



PRELIMINARY FOUNDATION INVESTIGATION REPORT

Nat River Bridge Replacement (Site No. 46X-0011/B0) Highway 101, Reeves Township, District of Sudbury Ministry of Transportation, Ontario GWP 5180-16-00; WP 5180-16-01

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1790414

December 10, 2019
GEOCRES No.: 42B-14

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Maxxam Analytics – Certificate of Analysis – Report #R5729598

PART A

PRELIMINARY FOUNDATION INVESTIGATION REPORT
NAT RIVER BRIDGE REPLACEMENT – SITE NO. 46X-0011/B0
HIGHWAY 101, REEVES TOWNSHIP, DISTRICT OF SUDBURY
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5180-16-00; WP 5180-16-01

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by AECOM Canada Ltd. (AECOM) on behalf of the Ministry of Transportation, Ontario (MTO) to provide preliminary design Foundation Engineering services for the replacement of the existing Nat River Bridge (Site No. 46X-0011/B0). The Nat River Bridge is located on Highway 101 at Station 18+080 in Reeves Township in the District of Sudbury, Ontario (i.e., approximately 48 km west of the Highway 144 junction). The general location of this section of Highway 101 and the location of the investigation area are presented on Drawing 1.

The Terms of Reference (TOR) for the Foundation Investigation are outlined in MTO's Request for Proposal (Assignment 5017-E-0018, dated October 2017), and the subsequent clarifications/addenda. Golder's originally proposed scope of work is outlined in our proposal dated January 26, 2018, which was included as Section 16.8 in AECOM's technical proposal for this assignment.

At time of the proposal submission, it was assumed that the bridge was to be replaced along the current alignment with a temporary detour bridge being utilized to carry traffic across the Nat River during construction as outlined in the RFP. Based on discussion with AECOM, we understand that a replacement bridge along a new alignment (i.e., approximately 18.6 m north of the existing alignment) has been selected by the AECOM and MTO design team as the preferred option to be carried forward for the Design-Build Ready package. Our revised Foundation Investigation scope of work is outlined in our Change Request 1 letter dated May 14, 2019.

This work has been carried out in accordance with Golder's Supplementary Specialty Plan for Foundation Engineering services for this project, dated April 11, 2018.

2.0 SITE DESCRIPTION

It should be noted that the orientation (i.e., north, south, east, west) stated in the text of the report is typically referenced to project north and therefore may differ from magnetic north shown on the drawing. For the purpose of this report, Highway 101 is oriented in a west-east direction with the Nat River flowing in a south-north direction at the bridge structure.

In general, the topography in the area of the bridge structure is relatively flat with gently rolling/undulating terrain and dense tree cover beyond the highway right-of-way. Ground surface conditions at the existing and proposed bridge locations are shown on Photographs 1 to 4.

The existing Nat River Bridge consists of an approximately 32.3 m long by 10.4 m wide (overall) three span, reinforced concrete slab on steel girder structure, which was constructed in 1964. The three spans (from west to east) are 7.6 m, 17.1 m, and 7.6 m in length. Based on the information provided in the Request for Proposal (RFP), the General Arrangement and Staging Details drawing included in Contract 94-202, and the General Arrangement drawing included in Contract 2010-5115, we understand that the existing bridge abutments and piers are supported by shallow timber crib foundations; however, the foundation bearing stratum (i.e., native soil or bedrock) is not known.

Based on the Ontario Structure Inspection Manual (OSIM) report, dated July 23, 2015, the existing bridge is generally in good condition with minor deterioration of several elements including more significant deterioration of the deck wearing surface, exterior deck soffit, abutment walls and interior parapet walls. The existing highway embankments were also noted to be in good conditions with no deficiencies identified in the 2015 OSIM report.

Based on our site observations at the time of the field investigation and a review of the available site photographs/satellite images, the existing embankments in the area of the existing bridge structure generally appear to be performing satisfactorily with no evidence of soil movement, tilted vegetation, or tension cracks which could indicate instability.

3.0 INVESTIGATION PROCEDURES

Field work for this subsurface investigation was carried out on May 10 and 11, 2019, during which time six boreholes (NR-1 to NR-6) were advanced at the approximate locations shown on Drawing 1. Boreholes NR-1 and NR-6 were advanced at the west and east approaches along the proposed re-alignment. Boreholes NR-2 and NR-3 were advanced at the proposed west abutment and Boreholes NR-4 and NR-5 were advanced at the proposed east abutment.

The boreholes were advanced using a CME-55 LC track-mounted drilling rig supplied and operated by George Downing Estate Drilling of Grenville-Sur-La-Rouge, Quebec. An excavator was used to provide drilling rig access to the borehole locations, which was supplied and operated by Demora Construction Services Inc. (Demora) of New Liskeard, Ontario. Demora also provided traffic control, to facilitate loading/unloading the excavator and drilling rig, which was performed in accordance with the Ontario Traffic Control Manual Book 7 – Temporary Conditions.

The boreholes were advanced using 108 mm inside diameter hollow-stem augers, NW casing with wash boring techniques, and NQ coring. Water from the Nat River was used for the wash boring and coring operations. Soil samples were obtained in the boreholes at 0.75 m intervals of depth using 50 mm outer diameter split-spoon samplers driven by an automatic hammer in accordance with the Standard Penetration Test (SPT) procedures (ASTM D1586). The groundwater conditions and water levels in the open boreholes were observed during the drilling operations. A standpipe piezometer, which was decommissioned prior to demobilizing from the site, was installed in Borehole NR-2 to obtain a stabilized groundwater level about one day following completion of drilling. The boreholes were backfilled and the standpipe piezometer was decommissioned in accordance with Ontario Regulation 903 Wells (as amended).

Field work was monitored on a full-time basis by a member of Golder's technical staff who: located the boreholes in the field; arranged for the clearance of underground services; supervised the drilling and sampling operations; logged the boreholes and drillholes; and examined the soil and rock core samples. The soil and rock core samples were identified in the field, placed in labelled containers and transported to Golder's geotechnical laboratory in Sudbury for further examination and laboratory testing. Index and classification testing consisting of water content determinations, grain size distributions and Atterberg limits were carried out on selected soil samples. In addition, four uniaxial compressive strength (UCS) tests were carried out on specimens of the retrieved bedrock core. The geotechnical laboratory testing was completed according to ASTM and MTO LS standards, as applicable.

The as-drilled borehole locations were measured by a member of our technical staff relative to the existing highway centreline and existing bridge structure using a measuring tape and converted into northing/easting coordinates on the plan drawing. Given the relatively moderate distances between the boreholes and the existing highway centerline / bridge structure, the measurements are considered to be accurate to within 0.5 m horizontally. The ground surface elevations at the borehole locations were obtained using a survey level and rod and the survey loop was closed to within 0.1 m vertically. The boreholes were surveyed relative to a nearby

benchmark [horizontal control point (HCP) 103] and the Geodetic elevation of the benchmark was obtained from the survey drawing (101REEVES GWP 5017-E-0018.dwg) provided by AECOM. The NAD 83 MTM Zone 12 northing and easting coordinates, World Geodetic System 1984 (WGS 84) geographical coordinates, ground surface elevations referenced to Geodetic datum, and borehole depths at each borehole location are presented on the Record of Borehole Sheets presented in Appendix A and summarized below.

Borehole Number	Location (NAD 83, MTM Zone 12)		Location (WGS 84)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing	Easting	Latitude	Longitude		
NR-1	5342735.6	221903.6	48.218013	-82.115666	324.5	4.9
NR-2	5342732.3	221918.7	48.217985	-82.115462	323.5	4.5
NR-3	5342727.7	221919.8	48.217944	-82.115447	323.4	5.5
NR-4	5342719.5	221958.7	48.217876	-82.114922	323.5	4.5
NR-5	5342714.8	221954.0	48.217833	-82.114984	323.5	3.8
NR-6	5342711.5	221971.7	48.217805	-82.114745	325.2	5.6

Note: Borehole depths include 3.0 m to 3.3 m of bedrock coring.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on Northern Ontario Engineering Geology Terrain Study (NOEGTS) ¹ mapping by the Ministry of Natural Resources, the Nat River Bridge site is located within an outwash plain, valley train deposit comprised of silt bordered by organic terrain deposits of peat/muck and ground moraine deposits of sand.

Based on geological mapping by the Ministry of Northern Development and Mines (MNDM) ², the overburden deposits are underlain by mafic to intermediate metavolcanics rocks consisting of basaltic and andesitic flows, tuffs, breccias, chert, iron formations, minor sedimentary and intrusive rocks, and related migmatites.

4.2 Subsurface Conditions

The detailed subsurface soil, bedrock and groundwater conditions encountered in the boreholes are presented on the Record of Borehole and Record of Drillhole Sheets in Appendix A. The detailed results of the geotechnical

¹ Ontario Ministry of Natural Resources and Forestry. Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Electronic Mapping. Map 42BSE

² Ontario Ministry of Northern Development of Mines. Bedrock Geology of Ontario – East Central Sheet, Ontario Geological Survey – Map 2543

laboratory testing are contained in Appendix B. The results of the in-situ field tests (i.e., SPT 'N' values) as presented on the Record of Borehole sheets and in Section 4 are uncorrected. The stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic profile and cross-sections on Drawings 1 and 2 are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations.

In summary, the subsurface conditions encountered at the site consist of sand fill, topsoil/peat, clayey silt-silt to silt, gravelly silty sand to sand, and silty gravel and sand underlain by bedrock at relatively shallow depth. A detailed description of the soil deposits, bedrock, and groundwater conditions encountered in the boreholes is provided in the following sections.

