or the scope of work for Foundations Engineering outlined in the MTO's Request for Proposal, dated April 2016, subsequent addenda or included as part of Golder's original scope of work for Foundations Engineering services contained in WSP's Technical Proposal.

The scope of work for the foundation engineering services associated with this investigation was outlined in Golder's Scope Change #8 Technical Memorandum dated November 11, 2019. The investigation program was developed to meet the requirements of Table 17.8a of the RFP Terms of Reference.

The work has been carried out in accordance with Golder's Quality Control Plan for foundation engineering services for the project dated August 29, 2016.

## 2.0 SITE DESCRIPTION AND GEOLOGY

### 2.1 Site Description

The presently proposed staging area site is located to the north of Raymond Street, between Rochester and Booth Streets, in Ottawa. The site is a former Community Housing Site that was scheduled for redevelopment. At the time of the investigation all the existing buildings had been demolished, foundations were removed, and the site had been restored including backfilling the basement/crawlspace excavations with a granular fill. Golder was not present during demolition or during site restoration activities. At present the site is generally flat with some trees, grass and brush cover.

The location of the proposed staging area is shown on the Key Plan on Drawing 1. Site photographs showing the general conditions at the site are presented in Appendix D.

### 2.2 Regional Geology

As delineated in *The Physiography of Southern Ontario*<sup>1</sup>, the proposed staging area lies within the minor physiographic region known as the Ottawa Valley Clay Plain, which lies within the major physiographic region of the Ottawa-St. Lawrence Lowland.

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<sup>1</sup> Chapman, L. J. and Putnam, D. F., 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey. Special Volume 2, Third Edition. Accompanied by Map P.2715, Scale 1:600,000. Ontario Ministry of Natural Resources

The Ottawa Valley Clay Plain region is characterized by relatively thick deposits of sensitive marine clay, silt and silty clay that were deposited within the former Champlain Sea basin. These deposits, known as the Champlain Sea clay or Leda clay, overlie relatively thin, commonly reworked glacial till and glaciofluvial deposits, that in turn overlie bedrock<sup>2</sup>.

This region is underlain by a series of sedimentary rocks, consisting of sandstones, dolostones, limestones and shales that are, in turn, underlain at depth by igneous and metamorphic bedrock of the Precambrian Shield. Regional bedrock mapping indicates that the bedrock west of Parkdale Avenue is dominantly interbedded limestone and dolomite of the Gull River Formation. East of Parkdale Avenue, the bedrock is indicated to be limestone of the Verulam Formation.<sup>3</sup> The limestone is described as interbedded bioclastic, sublithographic to fine crystalline with very thin to medium bedded shale interbeds up to 8 cm thick. Bedrock outcrops are mapped north and south of Highway 417 from about Fairmount Avenue to Bronson Avenue.

Highway 417 crosses two main faults striking southeast to northwest. The more prominent fault, the Gloucester fault, crosses Highway 417 at the approximate location of Preston Street<sup>4</sup>. The second fault crosses Highway 417 at the approximate location of Kent Street. Bedding which is normally sub-horizontal often dips steeply adjacent to and within fault zones.

The site falls within the Western Québec (WQ) seismic zone according to the Geological Survey of Canada. The WQ zone constitutes a large area which encompasses the urban areas of Montreal, Ottawa-Hull and Cornwall. Within the WQ zone recent seismic activity has been concentrated in two subzones: one along the Ottawa River and another more active subzone along the Montreal-Maniwaki axis. The two major earthquakes that have recently occurred in the WQ zone are the 1935 Témiscaming event, which had a magnitude (i.e., a measure of the intensity of the earthquake) of 6.2, and the 1944 Cornwall-Massena event, which had a magnitude of 5.6.

## 3.0 INVESTIGATION PROCEDURES

### 3.1 Current Investigation

The field work for the current investigation was carried out in Spring 2020 and included advancing a total of three boreholes, numbered 20-101 to 20-103 across the site.

The boreholes were advanced using truck-mounted drilling equipment supplied and operated by George Downing Estate Drilling of Hawkesbury, Ontario.

Soil samples in the boreholes were obtained at vertical sampling intervals of about 0.76 m, using a 50 mm outer diameter split-spoon sampler in general accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586). Bedrock core samples were obtained in all three boreholes using HQ sized equipment.

Monitoring wells were installed in all three boreholes to measure the groundwater level across the site. The monitoring wells consisted of 50 mm outside diameter PVC tubing with a 1.5 m long slotted tip. The groundwater levels were measured in the wells by WSP on June 15, 2020, approximately one week after drilling.

<sup>2</sup> Belanger, J.R. "Urban Geology of Canada's National Capital Area", in *Urban Geology of Canadian Cities*, Geological Association of Canada Special Paper 42, Ed. P.F. Karrow and O.L. White, 1998.

