FINAL REPORT

Foundation Investigation and Design
Noise Barrier Wall Replacement
Highway 417 from Island Park Drive to Bronson Avenue
Ottawa, Ontario

Site No. 417-09, 417-10 & 417-22

G.W.P. 4173-15-00

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PART A

Foundation Investigation
Noise Barrier Wall Replacement
Highway 417 from Island Park Drive to Bronson Avenue
Ottawa, Ontario

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, 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 investigations carried out for the replacement of the noise barrier walls (Sites Nos. 417-09, 417-10, and 417-22) located on Highway 417. The replacement of the structures is to be carried out in accordance with the current version of the Canadian Highway Bridge Design Code, S6-14 (CHBDC).

The terms of reference and scope of work for the foundation investigation are outlined in the MTO's Request for Proposal, dated May 2015, and subsequent addenda. Golder's scope of work for foundation engineering services associated with the noise walls is contained in Table 17.8.3 of WSP's Technical Proposal for this assignment dated June 28, 2016.

2.0 SITE DESCRIPTION AND GEOLOGY

2.1 Site Description

The noise barrier walls are located along the north and south sides of Highway 417 from Island Park Drive to Bronson Avenue. Noise walls are generally located where residential areas are present adjacent to Highway 417 and may not extend over interchanges.

This report provides geotechnical and foundation parameters for the noise walls at the following three site locations:

- Site 417-09 is located along the north side of Highway 417 from west of Island Park Drive to east of Parkdale Avenue (about 1.9 km)
- Site 417-10 is located along the south side of Highway 417 from west of Island Park Drive to west of the CPR/O-Train overpass (about 2.3 km)
- Site 417-22 is located on the north side of Highway 417 from the midpoint of the Rochester Street NS-W onramp to east of Bronson Avenue (about 0.5 km)

At these locations, Highway 417 is a divided highway with three or four lanes in each direction separated by a concrete median.

A total of seven noise barrier walls within Site 417-09 (designated NB2N to NB8N, inclusive, on the north side of Highway 417), nine noise barrier walls within Site 417-10 (designated NB1S to NB9S, inclusive, on the south side of Highway 417) and three noise barrier walls within Site 417-22 (designated NB10N, NB12N and NB14N) from Rochester Street to Bronson Avenue) required foundation investigation for the planned rehabilitation or replacement. The locations of the noise walls within each site were indicated on the drawing titled Site Overview, dated April 8, 2019, provided by WSP. The location of each noise barrier walls is shown on Drawings 1 to 11.

2.2 Regional Geology

As delineated in *The Physiography of Southern Ontario*[1], this section of Highway 417 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.

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[2].

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 at this site is primarily limestone of the Verulam Formation.[3] The limestone is described as interbedded bioclastic, sublithographic to fine crystalline, very thin to medium bedded, with shale interbeds up to 8 cm thick.

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[4]. 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 sites fall 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

The field work for the current investigation was carried out between April 10 and 25, 2017 and between July 30 and August 18, 2017 and included advancing a total of 54 boreholes designated 17-503 to 17-549, and 17-551 to 17-557, inclusive. In addition, Borehole 19-1601, which is part of the trenchless crossing investigation located along NB8N was advanced on August 2, 2019. The NAD83 CSRS CBNv6-2010.0 MTM Zone 9 locations and ground surface elevations of the boreholes are shown on Drawings 1 to 11. Table 1 below further outlines the location of the boreholes with respect to the current Highway 417 stationing.

[1] 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.

[2] 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.

[3] Williams, D.A. Rae, A.M., and Wolf, R.R. 1984: Paleozoic Geology of the Ottawa Area, Southern Ontario, Ontario Geological Survey, Map P.2716. Geological Series-Preliminary Map, scale 1:50,000. Geology 1982.

[4] 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 boreholes were drilled at an approximate spacing of between 60 and 75 m along Highway 417 on the north and south side of the highway. The boreholes were advanced using a truck-mounted hollow-stem auger drill rig supplied and operated by George Downing Estate Drilling of Grenville-sur-la-rouge, Québec. The boreholes were advanced to depths ranging from 1.0 to 10.9 m below the existing ground surface.