4.2.1 Sand (SW) Fill

A 150 mm thick layer of brown, moist, sand fill, trace gravel, trace silt was encountered from ground surface in Borehole NR-6, which was advanced from the existing boat launch located about 15 m north of the existing east abutment.

4.2.2 Topsoil/Peat

A 25 mm to 150 mm thick layer of topsoil/peat was encountered from ground surface in Boreholes NR-1 to NR-4.

4.2.3 Clayey Silt-Silt (CL-ML) to Silt (ML)

A deposit of brown to grey, moist to wet, clayey silt-silt, trace sand, trace organics was encountered below the topsoil in Borehole NR-2 and a deposit of silt, some sand, some clay, trace gravel was encountered below the sand fill in Borehole NR-6. The surface of the deposit was encountered at Elevation 323.4 m and 325.0 m in Boreholes NR-2 and NR-6, respectively and was 1.0 m and 0.5 m thick, respectively.

The SPT 'N'-value in the clayey silt-silt deposit is 2 blows per 0.3 m of penetration suggesting a soft consistency and in the silt deposit is 16 blows per 0.3 m of penetration indicating a compact state of compactness.

The water content measured on a sample of the clayey silt-silt deposit is 23 per cent and on a sample of the silt deposit is 13 per cent.

The results of grain size distribution tests completed on two samples of the clayey silt-silt to silt deposit are shown on Figure B1 in Appendix B.

Atterberg limits testing was carried out on two samples of the deposit, which measured liquid limits of about 20 per cent and 22 per cent, plastic limits of about 17 per cent and 18 per cent, and plasticity indices of about 3 per cent and 4 per cent. The Atterberg limit test results are shown on the plasticity chart on Figure B2 in Appendix B, which indicates the deposit ranges from a clayey silt-silt of low plasticity to a silt of slight plasticity.

4.2.4 Gravelly Silty Sand (SM) to Silty Sand (SM)

A deposit of brown to grey, moist to wet, gravelly silty sand to silty sand, trace to some gravel, trace clay, and some organics (in places), was encountered below the topsoil/peat in Boreholes NR-1, NR-3, and NR-4, from ground surface in Borehole NR-5, and below the clayey silt-silt to silt deposit in Boreholes NR-2 and NR-6. The surface of the deposit was encountered between Elevation 324.5 m and 322.4 m and the deposit was between 0.3 m and 2.3 m thick.

The SPT 'N'-values measured within the silty sand deposit range from 2 blows to 32 blows per 0.3 m of penetration, indicating a very loose to dense state of compactness.

The water content measured on two samples of the silty sand deposit are 14 per cent and 16 per cent.

The results of grain size distribution tests completed on two samples of the silty sand deposit are shown on Figure B3 in Appendix B.

4.2.5 Silty Gravel (GM) and Sand

A deposit of brown, wet, silty gravel and sand was encountered below the silty sand deposit in Borehole NR-1. The surface of the deposit was encountered at Elevation 323.8 m and the deposit was 0.4 m thick.

The SPT 'N'-value measured within the silty gravel and sand deposit was 26 blows per 0.3 m of penetration, indicating a compact state of compactness.

The water content measured on one sample of the deposit was 8 per cent.

The results of a grain size distribution test completed on one sample of the silty gravel and sand deposit is shown on Figure B4 in Appendix B.

4.2.6 Bedrock

Bedrock was encountered below the overburden soils in all boreholes advanced at the site. The upper portion of the bedrock in Boreholes NR-1 and NR-6 was completely to moderately weathered. The surface of the completely to moderately weathered zone of bedrock was encountered at Elevations 323.4 m and 323.1 m in Boreholes NR-1 and NR-6, respectively and was 0.8 m and 0.2 m thick, respectively at these locations.

The lower portion of the bedrock was slightly weathered to fresh. The surface of the slightly weathered to fresh zone was encountered between Elevation 322.9 m and 321.1 m.

Bedrock was cored in Boreholes NR-1 to NR-6. The bedrock surface elevations, as encountered in the cored boreholes, are presented below.

Borehole No.	Completely to Moderately Weathered Bedrock		Slightly Weathered to Fresh Bedrock	
	Elevation (m)	Thickness Sampled / Length Cored (m)	Elevation (m)	Length Cored (m)
NR-1	323.4	0.8	322.6	3.0
NR-2	-	-	322.1	3.1
NR-3	-	-	321.1	3.2
NR-4	-	-	322.1	3.1
NR-5	-	-	322.7	3.0
NR-6	323.1	0.2	322.9	3.3

The retrieved bedrock core in Boreholes NR-1 to NR-3 is described as a fine grained, strong, light grey, completely weathered to fresh, greywacke. In Boreholes NR-4 and NR-5, the bedrock is described as a fine grained, medium strong, light grey, slightly weathered to fresh, sericite-chlorite schist and in Borehole NR-6, the bedrock is described as a fine grained, dark to light grey, slightly weathered to fresh, talc schist.

More detailed descriptions and conditions of the bedrock core samples are presented on the Record of Drillhole sheets in Appendix A. Photographs of the bedrock core samples and the UCS test results are presented on Figures B5 and B6, respectively, which are included in Appendix B. The bedrock properties from core samples selected for laboratory testing are summarized below.

Borehole No.	Slightly Weathered to Fresh Bedrock					
	Total Core Recovery (%)	Solid Core Recovery (%)	Rock Quality Designation (%)	Quality Classification (Table 3.10 of CFEM 2006)	Uniaxial Compressive Strength (MPa)	Strength Classification (Table 3.5 of CFEM 2006)
NR-1	88 – 100	48 – 100	27 – 100	Poor to Excellent	n/a	-
NR-2	93 – 100	77 – 83	77 – 83	Good	85	(R4 – Strong)
NR-3	100	43 – 100	27 – 100	Poor to Excellent	77	(R4 – Strong)

Borehole No.	Slightly Weathered to Fresh Bedrock					
	Total Core Recovery (%)	Solid Core Recovery (%)	Rock Quality Designation (%)	Quality Classification (Table 3.10 of CFEM 2006)	Uniaxial Compressive Strength (MPa)	Strength Classification (Table 3.5 of CFEM 2006)
NR-4	100	73 – 100	70 – 100	Fair to Excellent	48	(R3 – Medium Strong)
NR-5	100	97 – 100	97 – 100	Excellent	41	(R3 – Medium Strong)
NR-6	95 – 98	71 – 90	71 – 88	Fair to Good	n/a	-

4.2.7 Groundwater Conditions

Unstabilized groundwater levels measured in the open boreholes upon or shortly after completion of drilling are summarized below. A standpipe piezometer was installed in Borehole NR-2 and the groundwater level was measured about one day following completion of drilling. The river water level, as surveyed by Golder on May 11, 2019, was at Elevation 323.3 m. Groundwater and river water levels in the area are subject to seasonal fluctuations and precipitation events.

Borehole No.	Depth to Groundwater Level (m)	Approximate Groundwater Elevation (m)
NR-1	1.1	323.4
NR-2	0.1 (piezometer)	323.4 (piezometer)
NR-3	0.1	323.3
NR-4	0.2	323.3
NR-5	0.2	323.3
NR-6	1.8	323.4

The water levels in Boreholes NR-1 to NR-6 could potentially have been affected by water introduced into the boreholes during wash boring for NW casing advancement and/or during NQ coring operations; however, the

water levels in the open boreholes are generally consistent and consistent with the surveyed river water levels at the time of the investigation.

4.3 Analytical Test Results of Soil Samples

One soil sample was selected from Borehole NR-2 (west abutment) and from Borehole NR-5 (east abutment) and submitted to Maxxam Analytics for corrosivity testing, under chain-of-custody documentation. The analytical laboratory test results are provided on the Certificate of Analysis presented in Appendix C and are summarized below.

Parameter	Units	West Abutment	East Abutment
		Borehole NR-2, Sample 2B (Elev. 322.3 m)	Borehole NR-5, Sample 1 (Elev. 323.2 m)
Resistivity	ohm-cm	5800	8100
Conductivity	µmho/cm	174	123
pH	pH	6.96	7.31
Sulphate	µg/g	<20 ¹	<20 ¹
Chloride	µg/g	60	41

Note(s): 1. The sulphate concentrations are below the reportable detection limit of 20 µg/g.

5.0 CLOSURE

The field drilling program was carried out under the supervision of Mr. Shane Albert, under the overall direction of Mr. David Muldowney, P.Eng. This Foundation Investigation Report was prepared by Ms. Kirsten Janssen, EIT, and Mr. David Muldowney, P.Eng. provided a technical review of the report. Mr. Paul Dittrich, P.Eng., an MTO Foundations Designated Contact and Principal of Golder, conducted an independent quality control review of this report.

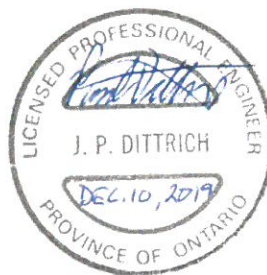
Signature Page

Golder Associates Ltd.