<sup>3</sup> Urban geology of the National Capital area / Géologie urbaine de la région de la Capitale nationale; Bélanger, R. Geological Survey of Canada, Open File 5311, 2008; 1 DVD, <https://doi.org/10.4095/226165>

<sup>4</sup> MacDonald, G. and Harrison, J.E. 1976: Generalized Bedrock Geology, Ottawa-Hull, Ontario and Quebec, Geological Survey of Canada, Map 1508A, scale 1:125,000. Geology 1967

The field work was supervised on a full-time basis by members of Golder's staff who located the boreholes in the field, directed the drilling, sampling, and in-situ testing operations, logged the boreholes and examined and cared for the samples. The soil and bedrock core samples were identified in the field, placed in labelled containers and transported to Golder's laboratory in Ottawa for further examination and testing. Unconfined compressive strength testing was carried out on select bedrock core samples of the bedrock at Stantec Consulting Ltd.'s Ottawa laboratory. The laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate.

The borehole locations and elevations were surveyed by Golder using a Trimble R10 GPS unit referenced to the NAD83 CSRS CBNv6-2010.0 MTM Zone 9 geodetic datum. The borehole locations, including northing and easting coordinates, ground surface elevations, and drilled depths, are summarized in Table 1.

**Table 1: Summary of Borehole Locations**

Borehole	NAD83 CSRS CBNv6-2010.0 MTM Zone 9		Ground Surface Elevation (m)	Drilled Length (m)
	Northing (m)	Easting (m)		
20-101	5029632.0	366753.8	64.7	4.2
20-102	5029682.4	366786.5	66.1	4.4
20-103	5029736.5	366791.8	66.8	4.4

## 3.2 Previous Investigations

As part of the current assignment, previously collected subsurface information pertinent to the proposed staging area site was reviewed and compiled.

The Record of Borehole sheets from the previous investigations pertinent to the current sites are provided for reference in Appendix C. The borehole locations and ground surface elevations for these boreholes are shown on Drawing 1. The subsurface conditions within the boreholes from the previous investigations are referenced in Section 4.0, only with respect to the bedrock conditions.

### 3.2.1 Replacement of Sites 3-56/1 & 3-56/2

A foundation investigation was carried out for the rapid bridge replacement of the Highway 417 Overpass Structures at Rochester Street (Sites 3-56/1 and 3-56/2) by Golder in 2018 and 2019. The subsurface information and results of the investigation are contained in the report titled:

- Foundation Investigation and Design Highway 417 Overpass Structures at Rochester Street Rapid Bridge Replacement Sites: 3-56/1 and 3-56/2, Ottawa, Ontario, dated July 2019, (Report No. 1655214-1110), GEOCREs No. 31G5-295.

A total of 24 coreholes and four boreholes were advanced along Rochester Street and twelve boreholes within the Highway 417 approach embankments. In particular, Boreholes 17-113 and 17-114, were advanced along the north side of Highway 417, east and west of Rochester Street to the southwest of the proposed staging area. In general, at the borehole locations the subsurface conditions consist of PCC sidewalk overlying a thin layer of sand fill materials, underlain by limestone bedrock.

### 3.2.2 Replacement of Sites 3-57/1 and 3-57/2

A foundation investigation was carried out for the rapid bridge replacement of the Highway 417 Overpass Structures at Booth Street (Sites 3-57/1 and 3-57/2) by Golder in 2018 and 2019. The subsurface information and results of the investigation are contained in the report titled:

- Foundation Investigation and Design Highway 417 Overpass Structures at Booth Street Rapid Bridge Replacement Sites: 3-57/1 and 3-57/2, Ottawa, Ontario, dated July 2019, (Report No. 1655214-1120), GEOCREs No. 31G5-308.

A total of 24 coreholes and four boreholes were advanced along Booth Street and eight boreholes within the Highway 417 approach embankments. In particular, Boreholes 17-123 and 17-124 were advanced along the north side of Highway 417, east and west of Booth Street, to the southeast of the proposed staging area. In general, at the borehole locations the subsurface conditions consist of PCC sidewalk at surface, overlying granular sand fill materials, underlain by limestone bedrock.

### 3.2.3 Retaining Wall Rehabilitation and Replacement Highway 417

A foundation investigation was carried out for the Rehabilitation and Replacement of a series of Retaining Walls along Highway 417 from Holland Avenue to Kent Street Golder in 2018 and 2019. The subsurface information and results of the investigation are contained in the report titled:

- Foundation Investigation and Design Retaining Wall Rehabilitation and Replacement Highway 417 from Holland Avenue to Kent Street Ottawa, Ontario March 2020, (Report No. 1655214-1900), GEOCREs No. 31G5-315.

A total 20 boreholes were advanced at the various retaining wall locations. In particular, Boreholes 18-908 and 18-909 were advanced on the south side of Raymond Street to the east of Booth Street to the southeast of the proposed staging area. In general, at the borehole locations the subsurface conditions consist of asphaltic concrete/topsoil surface cover, overlying granular sand fill materials, over glacial till, underlain by limestone bedrock.

## 4.0 DESCRIPTION OF SUBSURFACE CONDITIONS

### 4.1 General

The subsurface soil, bedrock and groundwater conditions encountered in the boreholes and the results of in-situ testing from the current investigation are given on the Record of Borehole and Drillhole sheets presented in Appendix A. The results of the laboratory testing carried out during the current investigation are presented on the Record of Borehole sheets as well as on Figure B1 in Appendix B. The borehole locations and the interpreted stratigraphic profile projected along across the site for the current investigation are provided on Drawing 1.

Photographs of the bedrock core recovered are shown on Figures A1 to A6 provided in Appendix A.

The stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic sections from Drawing 1 are inferred from observations of drilling progress and noncontinuous sampling and therefore represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

A detailed description of the overburden soil deposits, bedrock geology and groundwater conditions encountered at the proposed staging area during the field investigation is provided in the following sections.

## 4.2 Site Stratigraphy Overview

In general, the subsurface conditions at the borehole locations advanced within the proposed staging area consists of granular fill underlain by limestone bedrock.

The groundwater levels measured at the staging area sites ranged from 3.2 to 3.4 m in depth, corresponding to Elevations 63.4 to 61.5 m

A more detailed description of the overburden soil deposits, bedrock geology and groundwater conditions encountered during the field investigation is provided in the following sections.

### 4.2.1 Fill Materials

Fill consisting predominantly of sand with varying amount of gravel and silt was encountered at the ground surface of all three boreholes. The top of this layer was encountered at elevations ranging from 66.8 to 64.7 m. The thickness of this layer ranges from about 1.2 to 1.3 m. Cobbles were noted in this layer. Debris, including brick, glass and wood fragments, was also observed throughout the fill. SPT N values ranging from 6 to 24 blows per 0.3 m of penetration were measured in this layer, indicating a loose to compact state of packing. The SPT blow count (i.e., > 50) noted on the Record of Boreholes for 20-102 and 20-103 may have been influenced by the presence of the bedrock beneath the fill layer rather than the state of packing of the soil matrix.

## 4.3 Bedrock

Regional bedrock mapping indicates that the proposed staging area site is underlain by limestone bedrock.

Bedrock core samples were obtained in all three boreholes from the current investigation using HQ sized equipment. Photographs of the bedrock core from the current investigation are provided in Appendix A.

Bedrock was also proven by coring using NQ sized equipment in Boreholes 17-113, 17-114, 17-123, 17-124, 18-908 and 18-909 during the previous investigations.

Table 2 summarizes the depths and the elevations of the bedrock surface as encountered at the borehole locations from both the current and previous investigations.

**Table 2: Summary of Bedrock Surface Depths and Elevations UCS Test Results**

Borehole	Existing Ground Surface Elevation (m)	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)	UCS Test Results (MPa)
20-101	64.7	1.3	63.4	156
20-102	66.1	1.3	64.8	153
20-103	66.8	1.2	65.6	140
17-113	63.8	1.2	62.6	N/A
17-114	63.8	1.1	62.7	60
17-123	66.3	1.2	65.2	N/A
17-124	66.4	0.9	65.5	N/A
18-908	66.7	1.6	65.1	66
18-909	69.1	3.1	66.0	N/A

The bedrock encountered during the coring operations was slightly weathered to fresh and thinly to medium bedded limestone. Thin shale partings were also present in the bedrock core. Rock Quality Designation (RQD) values measured on recovered bedrock core samples from the current investigation ranged from about 48 to 99 percent, indicating a poor to excellent quality rock.

The results of UCS testing carried out on three bedrock core samples from the current investigation are summarized in Table 2 and are presented on Figure B1 provided in Appendix B. These results indicate a very strong bedrock.

#### 4.4 Groundwater Conditions

Monitoring wells were installed in all three boreholes and the groundwater levels were measured on June 15, 2020 by WSP. Table 3 summarizes the depths and the elevations of the groundwater levels measured in the monitoring wells installed during the current investigation. It is expected that the groundwater levels will be subject to fluctuations both seasonally and as a result of precipitation events.

**Table 3: Summary of Groundwater Conditions**

Borehole	Screened Interval	Depth (m)	Elevation (m)
20-101	Limestone Bedrock	3.2	61.5
20-102		3.3	62.8
20-103		3.4	63.4

## 5.0 CLOSURE

This report was prepared by Mr. Kenton Power, P.Eng. It was reviewed by Mr. Bill Cavers, P.Eng., a Senior Geotechnical Engineer and Associate with Golder. Mr. Fintan Heffernan, P.Eng. a Senior Consultant with Golder and the Designated MTO Foundations Contact for this project, carried out an independent quality control review of this report.