Soil samples in the boreholes were obtained at vertical intervals of about 0.8 to 1.5 m, using a 50 mm outer diameter split-spoon sampler in accordance with Standard Penetration Test (SPT) procedure (ASTM D1586).

Bedrock was not confirmed in any boreholes, but auger refusal was encountered in 43 of the 54 boreholes. Auger refusal was encountered in Borehole 17-528 at a depth of 3.1 m and two additional auger probes were advanced in the vicinity of this borehole, to confirm the refusal depth in the area. Boreholes 17-528A (located 1.2 m to the east) and 17-528B (located 1.5 m to the west) encountered auger refusal at 3.3 m and 2.9 m respectively. The location of the additional auger probes is shown on Drawing 7.

Monitoring wells were installed in Boreholes 17-504, 17-507A, 17-514, 17-523, 17-526, 17-533, 17-538, 17-543, 17-548 and 17-557 to observe the groundwater level at the sites and for groundwater sampling. The monitoring wells consist of 32 mm outside diameter PVC tubing with a 1.5 to 3.0 m long slotted screen. The groundwater levels were measured in the monitoring wells between October 16 and 19, 2017.

The boreholes were backfilled with a mixture of bentonite and soil cuttings and capped with asphaltic concrete cold patch. The site conditions were restored following completion of the field work. The boreholes were backfilled in general accordance with the intent of Ontario MOE Regulation 903, as amended. The site conditions were restored following completion of the field work.

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 samples were identified in the field, placed in labelled containers, and transported to Golder’s laboratory in Ottawa for further examination and testing. Index and classification tests consisting of water content determinations, grain size distribution analyses and Atterberg Limits were carried out on selected soil samples at Golder’s Ottawa laboratory. All geotechnical laboratory testing was completed to ASTM and/or MTO Standards, as applicable.

A total of six groundwater samples from Boreholes 17-507A, 17-514, 17-523, 17-526, 17-533, and 17-538 were submitted to Maxxam Analytics (Maxxam) for chemical analysis related to potential corrosion of exposed buried steel and potential sulphate attack on buried concrete elements (corrosion and sulphate attack).

The borehole locations and elevations were surveyed by Golder using a Trimble R8 GPS unit referenced to the NAD83 CSRS CBNv6-2010.0 MTM Zone 9 geodetic datum. The borehole locations, including, stationing, northing and easting coordinates, ground surface elevations, and drilled depths are summarized in Tables 1 to 3.

Table 1: Summary of Borehole Locations North Side of Highway 417 Station 24+700 to 26+974

Site	Approximate Highway 417 Stationing	Borehole	NAD83 CSRS CBNv6-2010.0 MTM Zone 9		Ground Surface Elevation (m)	Borehole Depth (m)
			Northing (m)	Easting (m)		
417-09	24+700	17-503	5028113.6	364781.6	77.1	7.5
417-09	24+770	17-505	5028175.4	364827.0	75.6	7.5
417-09	24+845	17-507A	5028237.0	364859.9	73.6	2.5
417-09	24+935	17-509	5028319.9	364903.8	72.2	1.3
417-09	25+015	17-511	5028389.0	364941.0	71.7	1.0
417-09	25+090	17-513	5028455.1	364977.1	71.3	4.1
417-09	25+170	17-515	5028526.6	365016.5	71.5	4.9
417-09	25+250	17-517	5028595.5	365054.5	72.5	6.4
417-09	25+325	17-519	5028662.6	365090.3	73.8	7.0
417-09	25+400	17-521	5028727.4	365133.4	74.9	8.9
417-09	25+495	17-523	5028797.4	365198.5	75.9	4.3
417-09	25+565	17-525	5028845.2	365250.3	76.2	8.7
417-09	25+625	17-527	5028884.4	365302.7	75.8	7.3
417-09	25+705	17-529	5028926.2	365364.4	74.8	4.5
417-09	25+780	17-531	5028970.1	365429.6	73.2	8.2
417-09	25+860	17-533	5029014.9	365495.7	71.1	5.2
417-09	25+935	17-535	5029055.5	365555.1	70.3	1.2
417-09	26+974	19-1601	5029516.4	366488.9	68.9	8.2