Kirsten Janssen, EIT
Geotechnical Engineering Intern



David Muldowney, P.Eng.
Senior Geotechnical Engineer

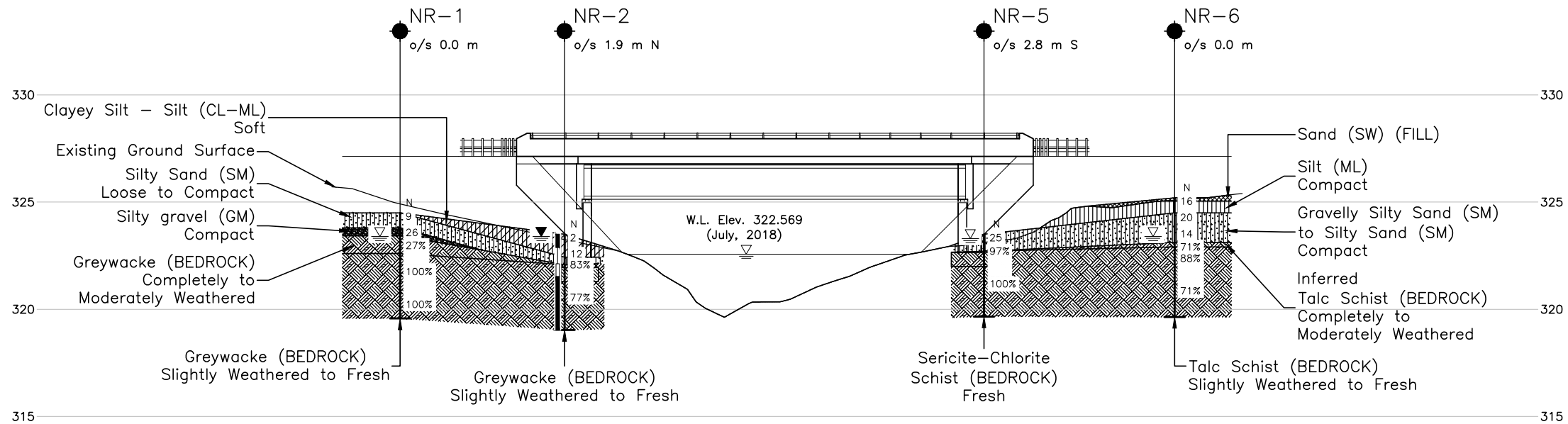
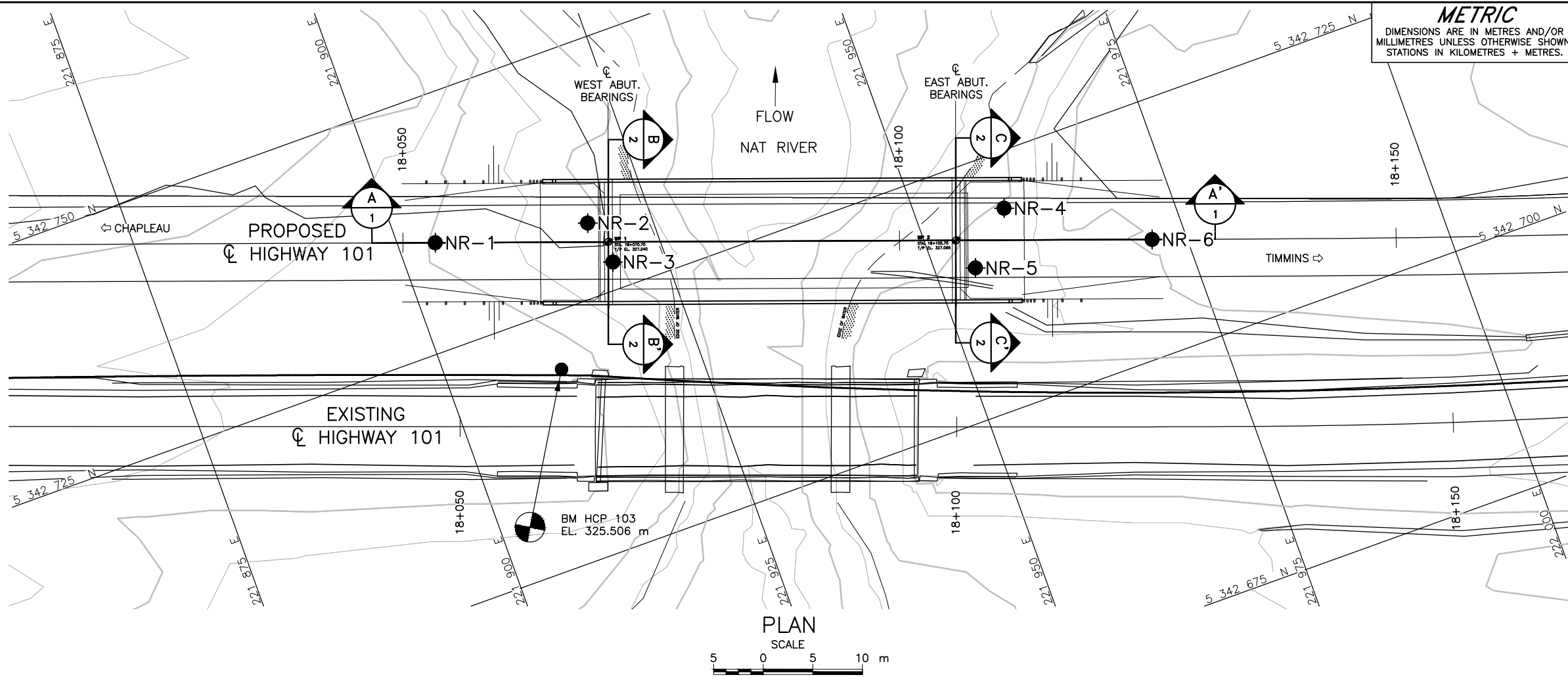


Paul Dittrich, Ph.D., P.Eng.
MTO Foundations Designated Contact, Principal

KJ/DAM/JPD/ca

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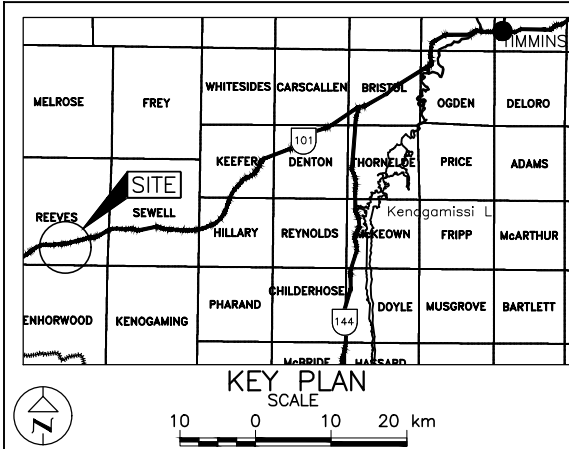
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METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No. 5180-16-01
WP No. 5180-16-01

HIGHWAY 101
NAT RIVER BRIDGE STA. 18+080
BOREHOLE LOCATIONS AND SOIL STRATA



LEGEND

- Borehole - Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- WL upon completion of drilling
- WL in piezometer, measured on May 12, 2019
- Seal
- Piezometer

BOREHOLE CO-ORDINATES (NAD 83 MTM ZONE 12)

No.	ELEVATION	NORTHING	EASTING
NR-1	324.5	5342735.6	221903.6
NR-2	323.5	5342732.3	221918.7
NR-3	323.4	5342727.7	221919.8
NR-4	323.5	5342719.5	221958.7
NR-5	323.5	5342714.8	221954.0
NR-6	325.2	5342711.5	221971.7



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 AECOM CANADA LTD. drawing file no. 101REEVES GWP 5017-E-0018, received JUNE 6, 2019.

NO.	DATE	BY	REVISION
1	12/10/2019	JPD	ISSUED FOR CONSTRUCTION

Geocres No. 42B-14

HWY. 101	PROJECT NO. 1790414	DIST. .
SUBM'D.	CHKD. .	DATE: 12/10/2019
DRAWN: TR	CHKD. DAM	APPD. JPD
		SITE: 46X-0011/B0
		DWG. 1

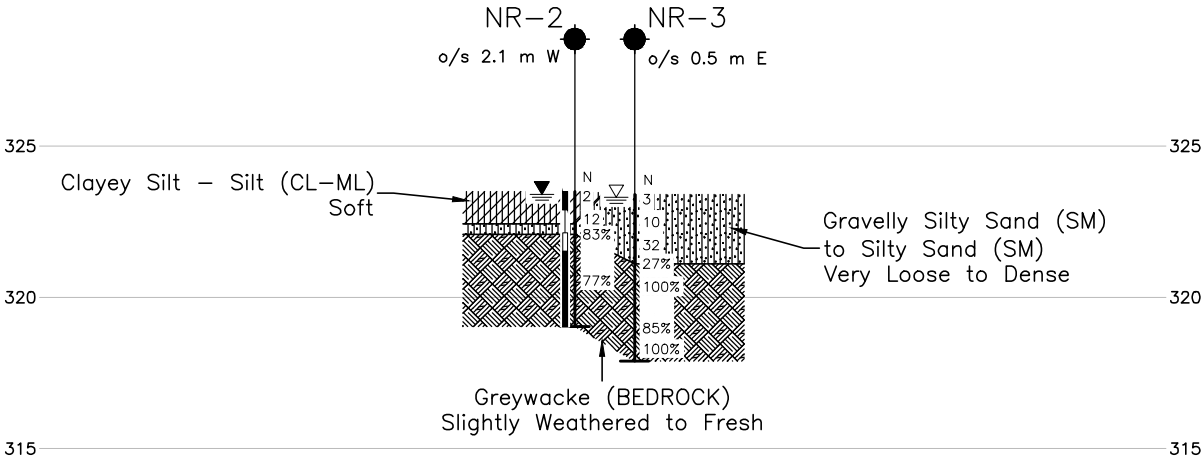
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No. 5180-16-01
HIGHWAY 101
NAT RIVER BRIDGE STA. 18+080
SOIL STRATA