### **Golder Associates Ltd.**



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KCP/WC/FJH/hdw

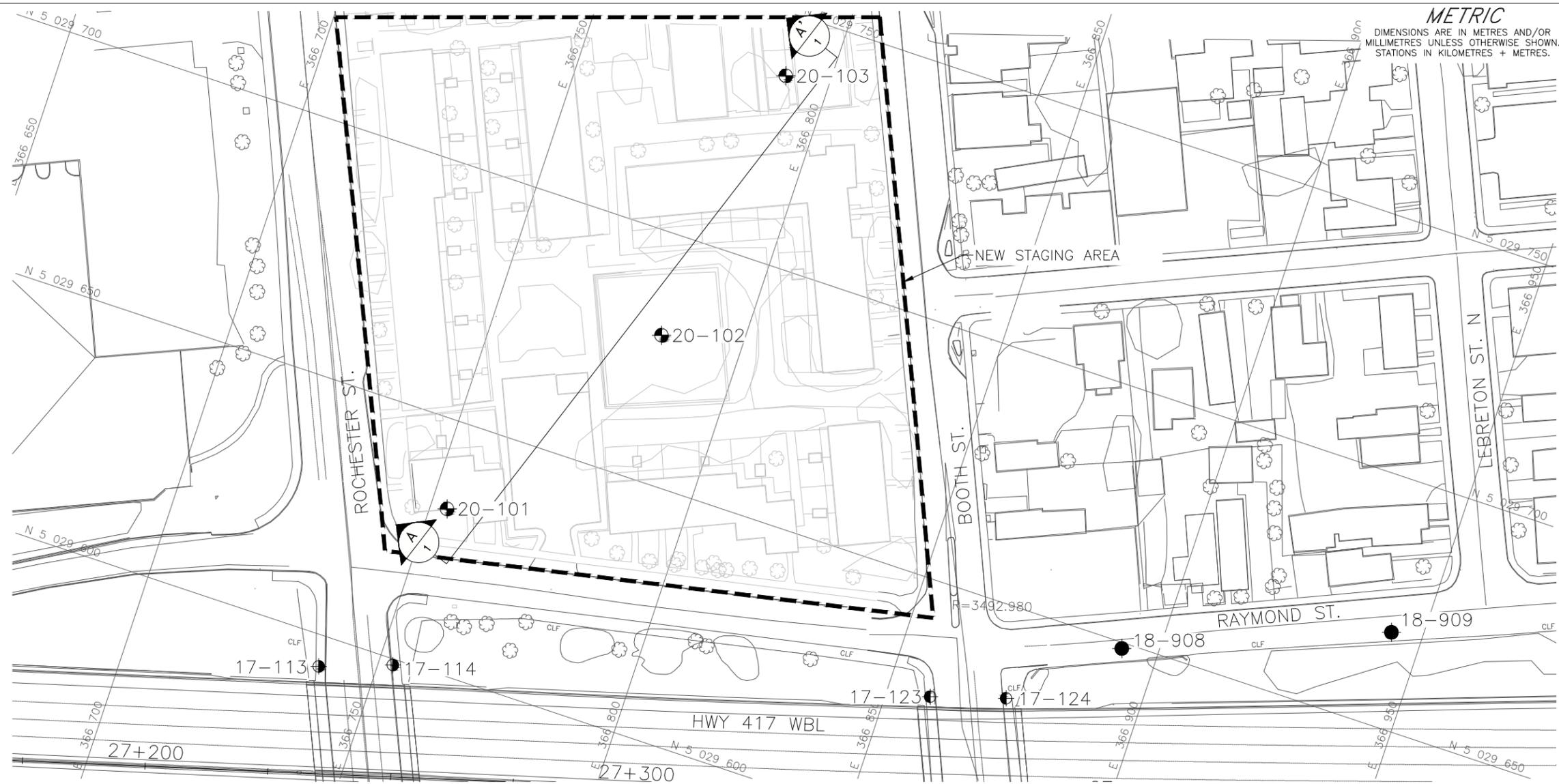
<https://golderassociates.sharepoint.com/sites/18579g/foundations/6-reports/1150-new-staging-area/draft-staging-area/rev1-new-staging/1655214-1150-reva-new-booth-rochester-sa-2020-07-30.docx>

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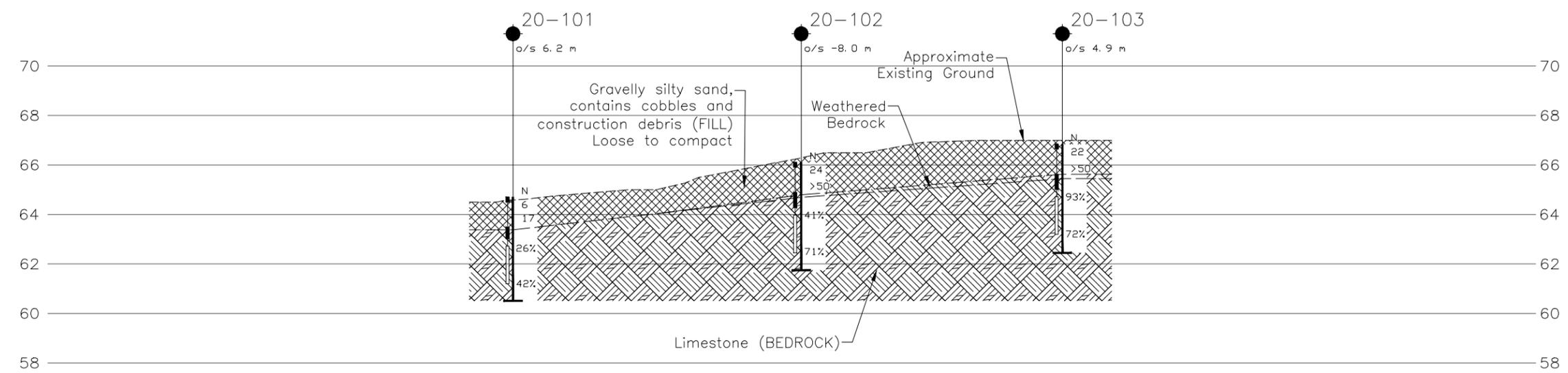