Table 2: Summary of Borehole Locations South Side of Highway 417 Station 24+750 to 26+860

Site	Approximate Highway 417 Stationing	Borehole	NAD83 CSRS CBNv6-2010.0 MTM Zone 9		Ground Surface Elevation (m)	Borehole Depth (m)
			Northing (m)	Easting (m)		
417-10	24+750	17-504	5028141.6	364843.8	76.2	5.9
417-10	24+825	17-506	5028206.3	364878.2	74.0	4.1
417-10	24+910	17-508	5028281.1	364917.8	72.5	2.3
417-10	24+995	17-510	5028354.4	364957.5	71.9	3.1
417-10	25+070	17-512	5028423.1	364995.9	71.4	3.8
417-10	25+135	17-514	5028480.3	365027.9	71.3	4.7
417-10	25+225	17-516	5028558.1	365070.2	72.1	4.7
417-10	25+300	17-518	5028623.9	365107.4	72.6	8.2
417-10	25+400	17-520	5028704.6	365162.6	73.3	8.2
417-10	25+470	17-522	5028753.7	365206.1	74.0	6.3
417-10	25+540	17-524	5028804.5	365252.7	74.8	6.7
417-10	25+620	17-526	5028852.7	365313.8	75.2	7.5
417-10	25+700	17-528	5028897.8	365380.6	74.9	3.1
417-10	25+701	17-528A	5028898.5	365381.8	74.9	3.3
417-10	25+699	17-528B	5028897.0	365379.6	74.9	2.9
417-10	25+770	17-530	5028925.6	365446.0	72.1	7.9
417-10	25+840	17-532	5028969.7	365503.8	71.6	2.2
417-10	25+930	17-534	5029022.8	365571.6	70.2	1.5
417-10	26+000	17-536	5029064.4	365629.8	70.3	1.5
417-10	26+015	17-537	5029105.1	365622.2	70.9	1.6
417-10	26+080	17-538	5029109.4	365696.9	70.9	10.5
417-10	26+160	17-539	5029149.7	365761.9	71.4	7.1
417-10	26+240	17-540	5029190.2	365830.7	72.2	7.5
417-10	26+315	17-541	5029228.0	365898.7	73.9	3.1
417-10	26+395	17-542	5029265.5	365969.9	75.6	6.7
417-10	26+475	17-543	5029300.2	366038.2	76.6	5.2
417-10	26+555	17-544	5029333.7	366110.4	76.9	5.8
417-10	26+600	17-545	5029366.8	366185.0	76.4	7.5
417-10	26+715	17-546	5029396.3	366255.8	75.3	7.3
417-10	26+790	17-547	5029423.0	366329.4	73.3	10.9
417-10	26+860	17-548	5029446.1	366393.7	71.3	8.6

Table 3: Summary of Borehole Locations North Side of Highway 417 Station 27+150 to 27+660

Site	Approximate Highway 417 Stationing	Borehole	NAD83 CSRS CBNv6-2010.0 MTM Zone 9		Ground Surface Elevation (m)	Borehole Depth (m)
			Northing (m)	Easting (m)		
417-22	27+150	17-549	5029564.8	366660.4	67.2	4.0/5.7 [1]
417-22	27+255	17-551	5029594.5	366761.2	70.0	6.2
417-22	27+310	17-552	5029609.0	366813.3	71.3	6.2
417-22	27+385	17-553	5029631.5	366886.6	72.4	6.2
417-22	27+435	17-554	5029647.1	366931.1	72.9	6.8
417-22	27+510	17-555	5029671.4	367001.9	73.6	5.7
417-22	27+600	17-556	5029701.1	367083.6	73.9	3.0
417-22	27+660	17-557	5029741.1	367138.6	72.8	2.0

Notes: [1] A void was encountered during drilling in Borehole 17-549 at a depth of 4.0 m.

4.0 DESCRIPTION OF SUBSURFACE CONDITIONS

4.1 General

The subsurface soil, 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 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 and on Figures B1A to B10, in Appendix B. The results of basic chemical analysis completed on select groundwater samples are provided in Appendix C. The borehole locations and the interpreted stratigraphic profiles projected along each noise wall are provided on Drawings 1 to 11.