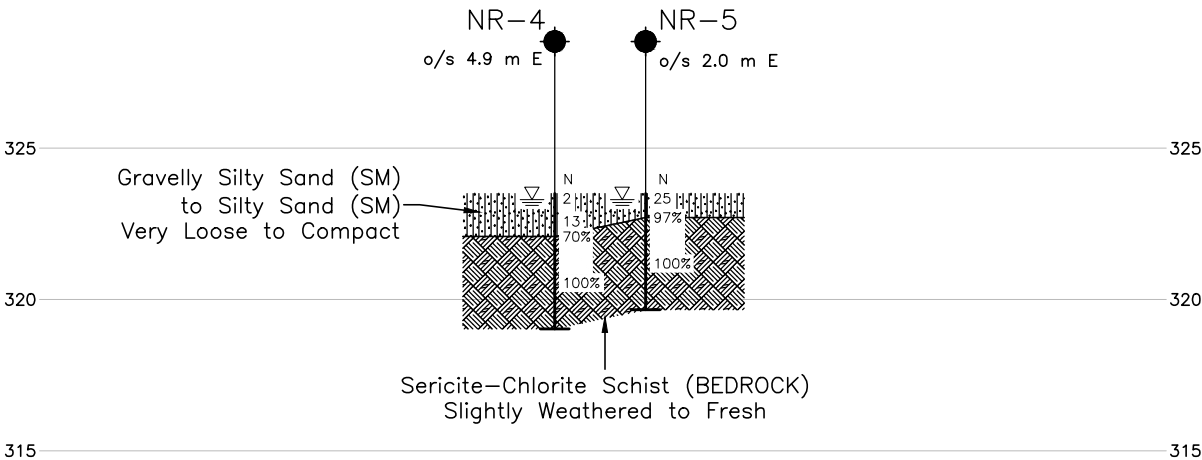


LEGEND

- Borehole - Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- WL upon completion of drilling
- WL in piezometer, measured on May 12, 2019
- Seal
- Piezometer



WEST ABUTMENT CROSS-SECTION
B-B' 1
HORIZONTAL SCALE
5 0 5 10 m
2.5 0 2.5 5 m
VERTICAL SCALE



EAST ABUTMENT CROSS-SECTION
C-C' 1
HORIZONTAL SCALE
5 0 5 10 m
2.5 0 2.5 5 m
VERTICAL SCALE



NOTES

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NO.	DATE	BY	REVISION
1	12/10/2019	JPD	1
Geocres No. 42B-14			
HWY. 101	PROJECT NO. 1790414	DIST. .	
SUBM'D.	CHKD.	DATE: 12/10/2019	SITE: 46X-0011/B0
DRAWN: TR	CHKD. DAM	APPD. JPD	DWG. 2

Photographs: Nat River Bridge - Highway 101



**Photograph 1: Nat River Bridge, Facing West (May 2019)
(looking towards location of proposed west abutment)**



**Photograph 2: Nat River Bridge, Facing Southeast (May 2019)
(from location of proposed west abutment)**



**Photograph 3: Nat River Bridge, Facing West (May 2019)
(from location of proposed east abutment)**



**Photograph 4: Nat River Bridge, Facing West (May 2019)
(from towards south side of existing bridge)**

APPENDIX A

Record of Borehole and Drillhole Sheets

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	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
FINES	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY COMPONENTS^{1,2}

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)

1. Only applicable to components not described by Primary Group Name.

2. 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 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (*q_t*), porewater pressure (*u*) and sleeve friction (*f_s*) are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

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 _p	plastic limit
LL, w _L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D _R	relative density (specific gravity, G _s)
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 ₄	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

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

COARSE-GRAINED SOILS

Compactness¹

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

3. 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.

4. 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' ^{1,2} (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

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

2. 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.

LIST OF SYMBOLS

MINISTRY OF TRANSPORTATION, ONTARIO

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
$\ln x$	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
U	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
E	void ratio
N	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index $= (w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index $= (w - w_p) / I_p$
I_C	consistency index $= (w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
C_v	coefficient of consolidation (vertical direction)
C_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction $= \tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

* Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1
2

$$\tau = c' + \sigma' \tan \phi'$$

$$\text{shear strength} = (\text{compressive strength})/2$$

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, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

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 1790414		RECORD OF BOREHOLE No NR-1				1 OF 1 METRIC											
G.W.P. 5180-16-00		LOCATION N 5342735.6; E 221903.6 NAD83 MTM ZONE 12 (LAT. 48.218013; LONG. -82.115666)				ORIGINATED BY SA											
DIST _____ HWY 101		BOREHOLE TYPE NW Casing with Wash Boring and NQ Coring				COMPILED BY TR											
DATUM GEODETIC		DATE May 11, 2019				CHECKED BY DAM											
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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
324.5	GROUND SURFACE																
0.0	TOPSOIL (25 mm)		1	SS	9												
323.8	SILTY SAND (SM), trace gravel, some organics																
0.7	Moist Brown		2A	SS	26												
323.4	SILTY GRAVEL (GM) and sand																
1.1	Compact Wet Brown		2B														
	Completely to moderately weathered, brown to grey, GREYWACKE (BEDROCK)																
322.6	GREYWACKE (BEDROCK)		1	RC	REC 88%												
1.9	Slightly weathered to fresh																
	For coring details see Record of Drillhole NR-1.																
			2	RC	REC 100%												
			3	RC	REC 100%												
319.6	END OF BOREHOLE																
4.9	NOTE: 1. Water level at a depth of 1.1 m below ground surface (Elev. 323.4 m) upon completion of drilling.																

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INCLINATION: -90° AZIMUTH: —

DRILLING CONTRACTOR: George Downing Estate Drilling Ltd.

DATUM: GEODETIC

1 : 60



CHECKED: DAM

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PROJECT 1790414		RECORD OF BOREHOLE No NR-2				1 OF 1 METRIC							
G.W.P. 5180-16-00		LOCATION N 5342732.3; E 221918.7 NAD83 MTM ZONE 12 (LAT. 48.217985; LONG. -82.115462)				ORIGINATED BY SA							
DIST _____ HWY 101		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers, NW Casing with Wash Boring and NQ Coring				COMPILED BY TR							
DATUM GEODETIC		DATE May 11, 2019				CHECKED BY DAM							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa		WATER CONTENT (%)			
323.5	GROUND SURFACE							20 40 60 80 100	20 40 60				
0.9	TOPSOIL (50 mm)		1	SS	2		323						
	CLAYEY SILT - SILT (CL-ML), trace sand, trace organics		2A	SS	12								0 6 78 16
322.4													
1.1	SILTY SAND (SM), some gravel		2B										
322.1	Compact												
1.4	Brown												
	Wet												
	GREYWACKE (BEDROCK)		1	RC	REC 93%		321						RQD = 83%
	Slightly weathered to fresh												
	For coring details see Record of Drillhole NR-2.		2	RC	REC 100%		320						RQD = 77%
319.0	END OF BOREHOLE												
4.5	NOTES:												
	1. Water level at a depth of 0.2 m below ground surface (Elev. 323.3 m) upon completion of drilling.												
	2. Water level at a depth of 0.1 m below ground surface (Elev. 323.4 m) on May 12, 2019 in standpipe piezometer.												

SHEET 1 OF 1

DATUM: GEODETIC

DRILLING CONTRACTOR: George Downing Estate Drilling Ltd.

CHECKED: DAM

1 : 60

PROJECT 1790414		RECORD OF BOREHOLE No NR-3		1 OF 1 METRIC													
G.W.P. 5180-16-00		LOCATION N 5342727.7; E 221919.8 NAD83 MTM ZONE 12 (LAT. 48.217944; LONG. -82.115447)		ORIGINATED BY SA													
DIST _____ HWY 101		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers, NW Casing with Wash Boring and NQ Coring		COMPILED BY TR													
DATUM GEODETIC		DATE May 11, 2019		CHECKED BY DAM													
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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
323.4	GROUND SURFACE																
0.0	TOPSOIL (25 mm)																
	Gravelly SILTY SAND (SM) to SILTY SAND (SM), trace gravel Very loose to dense Brown to grey Moist to wet		1	SS	3												
	- 50 mm peat layer at 0.8 m depth		2	SS	10												
	- Auger refusal on inferred cobble / boulder at 1.5 m depth. Switched to NW Casing.		3	SS	32												
321.1	GREYWACKE (BEDROCK)																
2.3	Slightly weathered to fresh		1	RC	REC 100%												RQD = 27%
	For coring details see Record of Drillhole NR-3.		2	RC	REC 100%												RQD = 100%
			3	RC	REC 100%												RQD = 85%
			4	RC	REC 100%												RQD = 100%
317.9	END OF BOREHOLE																
5.5	NOTE: 1. Water level at a depth of 0.1 m below ground surface (Elev. 323.3 m) approximately 30 minutes after completion of drilling.																