LEGEND

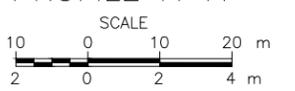
- Borehole - Current Investigation
- Borehole - From Geocres 3165-315
- Borehole - From Geocres 3165-295
- Borehole - From Geocres 3165-308
- Seal
- Piezometer
- Standard Penetration Test Value
- Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- WL in piezometer, measured on MMM DD, YYYY



PLAN



PROFILE A-A'



BOREHOLE CO-ORDINATES NAD 83 (CSRS)/MTM ZONE 9

No.	ELEVATION	NORTHING	EASTING
20-101	64.7	5029632.0	366753.8
20-102	66.1	5029682.4	366786.5
20-103	66.8	5029736.5	366791.8
17-113	63.8	5029593.8	366738.7
17-114	63.8	5029598.8	366753.0
17-123	66.3	5029627.2	366858.8
17-124	66.4	5029631.8	366873.5
18-908	66.7	5029648.8	366892.7
18-909	69.1	5029669.2	366943.7

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

REFERENCE

Base plans provided in digital format by WSP, drawing file no. 3416024-Noise and Retaining wall overview.dwg, received MAR. 18, 2019.

NO.	DATE	BY	REVISION

Geocres No.:		PROJECT NO. 1655214/1150		DIST. EASTERN	
HWY. 417	CHKD. KCP	DATE: 7/9/2020	SITE:		
SUBM'D. KCP	CHKD. WC	APPD. FJH	DWG. 1		

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**APPENDIX A**

Lists of Abbreviations and Symbols  
Lithological and Geotechnical Rock Description Terminology  
Record of Boreholes 20-101 to 20-103  
Bedrock Core Photographs, Figures A1 to A6

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# ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS MINISTRY OF TRANSPORTATION, ONTARIO

## PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>200	>8
COBBLES	Not Applicable	75 to 200	3 to 8
GRAVEL	Coarse	19 to 75	0.75 to 3
	Fine	4.75 to 19	(4) to 0.75
SAND	Coarse	2.00 to 4.75	(10) to (4)
	Medium	0.425 to 2.00	(40) to (10)
	Fine	0.075 to 0.425	(200) to (40)
FINES	Classified by plasticity	<0.075	< (200)

## MODIFIERS FOR SECONDARY COMPONENTS<sup>1,2</sup>

Percentage by Mass	Modifier
> 35	Use 'and' to combine primary and secondary component ( <i>i.e.</i> , SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some ( <i>i.e.</i> , some sand)
≤ 10	trace ( <i>i.e.</i> , trace fines)

- Only applicable to components not described by Primary Group Name.
- Classification of Primary Group Name based on Unified Soil Classification System (ASTM D2487) for coarse-grained soils; fine-grained soils described per current MTO Soil Classification System.

## PENETRATION RESISTANCE

### Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

### Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm<sup>2</sup> pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q<sub>t</sub>), porewater pressure (u) and sleeve friction (f<sub>s</sub>) are recorded electronically at 25 mm penetration intervals.

### Dynamic Cone Penetration Resistance (DCPT); N<sub>d</sub>:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

- PH:** Sampler advanced by hydraulic pressure  
**PM:** Sampler advanced by manual pressure  
**WH:** Sampler advanced by static weight of hammer  
**WR:** Sampler advanced by weight of sampler and rod

## SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC / SC	Rock core / Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample
OD / ID	Outer Diameter / Inner Diameter
HSA / SSA	Hollow-Stem Augers / Solid-Stem Augers

## SOIL TESTS

w	water content
PL, w <sub>p</sub>	plastic limit
LL, w <sub>L</sub>	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test <sup>1</sup>
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement <sup>1</sup>
D <sub>R</sub>	relative density (specific gravity, G <sub>s</sub> )
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO <sub>4</sub>	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
Y	unit weight

- Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

## COARSE-GRAINED SOILS

### Compactness<sup>1</sup>

Term	SPT 'N' (blows/0.3m) <sup>2</sup>
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

- Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grain size. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.
- SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.

## FINE-GRAINED SOILS

### Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N' <sup>1,2</sup> (blows/0.3m)
Very Soft	< 12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	> 200	> 30

- SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
- SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

## Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.



# LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

## WEATHERINGS STATE

**Fresh:** no visible sign of weathering

**Faintly weathered:** weathering limited to the surface of major discontinuities.

**Slightly weathered:** penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

**Moderately weathered:** weathering extends throughout the rock mass but the rock material is not friable.

**Highly weathered:** weathering extends throughout rock mass and the rock material is partly friable.

**Completely weathered:** rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

## BEDDING THICKNESS

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

## JOINT OR FOLIATION SPACING

<u>Description</u>	<u>Spacing</u>
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

## GRAIN SIZE

<u>Term</u>	<u>Size*</u>
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: \* Grains greater than 60 microns diameter are visible to the naked eye.

## CORE CONDITION

### Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

### Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

### Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid segments.