The stratigraphic boundaries shown on the Record of Borehole sheets and Drawings 1 to 11 are inferred from observations of drilling progress and 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 general, the subsurface conditions at the borehole locations consist of pavement structure and embankment fill, extending to depths ranging from about 0.8 to 8.9 m (Elevations 62.7 to 73.2 m), over a discontinuous deposit of glacial till proven to extend to depths ranging from about 3.1 to 10.9 m (Elevations 60.6 to 71.1 m). The thickness of fill varies significantly along the noise wall alignments.

The groundwater level was measured across the sites at depths ranging from 1.5 to 4.8 m (Elevations 66.1 to 73.0 m).

A detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2 Section 1: Highway 417, Station 24+700 to 26+000 (Sites 417-09 and 417-10)

Boreholes 17-503, 17-505, 17-507, 17-509, 17-511, 17-513, 17-515, 17-517, 17-519, 17-521, 17-523, 17-525, 17-527, 17-529, 17-531, 17-533, 17-535 and 19-1601 were advanced along the right lane/shoulder of the WBL of Highway 417 for the noise barrier walls between Island Park Drive and west of Preston Street.

Boreholes 17-504, 17-506, 17-508, 17-510, 17-512, 17-514, 17-516, 17-518, 17-520, 17-522, 17-524, 17-526, 17-528 and 17-530, 17-532 and 17-534 were advanced along the right lane/shoulder of the EBL of Highway 417 for the noise barrier walls between Island Park Drive and east of Parkdale Avenue.

4.2.1 Pavement Structure and Fill

Asphaltic concrete, ranging in thickness from 0.1 to 0.5 m, was encountered at the ground surface at all the borehole locations along this section.

Portland Cement Concrete (PCC) was encountered below the asphaltic concrete at Boreholes 17-503, 17-516, 17-517, 17-519, 17-520, 17-521, 17-522, 17-525, 17-527, 17-530, 17-532, 17-534 and 19-1601 and ranges in thickness from 0.1 to 0.5 m.

The composition of the granular base/subbase varies from gravelly sand to sand with varying amounts of silt and gravel. The pavement structure extends to depths ranging from about 0.6 to 1.5 m.

The pavement structure is underlain by heterogenous fill at all borehole locations, except at Boreholes 17-512 to 17-516. The composition of the fill is variable consisting of sand and gravel or silty clay, silty sand, sand, gravelly sand to sandy gravel with varying amounts of cobbles, and organic matter. The fill was proven to extend or extends to depths ranging from about 0.8 to 8.9 m (Elevations ranging from 71.8 to 65.7 m) below the existing ground surface, where encountered.

Standard Penetration Tests (SPT) carried out within the embankment fill gave SPT N values ranging from weight of hammer to greater than 100, indicating a very loose to very dense state of packing. The measured water content of 50 samples of the fill ranged from about 3 to 24 percent. The results of grain size distribution testing carried out on 14 selected samples of the fill are provided on Figures B1A and B1B in Appendix B.

Portland cement concrete was encountered below the fill in Borehole 17-519 at a depth of about 7 m below the ground surface.

4.2.2 Glacial Till

A discontinuous deposit of glacial till was encountered below the fill in Boreholes 17-503 to 17-506, 17-510, 17-512 to 17-518, 17-520, 17-522, 17-524 to 17-526, 17-530 and 17-531. The glacial till generally consists of a heterogeneous mixture of gravel, cobbles, and boulders in a soil matrix of silty sand to clayey silt. The glacial till extends to depths ranging from about 3.1 to 8.7 m below the existing ground surface (Elevations ranging from about 70.3 to 64.2 m). The SPT N values ranged from 2 to more than 100 indicating a very loose to very dense state of packing. Higher blow counts (i.e., greater than 50) likely indicate the underlying bedrock surface or the presence of cobbles or boulders within the till, rather than the state of packing of the soil matrix.