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PROJECT: 1790414

RECORD OF DRILLHOLE: NR-3

SHEET 1 OF 1

LOCATION: N 5342727.7; E 221919.8

DRILLING DATE: May 11, 2019

DATUM: GEODETIC

NAD83 MTM ZONE 12 (LAT. 48.217944; LONG. -82.115447)

DRILL RIG: CME55 LC

INCLINATION: -90° AZIMUTH: —

DRILLING CONTRACTOR: George Downing Estate Drilling Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.										HYDRAULIC CONDUCTIVITY k, cm/s	Diametral Point Load Index (MPa)	RMC -Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
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LOGGED: SA

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DEPTH SCALE

1 : 60

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PROJECT		1790414		RECORD OF BOREHOLE No NR-4				1 OF 1		METRIC							
G.W.P.		5180-16-00		LOCATION				N 5342719.5; E 221958.7 NAD83 MTM ZONE 12 (LAT. 48.217876; LONG. -82.114922)									
DIST		HWY 101		BOREHOLE TYPE				NW Casing with Wash Boring and NQ Coring									
DATUM		GEODETIC		DATE				May 11, 2019									
ORIGINATED BY		SA		COMPILED BY				TR									
CHECKED BY		DAM															
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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
323.5	GROUND SURFACE																
0.0	Fibrous PEAT (150 mm), trace sand, trace silt		1A	SS	2												
0.2	Soft Black Moist		1B														
	Gravelly SILTY SAND (SM) to SILTY SAND (SM), trace gravel		2	SS	13												26 50 (24)
322.1	Very loose to compact Brown to grey Moist to wet																
1.4	- Trace organics in Sample 1B																
	SERICITE-CHLORITE SCHIST (BEDROCK)		1	RC	REC 100%												RQD = 70%
	Slightly weathered to fresh																
	For coring details see Record of Drillhole NR-4.																
			2	RC	REC 100%												RQD = 100%
319.0	END OF BOREHOLE																
4.5	NOTE: 1. Water level at a depth of 0.2 m below ground surface (Elev. 323.3 m) upon completion of drilling.																

PROJECT: 1790414

LOCATION: N 5342719.5; E 221958.7

NAD83 MTM ZONE 12 (LAT. 48.217876; LONG. -82.114922)

INCLINATION: -90° AZIMUTH: —

RECORD OF DRILLHOLE: NR-4

SHEET 1 OF 1



DRILLING DATE: May 11, 2019

DATUM: GEODETIC

DRILL RIG: CME55 LC

DRILLING CONTRACTOR: George Downing Estate Drilling Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate										BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage										PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular										PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break										BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
							FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA										HYDRAULIC CONDUCTIVITY		Diametral Point Load Index (MPa)	RMC -Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
								TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	k, cm/s																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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PROJECT 1790414		RECORD OF BOREHOLE No NR-5				1 OF 1 METRIC											
G.W.P. 5180-16-00		LOCATION N 5342714.8; E 221954.0 NAD83 MTM ZONE 12 (LAT. 48.217833; LONG. -82.114984)				ORIGINATED BY SA											
DIST _____ HWY 101		BOREHOLE TYPE NW Casing with Wash Boring and NQ Coring				COMPILED BY TR											
DATUM GEODETIC		DATE May 11, 2019				CHECKED BY DAM											
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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
323.5	GROUND SURFACE																
0.0	SILTY SAND (SM), trace gravel, trace clay Compact Brown Moist to wet		1	SS	25												2 62 31 5
322.7	- 100 mm cobble at 0.7 m depth SERICITE-CHLORITE SCHIST (BEDROCK) Fresh		1	RC	REC 100%												RQD = 97%
0.8	For coring details see Record of Drillhole NR-5.		2	RC	REC 100%												RQD = 100%
319.7	END OF BOREHOLE																
3.8	NOTE: 1. Water level at a depth of 0.2 m below ground surface (Elev. 323.3 m) upon completion of drilling.																

PROJECT: 1790414

RECORD OF DRILLHOLE: NR-5

SHEET 1 OF 1

LOCATION: N 5342714.8; E 221954.0

DRILLING DATE: May 11, 2019

DATUM: GEODETIC

NAD83 MTM ZONE 12 (LAT. 48.217833; LONG. -82.114984)

DRILL RIG: CME55 LC

INCLINATION: -90° AZIMUTH: —

DRILLING CONTRACTOR: George Downing Estate Drilling Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.										HYDRAULIC CONDUCTIVITY k, cm/s	Diametral Point Load Index (MPa)	RMC -Q AVG																																																																																																																																																																																																																															
							RECOVERY		R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA									Jr	Ja	Jn																																																																																																																																																																																																																												
							TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	TYPE AND SURFACE DESCRIPTION	TYPE AND SURFACE DESCRIPTION																																																																																																																																																																																																																																			
							FLUSH	80 90 95 98 99 100								80 90 95 98 99 100							80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100	80 90 95 98 99 100

UCS = 41 MPa

DEPTH SCALE

1 : 60



GOLDER

LOGGED: SA

CHECKED: DAM

SUD-MTO-RCK S:\CLIENTS\MTOWHY17&10102 DATA\GINT\1790414.GPJ GAL-MISS.GDT 12-4-19 TR

PROJECT 1790414		RECORD OF BOREHOLE No NR-6				1 OF 1 METRIC											
G.W.P. 5180-16-00		LOCATION N 5342711.5; E 221971.7 NAD83 MTM ZONE 12 (LAT. 48.217805; LONG. -82.114745)				ORIGINATED BY SA											
DIST _____ HWY 101		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers, NW Casing with Wash Boring and NQ Coring				COMPILED BY TR											
DATUM GEODETIC		DATE May 10, 2019				CHECKED BY DAM											
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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
325.2	GROUND SURFACE																
0.0	Sand (SW), some gravel, trace silt (FILL)		1A	SS	16												
0.2	Brown Moist		1B														
324.5	SILT (ML) of slight plasticity, some sand, some clay, trace gravel																
0.7	Compact Brown Moist		2	SS	20												
	Gravelly SILTY SAND (SM) to SILTY SAND (SM), some gravel, trace clay																
	Compact Brown to grey Moist to wet		3	SS	14												
323.1	Inferred completely to moderately weathered, Brown to grey, TALC SCHIST (BEDROCK)																
2.3	TALC SCHIST (BEDROCK) Slightly weathered to fresh		1	RC	REC 95%												RQD = 71%
	For coring details see Record of Drillhole NR-6.																
			2	RC	REC 98%												RQD = 88%
			3	RC	REC 98%												RQD = 71%
320																	
319.6	END OF BOREHOLE																
5.6	NOTE: 1. Water level at a depth of 1.8 m below ground surface (Elev. 323.4 m) approximately 30 minutes after completion of drilling.																

SUD-MTO 001 S:\CLIENTS\MT\Hwy17&101\02_DATA\GINT\1790414.GPJ GAL-MISS.GDT 12-9-19 TR

PROJECT: 1790414

RECORD OF DRILLHOLE: NR-6

SHEET 1 OF 1

LOCATION: N 5342711.5; E 221971.7

DRILLING DATE: May 10, 2019

DATUM: GEODETIC

NAD83 MTM ZONE 12 (LAT. 48.217805; LONG. -82.114745)

DRILL RIG: CME55 LC

INCLINATION: -90° AZIMUTH: —

DRILLING CONTRACTOR: George Downing Estate Drilling Ltd.

DEPTH SCALE METRES	DRILLING RECORD		DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.										DISCONTINUITY DATA				Diametral Point Load Index (MPa)	RMC -Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
	FLUSH	RECOVERY						R.Q.D. %	FRACT. INDEX METRES	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY k, cm/s																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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DEPTH SCALE