## DISCONTINUITY DATA

### Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

### Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

### Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

### Abbreviations

JN Joint	PL Planar
FLT Fault	CU Curved
SH Shear	UN Undulating
VN Vein	IR Irregular
FR Fracture	K Slickensided
SY Stylolite	PO Polished
BD Bedding	SM Smooth
FO Foliation	SR Slightly Rough
CO Contact	RO Rough
AXJ Axial Joint	VR Very Rough
KV Karstic Void	
MB Mechanical Break	





PROJECT <u>1655214-1150</u>	<b>RECORD OF BOREHOLE No 20-102</b>	SHEET 1 OF 2	<b>METRIC</b>
G.W.P. <u>4173-15-00</u>	LOCATION <u>N 5029682.4; E 366786.5 NAD 83 MTM ZONE 9 (LAT. 45.404334; LONG. -75.708168)</u>	ORIGINATED BY <u>JS</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, HQ Core</u>	COMPILED BY <u>JEM</u>	
DATUM <u>Geodetic</u>	DATE <u>June 8, 2020</u>	CHECKED BY <u>KCP</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	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 <b>γ</b> kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
								20	40	60	80	100						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%)					
								20	40	60	80	100	25	50	75			
66.1	GROUND SURFACE																	
0.0	(SM) gravelly silty sand, contains brick, wood, and organics (FILL) Compact Dark brown Moist		1	SS	24		66											
			2	SS	>50		65											
64.8	Weathered bedrock																	
1.4	Limestone (BEDROCK), with interbedded shale  Bedrock cored from depths 1.42 m to 4.37 m  For bedrock coring details refer to Record of Drillhole 20-102		1	RC	REC 100%		64										RQD = 83%	
			2	RC	REC 98%		63											RQD = 88%
61.7	END OF BOREHOLE						62											
4.4	NOTES:  1. Water level in well screen at a depth of 3.3 m below ground surface (Elev. 62.8 m), measured on June 15, 2020.																	

GTA-MTO 001 N:\ACTIVE\SPATIAL\_IMMTO\HWY417\REHAB&amp;WIDENING\02\_DATA\GINT\1655214.GPJ\_GAL-GTA.GDT 7/3/20 JM



PROJECT <u>1655214-1150</u>	<b>RECORD OF BOREHOLE No 20-103</b>	SHEET 1 OF 2	<b>METRIC</b>
G.W.P. <u>4173-15-00</u>	LOCATION <u>N 5029736.5; E 366791.8 NAD 83 MTM ZONE 9 (LAT. 45.404821; LONG. -75.708094)</u>	ORIGINATED BY <u>JS</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, HQ Core</u>	COMPILED BY <u>JEM</u>	
DATUM <u>Geodetic</u>	DATE <u>June 9, 2020</u>	CHECKED BY <u>KCP</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	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
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
							20 40 60 80 100	20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>			
									WATER CONTENT (%)					
									25 50 75					
66.8 0.0	GROUND SURFACE (SM) gravelly silty sand (FILL), contains brick, wood, cobbles Compact Dark brown Dry		1	SS	22									
			2	SS	>50		66							
65.6 65.4	Weathered bedrock													
1.4	Limestone (BEDROCK), with interbedded shale  Bedrock cored from depths 1.40 m to 4.40 m  For bedrock coring details refer to Record of Drillhole 20-103		1	RC	REC 100%		65						RQD = 99%	
			2	RC	REC 100%		64						RQD = 95%	
62.4 4.4	END OF BOREHOLE						63							
	NOTES:  1. Water level in well screen at a depth of 3.4 m below ground surface (Elev. 63.4 m), measured on June 15, 2020.													

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE



**BH 20-101 (Dry)  
Core Box 1 of 1**



**Foundation Investigation**  
**New Rochester and Booth Street Staging Area**  
**Raymond Avenue and Highway 417, Ottawa ON**

Project No.	1655214 / 1150
Drawn:	JS
Date:	2020-06-09
Checked:	KCP
Review:	FJH

**Figure A1**

BH 20-101 (Dry)  
Core Box 1 of 1



Foundation Investigation  
New Rochester and Booth Street Staging Area  
Raymond Avenue and Highway 417, Ottawa ON

Project No.	1655214 / 1150
Drawn:	JS
Date:	2020-06-09
Checked:	KCP
Review:	FJH

Figure A2

**BH 20-102 (Dry)  
Core Box 1 of 1**



**Foundation Investigation**  
**New Rochester and Booth Street Staging Area**  
**Raymond Avenue and Highway 417, Ottawa ON**

Project No.	1655214 / 1150
Drawn:	JS
Date:	2020-06-09
Checked:	KCP
Review:	FJH

**Figure A3**

**BH 20-102 (Wet)  
Core Box 1 of 1**



**Foundation Investigation**  
**New Rochester and Booth Street Staging Area**  
**Raymond Avenue and Highway 417, Ottawa ON**

Project No.	1655214 / 1150
Drawn:	JS
Date:	2020-06-09
Checked:	KCP
Review:	FJH

**Figure A4**

**BH 20-103 (Dry)  
Core Box 1 of 1**



**Foundation Investigation**  
**New Rochester and Booth Street Staging Area**  
**Raymond Avenue and Highway 417, Ottawa ON**

Project No.	1655214 / 1150
Drawn:	JS
Date:	2020-06-09
Checked:	KCP
Review:	FJH

**Figure A5**

**BH 20-103 (Wet)  
Core Box 1 of 1**



**Foundation Investigation**  
**New Rochester and Booth Street Staging Area**  
**Raymond Avenue and Highway 417, Ottawa ON**