The measured water content of 32 samples of the glacial till ranged from approximately 2 to 36 percent. The results of grain size distribution testing carried out on eleven samples of the glacial till are provided on Figures B2 and B3 in Appendix B. The results of Atterberg Limits testing carried out on four samples indicate that the fines portion of this deposit consists of non-plastic to low plastic silt. Atterberg Limits analysis results are provided on Figure B4 in Appendix B.

4.3 Section 2: Highway 417 Station 26+000 to 26+860 (Site Numbers 417-09 and 417-10)

Boreholes 17-536 to 17-548, inclusive, were advanced along the right lane/shoulder of Highway 417 EBL for the noise barrier walls between Parkdale Avenue and CPR/O-Train overpass.

4.3.1 Pavement Structure and Fill

A surficial layer of asphaltic concrete was encountered at the ground surface of all the boreholes along this section, ranging in thickness from 100 to 300 mm.

A layer of PCC was encountered below the asphaltic concrete at Boreholes 17-536, 17-543, 17-547, and 17-548, ranging in thickness from 100 to 200 mm.

The asphaltic concrete or PCC is underlain by granular base/subbase. The composition of the granular base/subbase varies from gravelly sand to sand. The pavement structure extends to depths ranging from 0.5 to 1.3 m. The measured water content of one sample of the granular base was approximately 7 percent.

The pavement structure is underlain by heterogenous fill at all the borehole locations, with the exception of borehole 17-536. The composition of the fill ranges from clayey silt to clay, sand, silty sand with varying amounts of gravel and containing cobbles, boulders, concrete, wood, brick, asphalt and organic matter. The fill extends to depths ranging from 3.1 to 8.6 m (Elevations 73.2 to 62.7 m) below the existing ground surface. The SPT N values ranged from 2 to more than 50, indicating very loose to very dense state of packing for the cohesionless fill and firm to very stiff consistency for the cohesive fill.

The measured water contents of 22 samples of the fill ranged from 3 to 35 percent. The results of grain size distribution testing carried out on four samples of the fill are provided on Figure B5 in Appendix B. The results of Atterberg Limits testing carried out on three samples of the cohesive fill gave plasticity index values ranging from 14 to 39 percent and liquid limit values ranging from 25 to 54 percent. The Atterberg Limits testing results are provided on Figure B6 in Appendix B and indicate a clayey silt (CL) of low plasticity to a clay (CH) of high plasticity (CH).

4.3.2 Glacial Till

A deposit of glacial till was encountered below the fill in Boreholes 17-536, 17-538, 17-539, 17-542 and 17-544 to 17-547 at elevations ranging from 65.7 to 73.2 m. The glacial till generally consists of a heterogeneous mixture of clay, gravel, cobbles and boulders within a matrix of silty sand. The till was not fully penetrated but was proven to the depth of auger refusal ranging from 1.5 to 10.9 m, corresponding to elevations ranging from 60.6 and 71.1 m.

The SPT N values ranged from 7 to more than 50 indicating a loose to very dense state of packing. Higher blow counts (i.e., greater than 50) likely indicate the underlying bedrock surface or the presence of cobbles or boulders within the till, rather than the state of packing of the soil matrix.

The measured water contents of 13 samples of the glacial till ranged from about 6 to 18 percent. The results of grain size distribution testing carried out on three samples of the glacial till are provided on Figure B7 in Appendix B.

4.4 Section 3: Highway 417 Station 27+125 to 27+660 (Site Number 417-22)

Boreholes 17-549 and 17-551 to 17-557, inclusive, were advanced for the noise barrier walls along the right lane/shoulder of the WBL of Highway 417 and ramps between the midpoint of the Rochester Street NS-W on-ramp to Bronson Avenue.

4.4.1 Topsoil

Topsoil, about 200 mm in thickness, was encountered at the ground surface at Borehole 17-557.

4.4.2 Pavement Structure, and Fill

Asphaltic concrete, with a thickness ranging from 0.2 to 0.3 m, was encountered at the ground surface of all the boreholes along this section, except for Borehole 17-557.

PCC was encountered below the asphaltic concrete at all boreholes, except Boreholes 17-552 and 17-557, and ranged in thickness from 0.1 to 0.2 m.

The pavement structure fill extends to depths ranging from about 0.5 to 0.8 m. The composition of the granular base varies from gravelly sand to sand with varying amounts of silt and gravel.