1 : 60

**GOLDER**

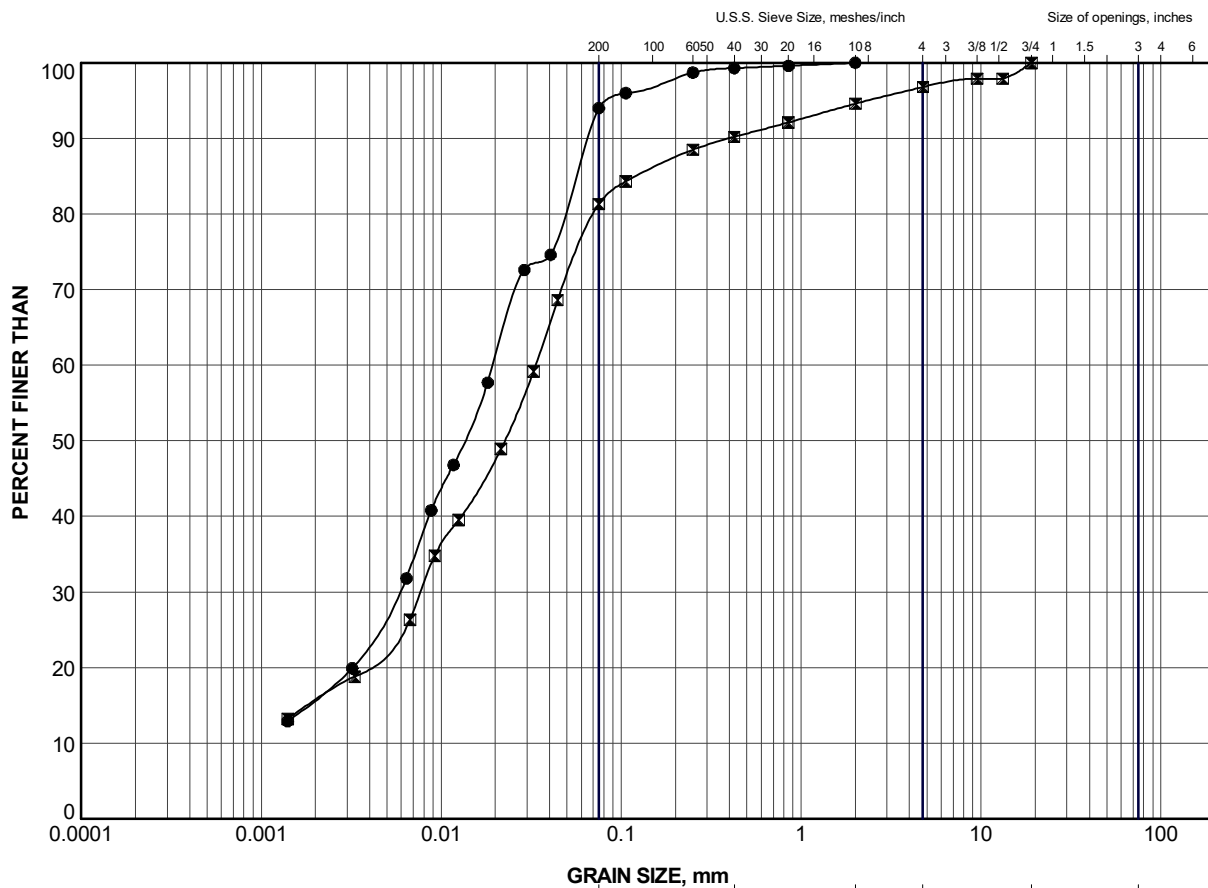
LOGGED: SA

CHECKED: DAM

SUD-MTO-RCK S:\CLIENTS\MTOWHY17&101102 DATA\GINT\1790414.GPJ GAL-MISS.GDT 12-4-19 TR

APPENDIX B

Laboratory Test Results



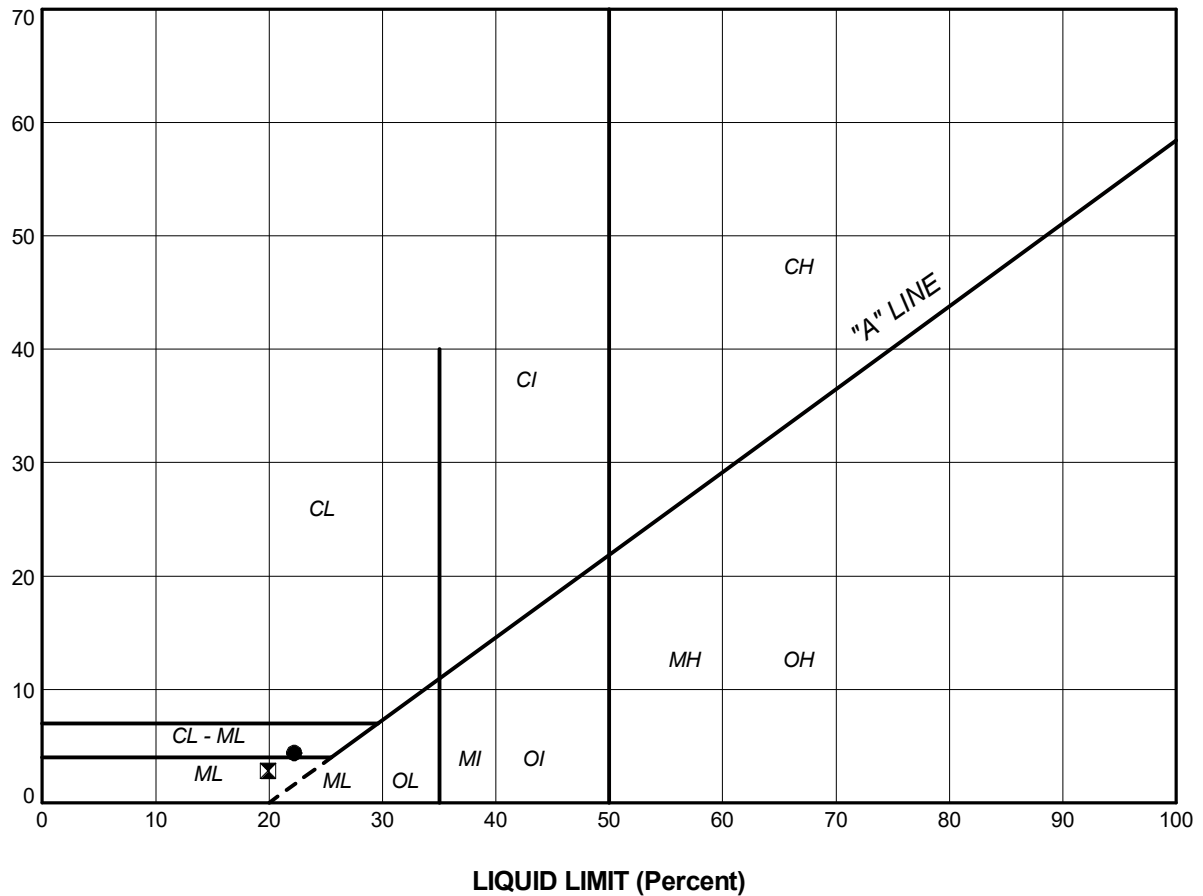
CLAY AND SILT	SAND SIZE			GRAVEL SIZE		Cobble Size
	fine	medium	coarse	fine	coarse	

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	NR-2	2A	322.6
×	NR-6	1B	324.8

PROJECT						HIGHWAY 101 NAT RIVER BRIDGE						
TITLE						GRAIN SIZE DISTRIBUTION CLAYEY SILT - SILT (CL-ML) to SILT (ML)						
PROJECT No.				1790414		FILE No.				1790414.GPJ		
DRAWN	TR	Sep 2019	SCALE		N/A	REV.						
CHECK	DAM	Sep 2019										
APPR	JPD	Sep 2019										
GOLDER SUDBURY, ONTARIO						FIGURE B1						

PLASTICITY INDEX (Percent)



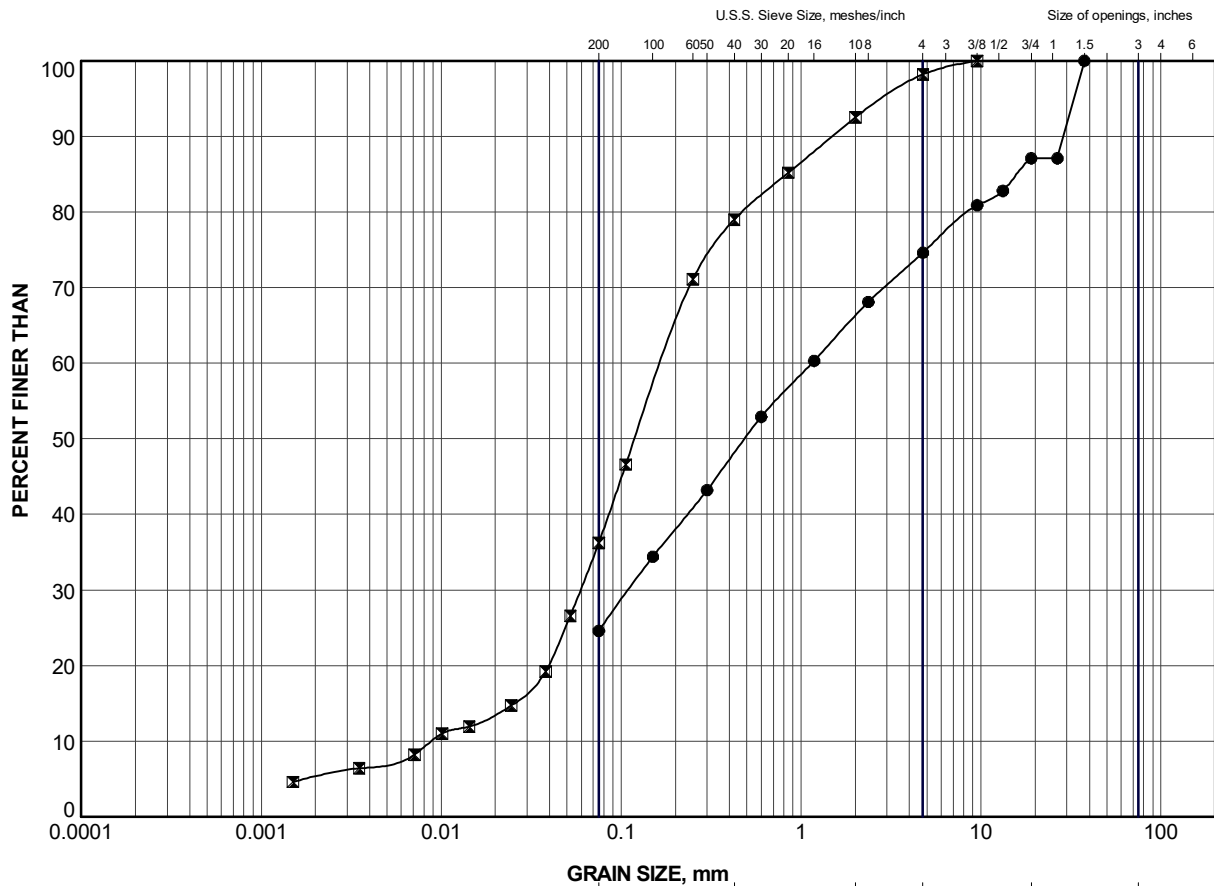
SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	NR-2	2A	22.2	17.8	4.4
⊠	NR-6	1B	19.9	17.1	2.8