Project No.	1655214 / 1150
Drawn:	JS
Date:	2020-06-09
Checked:	KCP
Review:	FJH

**Figure A6**

**APPENDIX B**

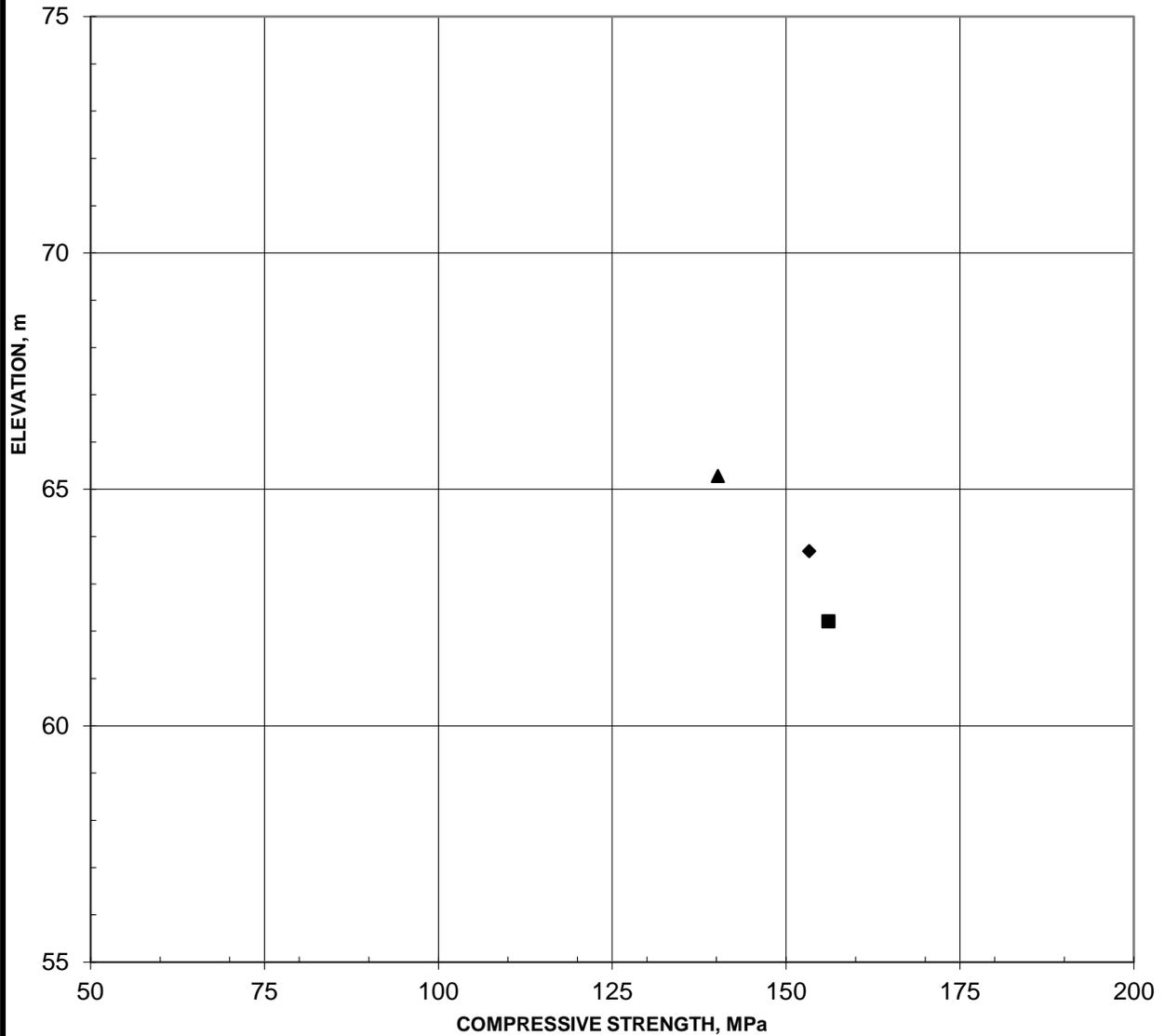
## **Laboratory Test Results, Current Investigation**

Figures B1

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**SUMMARY OF LABORATORY COMPRESSIVE STRENGTH  
UNCONFINED COMPRESSION TESTS**

**FIGURE B1**



	Borehole	Compressive Strength (MPa)
■	20-101	156
◆	20-102	153
▲	20-103	140

**APPENDIX C**

**Previous Investigations**

GEOCRES No. 31G5-315: Record of Boreholes 18-908 and 18-909

GEOCRES No. 31G5-308: Record of Boreholes 17-123 and 17-124

GEOCRES No. 31G5-295: Record of Boreholes 17-113 and 17-114





PROJECT <u>1655214-1110</u>	<b>RECORD OF BOREHOLE No 17-114</b>	SHEET 1 OF 2	<b>METRIC</b>
G.W.P. <u>4173-15-00</u>	LOCATION <u>N 5029598.8; E 366753.0 NAD 83 MTM ZONE 9 (LAT. 45.403594; LONG. -75.708610)</u>	ORIGINATED BY <u>DWM</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Hydro-excavation/NQ Core</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>April 6/7, 2017</u>	CHECKED BY <u>KCP</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								20	40	60	80	100					
63.8	GROUND SURFACE																
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																
63.7																	
0.1	(GP/SP) Gravel and sand, trace silt (FILL) Grey Moist																
			1	GRAB	-												53 42 4 1
62.7																	
1.1	Limestone (BEDROCK)  Bedrock cored from depths 1.1 m to 4.8 m  For bedrock coring details refer to Record of Drillhole 17-114		C1	RC	REC 56%												RQD = 13%
			C2	RC	REC 100%												RQD = 87%
			C3	RC	REC 91%												RQD = 54%
59.0																	
4.8																	