The pavement structure fill and topsoil are underlain by heterogenous fill at all the borehole locations. The fill consists of sand and gravel to silty sand and sand to silty clay and clayey silt and contains varying amounts of organic matter, wood, concrete, ash, metal, ceramic, brick fragments, cobbles and boulders. The fill extends to depths ranging from about 2.0 to 6.2 m (Elevations 63.2 to 70.9 m), below the existing ground surface.

The measured water contents of fifteen samples of the fill ranged from approximately 4 to 18 percent. The SPT N values ranged from 2 to more than 50 indicating a very loose to very dense state of packing for the cohesionless fill and a very stiff consistency for the cohesive fill. The results of grain size distribution testing carried out on three samples of the fill material are provided on Figure B8 in Appendix B.

The results of Atterberg Limits testing carried out on one sample of the cohesive fill gave a plasticity index value of 11 percent and a liquid limit value of 24 percent. The Atterberg Limits analysis results are provided on Figure B9 in Appendix B and indicate a clayey silt (CL) of low plasticity.

Portland cement concrete was encountered below the fill in Borehole 17-552 at a depth of about 6 m below the ground surface.

4.4.3 Void

A void was encountered in Borehole 17-549 during drilling at a depth of 4.0 m. The void extends to a depth of about 5.7 m below the existing ground surface or about 1.7 metres below the encountered bottom of the fill.

4.4.4 Glacial Till

A non-cohesive glacial till deposit was encountered below the fill material in Boreholes 17-554 and 17-555 at elevations of 67.6 and 68.6 m, respectively (i.e., depths of 5.3 and 5.0 metres below ground surface, respectively). The glacial till consists of gravelly sand with various amount of silt, and cobbles. The till was not fully penetrated but was proven to the depth of auger refusal at 5.7 and 6.8 m below the existing ground surface (Elevations 66.1 and 67.9 m). The SPT N values ranged from 15 to more than 50 indicating a compact to very dense state of packing. Higher blow counts (i.e., greater than 50) likely indicate the underlying bedrock surface or the presence of cobbles or boulders within the till, rather than the state of packing of the soil matrix.

The measured water contents of two samples of the glacial till were 5 and 7 percent. The results of grain size distribution testing carried out on a sample of the glacial till are provided on Figure B10 in Appendix B.

4.5 Auger Refusal

Bedrock was not proven by core drilling as part of the current investigation. Auger or sampler refusal was encountered in the boreholes, with the exception of Boreholes 17-504, 17-518, 17-520, 17-524, 17-525, 17-526, 17-531, 17-542, 17-545, 17-546 and 17-549 , at depths ranging from about 1.0 to 10.9 m below the existing ground surface, corresponding to elevations ranging from about 60.4 to 71.8 m.

Based on boreholes from previous investigations along Highway 417, auger/sampler refusal could represent the presence of cobbles and boulders in the fill or glacial till, existing concrete footings, or the bedrock surface.

Tables 4 to 6 summarize the auger refusal depths and elevations as encountered at the borehole locations and outlined in Sections 4.2 to 4.4.

Table 4: Summary of Depths to Auger or Sampler (indicated with *) Refusal – Section 1

Borehole	Existing Ground Surface Elevation (m)	Auger Refusal Elevation (m)	Depth to Auger Refusal (m)
17-503	77.1	69.6	7.5
17-505	75.6	68.1	7.5
17-506	74.0	69.9	4.1
17-507A	73.6	71.1	2.5
17-508	72.5	70.2	2.3
17-509	72.2	70.9	1.3
17-510	71.9	68.8	3.1
17-511	71.7	70.7	1.0
17-512	71.4	67.6	3.8
17-513*	71.3	67.2	4.1
17-514	71.3	66.6	4.7
17-515	71.5	66.6	4.9
17-516	72.1	67.4	4.7
17-517	72.5	66.1	6.4
17-519	73.8	66.8	7.0
17-521	74.9	66.0	8.9
17-522	74.0	67.7	6.3
17-523	75.9	71.6	4.3
17-527	75.8	68.5	7.3
17-528	74.9	71.8	3.1
17-528A	74.9	71.6	3.3
17-528B	74.9	72.0	2.9
17-529	74.8	70.3	4.5
17-530	72.1	64.2	7.9
17-532	71.6	69.4	2.2
17-533	71.1	65.9	5.2
17-534	70.2	68.7	1.5
17-535	70.3	69.1	1.2
17-537	70.9	69.3	1.6