PROJECT					
HIGHWAY 101 NAT RIVER BRIDGE					
TITLE					
PLASTICITY CHART CLAYEY SILT - SILT (CL-ML) TO SILT (ML)					
PROJECT No. 1790414			FILE No. 1790414.GPJ		
DRAWN	TR	Sep 2019	SCALE	N/A	REV.
CHECK	DAM	Sep 2019	FIGURE B2		
APPR	JPD	Sep 2019			
SUDBURY, ONTARIO					

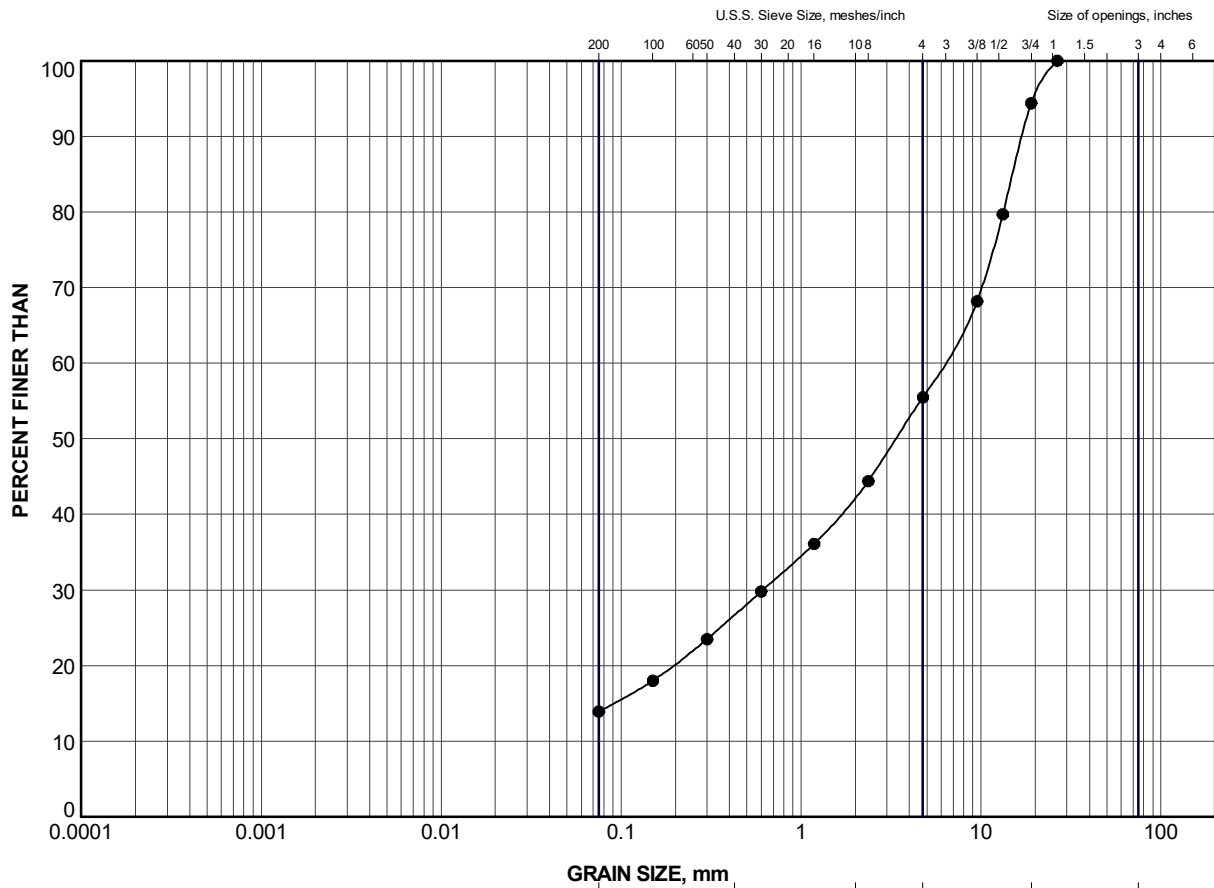


GRAVEL SIZE, mm							Cobble Size
CLAY AND SILT	fine	medium	coarse	fine	coarse		
	SAND SIZE			GRAVEL SIZE			

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	NR-4	2	322.4
×	NR-5	1	323.2


PROJECT					
HIGHWAY 101 NAT RIVER BRIDGE					
TITLE					
GRAIN SIZE DISTRIBUTION GRAVELLY SILTY SAND (SM) TO SILTY SAND (SM)					
PROJECT No.		1790414		FILE No. 1790414.GPJ	
DRAWN	TR	Sep 2019	SCALE	N/A	REV.
CHECK	DAM	Sep 2019			
APPR	JPD	Sep 2019			
GOLDER SUDBURY, ONTARIO			FIGURE B3		



GRAVEL SIZE, mm							Cobble Size
CLAY AND SILT	fine	medium	coarse	fine	coarse		
	SAND SIZE			GRAVEL SIZE			

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	NR-1	2	323.6

PROJECT					
HIGHWAY 101 NAT RIVER BRIDGE					
TITLE					
GRAIN SIZE DISTRIBUTION SILTY GRAVEL (GM) AND SAND					
PROJECT No. 1790414			FILE No. 1790414.GPJ		
DRAWN	TR	Sep 2019	SCALE	N/A	REV.
CHECK	DAM	Sep 2019			
APPR	JPD	Sep 2019			
 GOLDER SUDBURY, ONTARIO			FIGURE B4		

Bedrock Core Photographs

Nat River Bridge (Site 46X-011/B0)
Highway 101

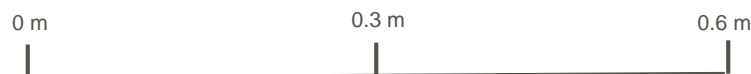
Figure B5
Page 1 of 3



Borehole NR-1
Elevation 323.0 m to 319.6 m



Borehole NR-2
Elevation 322.1 m to 319.0 m



Bedrock Core Photographs

Nat River Bridge (Site 46X-011/B0)
Highway 101

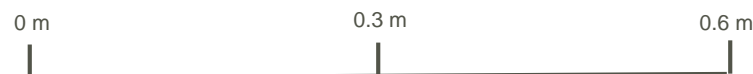
Figure B5
Page 2 of 3



Borehole NR-3
Elevation 321.1 m to 317.9 m



Borehole NR-4
Elevation 322.1 m to 319.0 m

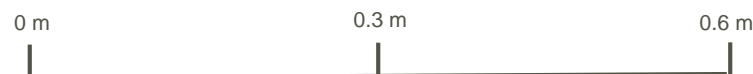




Borehole NR-5
Elevation 322.7 m to 319.7 m



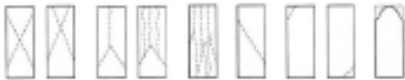
Borehole NR-6
Elevation 322.9 m to 319.6 m



Rock Core Test Data

Nat River Bridge (Site 46X-011/B0)
Highway 101

Figure B6

SUMMARY OF ROCK CORE TEST DATA					
PROJECT NO.:	<u>1790414-1000-1300</u>				
PROJECT NAME:	<u>AECOM-Nat River Bridge, Hwy 17/101</u>				
TYPE OF UNIT:	<u>Rock Core</u>				
TESTED BY:	<u>JP</u>				
DATE TESTED:	<u>June 4, 2019</u>				
GOLDER LAB NUMBER	T723	T724	T725	T726	
BOREHOLE NUMBER:	NR-2	NR-3	NR-4	NR-5	
SAMPLE NUMBER:	Run 1	Run 2	Run 1	Run 1	
DEPTH OF TESTED CORE	7'6"	12'9"	7'9"	7'0"	
LENGTH AS CUT (mm)	103.5	101.7	101.0	102.1	
DIAMETER (mm)	47.2	47.1	47.1	45.0	
DENSITY (kg/m3)	2764	2821	2841	2775	
COMPRESSIVE STRENGTH (KN)	147.9	133.8	83.8	65.4	
CORRECTED STRENGTH (MPa)	84.6	76.8	48.1	41.2	
TYPE OF FRACTURE	3	3	3	3	
<p>Type of Fracture</p>  <p>1 2 3 4 5 6</p>					
COMMENTS:					

Input by: SM
Reviewed by: JM

APPENDIX C

Analytical Test Results

Your Project #: 1790414
Your C.O.C. #: 712313-01-01

Attention: David Muldowney

Golder Associates Ltd
33 Mackenzie Street
Suite 100
Sudbury, ON
Canada P3C 4Y1

Report Date: 2019/05/29
Report #: R5729598
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B9C8163

Received: 2019/05/13, 15:20

Sample Matrix: Soil
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	3	2019/05/15	2019/05/16	CAM SOP-00463	SM 4500-Cl E m
Conductivity	3	2019/05/17	2019/05/17	CAM SOP-00414	OMOE E3530 v1 m
Moisture (Subcontracted) (1, 3)	3	2019/05/21	2019/05/21	BBY8SOP-00017	BCMOE BCLM Dec2000 m
Sulphide in Soil (1)	3	2019/05/21	2019/05/23	BBY6SOP-00052 BBY6SOP-00006	EPA-821-R-91-100 m
pH CaCl2 EXTRACT	3	2019/05/15	2019/05/15	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	3	2019/05/14	2019/05/17	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	3	2019/05/15	2019/05/16	CAM SOP-00464	EPA 375.4 m
Redox Potential (2, 4)	3	N/A	N/A		

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing. Maxxam is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

(1) This test was performed by Campo to Burnaby - Offsite

(2) This test was performed by Sub from Campo to Env. Testing Canada (Eurofins)

(3) Offsite analysis requires that subcontracted moisture be reported.