GTA-MTO 001 \GOLDER.GDS\GALOTTAWACTIVE\SPATIAL\_IMMITO\HWY417\REHAB&amp;WIDENING\02\_DATA\GINT\1655214.GPJ GAL-GTA.GDT 19-8-1 JM

Continued Next Page

 +<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT <u>1655214-1110</u>	<b>RECORD OF BOREHOLE No 17-114</b>	SHEET 2 OF 2	<b>METRIC</b>
G.W.P. <u>4173-15-00</u>	LOCATION <u>N 5029598.8; E 366753.0 NAD 83 MTM ZONE 9 (LAT. 45.403594; LONG. -75.708610)</u>	ORIGINATED BY <u>DWM</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Hydro-excavation/NQ Core</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>April 6/7, 2017</u>	CHECKED BY <u>KCP</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
	END OF BOREHOLE															
	NOTES:  1. Water level in well screen at a depth of 1.8 m below ground surface (Elev. 62.0 m), measured on April 26, 2017.															

GTA-MTO 001 \GOLDER.GDS\GALLOTTAWACTIVE\SPATIAL\_IMMTO\HWY417\REHAB&amp;WIDENING\02\_DATA\GINT\1655214.GPJ\_GAL-GTA.GDT 19-8-1 JM

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE



PROJECT <u>1655214-1120</u>	<b>RECORD OF BOREHOLE No 17-123</b>	SHEET 1 OF 2	<b>METRIC</b>
G.W.P. <u>4173-15-00</u>	LOCATION <u>N 5029627.2; E 366858.8 NAD 83 MTM ZONE 9 (LAT. 45.403840; LONG. -75.707255)</u>	ORIGINATED BY <u>KM</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Hydro-excavation/NQ Core</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>April 6/10, 2017</u>	CHECKED BY <u>KCP</u>	

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)	
						20	40	60	80	100				25	50	75		GR SA SI CL
66.3	GROUND SURFACE																	
0.0	PORTLAND CEMENT CONCRETE (SIDEWALK)																	
66.2	(SP) Gravelly sand (FILL) Grey																	
0.1																		
66.0																		
0.3	(SP) Sand, trace gravel and silt, contains organic matter (FILL) Brown Moist		1	GRAB	-													
65.5																		
0.8	(GP) Gravel and cobbles (FILL)																	
65.2			2	RC	DD													
1.2	Limestone (BEDROCK)																	
	Bedrock cored from depths of 1.2 m to 4.8 m		C1	RC	REC 65%													RQD = 0%
	For bedrock coring details refer to Record of Drillhole 17-123		C2	RC	REC 95%													RQD = 77%
			C3	RC	REC 99%													RQD = 92%
			C4	RC	REC 97%													RQD = 97%
61.5																		
4.8	END OF BOREHOLE																	

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE











PROJECT <u>1655214-1900</u>	<b>RECORD OF BOREHOLE No 18-909</b>	SHEET 1 OF 2	<b>METRIC</b>
G.W.P. <u>4173-15-00</u>	LOCATION <u>N 5029667.4; E 366944.3 NAD 83 MTM ZONE 9 (LAT. 45.404195; LONG. -75.706157)</u>	ORIGINATED BY <u>PAH</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Rotary Drill, HW Casing/HQ Core</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>May 21, 2019</u>	CHECKED BY <u>KCP</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	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 <b>γ</b> kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
69.1	GROUND SURFACE																
0.0	(SM) Silty sand, contains organic matter (roots) (TOPSOIL) Brown																
0.2																	
68.6	(SM) Silty sand, trace organic matter (FILL) Brown																
0.5																	
68.3	Moist																
0.8	(SW) Gravelly sand (FILL) Grey																
	(SM/GM) Gravelly SILTY SAND, contains cobbles (TILL) Compact to dense Grey brown Moist - Cobbles and boulders from 1.5 m to 2.3 m depth		2	SS	13												16 56 (28)
			3	RC	-												
			4	SS	32												26 48 (26)
66.0																	
3.1	Limestone (BEDROCK), with thin black shale partings  Bedrock cored from depths 3.1 m to 4.9 m  For bedrock coring details refer to Record of Drillhole 18-909		1	RC	REC 95%												RQD = 63%
			2	RC	REC 98%												RQD = 87%
64.2																	
4.9	END OF BOREHOLE																

GTA-MTO 001 N:\ACTIVE\SPATIAL\_IMMTO\HWY417\REHAB&amp;WIDENING\02\_DATA\GINT\1655214.GPJ GAL-GTA.GDT 20-3-5 JM

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE



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APPENDIX D

## Site Photographs



**Photograph 1: Looking north along Rochester Street across the proposed staging area site**



**Photograph 2: Looking south across the site towards Raymond Street**

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[golder.com](http://golder.com)