Your Project #: 1790414
Your C.O.C. #: 712313-01-01

Attention: David Muldowney

Golder Associates Ltd
33 Mackenzie Street
Suite 100
Sudbury, ON
Canada P3C 4Y1

Report Date: 2019/05/29
Report #: R5729598
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B9C8163

Received: 2019/05/13, 15:20

(4) Oxidation-Reduction Potential (ORP) values are determined using a Ag/AgCl reference electrode.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Alisha Williamson, Project Manager

Email: AWilliamson@maxxam.ca

Phone# (613)274-0573

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

RESULTS OF ANALYSES OF SOIL

Maxxam ID		JSA209		JSA210			JSA210		
Sampling Date		2019/05/09 11:00		2019/05/11 10:30			2019/05/11 10:30		
COC Number		712313-01-01		712313-01-01			712313-01-01		
	UNITS	AB-1	QC Batch	NR-2	RDL	QC Batch	NR-2 Lab-Dup	RDL	QC Batch
CONVENTIONALS									
Sulphide	ug/g	<0.30	6139910	<0.30	0.30	6139910			
Calculated Parameters									
Resistivity	ohm-cm	24000	6120894	5800		6120894			
Inorganics									
Soluble (20:1) Chloride (Cl-)	ug/g	<20	6122300	60	20	6122300			
Conductivity	umho/cm	42	6127141	174	2	6127141	177	2	6127141
Available (CaCl2) pH	pH	5.34	6122353	6.96		6122355			
Soluble (20:1) Sulphate (SO4)	ug/g	<20	6122302	<20	20	6122302			
Physical Testing									
Moisture-Subcontracted	%	16	6139909	9.9	0.30	6139909			
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate									

Maxxam ID		JSA211			JSA211		
Sampling Date		2019/05/11 15:00			2019/05/11 15:00		
COC Number		712313-01-01			712313-01-01		
	UNITS	NR-5	RDL	QC Batch	NR-5 Lab-Dup	RDL	QC Batch
CONVENTIONALS							
Sulphide	ug/g	<0.50	0.50	6139910	<0.50	0.50	6139910
Calculated Parameters							
Resistivity	ohm-cm	8100		6120894			
Inorganics							
Soluble (20:1) Chloride (Cl-)	ug/g	41	20	6122300			
Conductivity	umho/cm	123	2	6127141			
Available (CaCl2) pH	pH	7.31		6122353			
Soluble (20:1) Sulphate (SO4)	ug/g	<20	20	6122302			
Physical Testing							
Moisture-Subcontracted	%	18	0.30	6139909			
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate							

TEST SUMMARY

Maxxam ID: JSA209
Sample ID: AB-1
Matrix: Soil

Collected: 2019/05/09
Shipped:
Received: 2019/05/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6122300	2019/05/15	2019/05/16	Deonarine Ramnarine
Conductivity	AT	6127141	2019/05/17	2019/05/17	Kazzandra Adeva
Moisture (Subcontracted)	BAL	6139909	2019/05/21	2019/05/21	William Zou
Sulphide in Soil	SPEC/UVVS	6139910	2019/05/21	2019/05/23	David Huang
pH CaCl2 EXTRACT	AT	6122353	2019/05/15	2019/05/15	Gnana Thomas
Resistivity of Soil		6120894	2019/05/17	2019/05/17	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	6122302	2019/05/15	2019/05/16	Deonarine Ramnarine
Redox Potential	COND	6146214	2019/05/29		Katherine Szozda

Maxxam ID: JSA210
Sample ID: NR-2
Matrix: Soil

Collected: 2019/05/11
Shipped:
Received: 2019/05/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6122300	2019/05/15	2019/05/16	Deonarine Ramnarine
Conductivity	AT	6127141	2019/05/17	2019/05/17	Kazzandra Adeva
Moisture (Subcontracted)	BAL	6139909	2019/05/21	2019/05/21	William Zou
Sulphide in Soil	SPEC/UVVS	6139910	2019/05/21	2019/05/23	David Huang
pH CaCl2 EXTRACT	AT	6122355	2019/05/15	2019/05/15	Gnana Thomas
Resistivity of Soil		6120894	2019/05/17	2019/05/17	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	6122302	2019/05/15	2019/05/16	Deonarine Ramnarine
Redox Potential	COND	6146214	2019/05/29		Katherine Szozda

Maxxam ID: JSA210 Dup
Sample ID: NR-2
Matrix: Soil

Collected: 2019/05/11
Shipped:
Received: 2019/05/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	6127141	2019/05/17	2019/05/17	Kazzandra Adeva

Maxxam ID: JSA211
Sample ID: NR-5
Matrix: Soil

Collected: 2019/05/11
Shipped:
Received: 2019/05/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6122300	2019/05/15	2019/05/16	Deonarine Ramnarine
Conductivity	AT	6127141	2019/05/17	2019/05/17	Kazzandra Adeva
Moisture (Subcontracted)	BAL	6139909	2019/05/21	2019/05/21	William Zou
Sulphide in Soil	SPEC/UVVS	6139910	2019/05/21	2019/05/23	David Huang
pH CaCl2 EXTRACT	AT	6122353	2019/05/15	2019/05/15	Gnana Thomas
Resistivity of Soil		6120894	2019/05/17	2019/05/17	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	6122302	2019/05/15	2019/05/16	Deonarine Ramnarine
Redox Potential	COND	6146214	2019/05/29		Katherine Szozda

TEST SUMMARY

Maxxam ID: JSA211 Dup
Sample ID: NR-5
Matrix: Soil

Collected: 2019/05/11
Shipped:
Received: 2019/05/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphide in Soil	SPEC/UVVS	6139910	2019/05/21	2019/05/23	David Huang

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	5.0°C
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Results relate only to the items tested.

QUALITY ASSURANCE REPORT

Golder Associates Ltd
Client Project #: 1790414
Sampler Initials: SA

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
6122300	Soluble (20:1) Chloride (Cl-)	2019/05/16	114	70 - 130	106	70 - 130	<20	ug/g	NC	35
6122302	Soluble (20:1) Sulphate (SO4)	2019/05/16	101	70 - 130	101	70 - 130	<20	ug/g	20	35
6122353	Available (CaCl2) pH	2019/05/15			100	97 - 103			0.68	N/A
6122355	Available (CaCl2) pH	2019/05/15			100	97 - 103			0.025	N/A
6127141	Conductivity	2019/05/17			104	90 - 110	<2	umho/cm	1.8	10
6139909	Moisture-Subcontracted	2019/05/21					<0.30	%		
6139910	Sulphide	2019/05/23	89	75 - 125	107	75 - 125	<0.50	ug/g	NC	30

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Anastassia Hamanov, Scientific Specialist



David Huang, BBY Scientific Specialist

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Maxxam Analytics International Corporation o/a Maxxam Analytics
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CHAIN OF CUSTODY RECORD

Page of

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name: #7575 Golder Associates Ltd		Company Name: Golder Associates		Quotation #: B80683		Maxxam Job #:	
Attention: Accounts Payable		Attention: David Muldowney		P.O. #:		Bottle Order #:	
Address: 33 Mackenzie Street Suite 100		Address: 33 Mackenzie St. Suite 100		Project: 1790414		712313	
Sudbury ON P3C 4Y1		Sudbury ON P3C 4Y1		Project Name:		COC #:	
Tel: (705) 524-6861 Fax: (705) 524-1984		Tel: 705 524-6861 Fax:		Site #:		Project Manager:	
Email: AP_CustomerService@golder.com		Email: D_Muldowney@Golder.com		Sampled By:		Alisha Williamson	

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY						ANALYSIS REQUESTED (PLEASE BE SPECIFIC)										Turnaround Time (TAT) Required:			
Regulation 153 (2011)						Other Regulations						Special Instructions						Please provide advance notice for rush projects	
<input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Medium/Fine						<input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw												Regular (Standard) TAT:	
<input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse						<input type="checkbox"/> Reg 558 <input type="checkbox"/> Storm Sewer Bylaw												<small>(will be applied if Rush TAT is not specified):</small>	
<input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/Other <input type="checkbox"/> For RSC						<input type="checkbox"/> MISA Municipality												<small>Standard TAT = 5-7 Working days for most tests.</small>	
<input type="checkbox"/> Table						<input type="checkbox"/> PWQO												<small>Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.</small>	
<input type="checkbox"/> Other						<input type="checkbox"/> Other												Job Specific Rush TAT (if applies to entire submission)	
Include Criteria on Certificate of Analysis (Y/N)?																		Date Required: Time Required:	
																		Rush Confirmation Number: (call lab for #)	
																		# of Bottles Comments	
1 AB-1 Alona Bay CK HWY 17 Culvert May 09/19 11:00 Soil																		13-May-19 15:20	
2 NR-2 NAT RIVER Bridge HWY 101 May 11/19 10:30 Soil																		Alisha Williamson	
3 NR-5 NAT RIVER Bridge HWY 101 May 11/19 15:00 Soil																		B9C8163	
4																		URE ENV-1367	
5																		Received in Sudbury	
6																			
7																			
8																			
9																			
10																			
* RELINQUISHED BY: (Signature/Print)						RECEIVED BY: (Signature/Print)						Laboratory Use Only							
19/05/13 15:20						19/05/13 15:20						Time Sensitive						Temperature (°C) on Reel	
19/05/14 08:56						19/05/14 08:56						Custody Seal Present						Intact	
																		Yes No	
																		White: Maxxa Yellow: Client	

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.

** IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/WP-CONTENT/UPLOADS/ONTARIO-COC.PDF.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM



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