Table 5: Summary of Depths to Auger Refusal – Section 2

Borehole	Existing Ground Surface Elevation (m)	Auger Refusal Elevation (m)	Depth to Auger Refusal (m)
17-536	70.3	68.8	1.5
17-538	70.9	60.4	10.5
17-539	71.4	64.3	7.1
17-540	72.2	64.7	7.5
17-541	73.9	70.8	3.1
17-543	76.6	71.4	5.2
17-544	76.9	71.1	5.8
17-547	73.3	62.4	10.9
17-548	71.3	62.7	8.6

Table 6: Summary of Depths to Auger Refusal – Section 3

Borehole	Existing Ground Surface Elevation (m)	Auger Refusal Elevation (m)	Depth to Auger Refusal (m)
17-551	70.0	63.8	6.2
17-552	71.3	65.1	6.2
17-553	72.4	66.2	6.2
17-554	72.9	66.1	6.8
17-555	73.6	67.9	5.7
17-556	73.9	70.9	3.0
17-557	72.8	70.8	2.0

4.6 Groundwater Conditions

Monitoring wells were installed in Boreholes 17-504, 17-507, 17-514, 17-523, 17-526, 17-533, 17-538, 17-543, 17-548 and 17-557 to monitor the groundwater level across the sites.

Table 7 summarizes the depths to, and the elevations of, the water levels measured in the monitoring wells installed during the current investigation.

Table 7: Summary of Groundwater Conditions

Borehole	Screened Interval	Water Level Depth (m)	Water Level Elevation (m)	Date of Reading
17-504	Fill / Glacial Till	Dry	< 71.0	October 16, 2017
17-507A	Fill	1.5	72.1	October 19, 2017
17-514	Glacial Till	1.9	69.4	October 16, 2017
17-523	Fill / Glacial Till	3.5	72.4	October 19, 2017
17-526	Fill / Glacial Till	2.2	73.0	October 16, 2017
17-533	Fill / Glacial Till	3.8	67.3	October 19, 2017
17-538	Glacial Till	4.8	66.1	October 18, 2017
17-543	Fill	Dry	< 71.4	October 18, 2017
17-548	Fill	Dry	< 62.7	October 18, 2017
17-557	Fill	Dry	< 70.8	October 16, 2017

It should be expected that the water levels across the sites will fluctuate seasonally in response to changes in precipitation and snow melt and is expected to be higher during the spring and periods of precipitation.

4.7 Steel Corrosion and Sulphate Attack, Chemical Analysis

A total of six groundwater samples were submitted to Maxxam for chemical analysis related to potential corrosion of exposed buried steel and potential sulphate attack on buried concrete elements (corrosion and sulphate attack). The test results are provided in Appendix C and are summarized in Table 8.

Table 8: Steel Corrosion and Sulphate Attack, Chemical Analysis

Borehole	Screened Interval (m)	Resistivity (ohm-cm)	Electrical Conductivity (µS/cm)	pH	Sulphate (mg/L)	Chloride (mg/L)
17-507A	0.3 – 2.5	750	1,300	8.9	45	140
17-514	2.7 – 4.7	160	6,300	7.9	130	1,800
17-523	2.5 – 4.3	58	17,000	7.6	220	5,500
17-526	5.4 – 7.5	160	6,300	7.9	120	1,700
17-533	1.8 – 5.2	70	14,000	7.9	190	4,400
17-538	7.0 – 10.5	70	14,000	7.9	310	4,300

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 of 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.

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PART B

Foundation Design
Noise Barrier Wall Replacement
Highway 417 from Island Park Drive to Bronson Avenue
Ottawa, Ontario

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides geotechnical parameters and recommendations for the geotechnical aspects of design of the proposed noise barrier (NB) walls associated with the improvements to the Highway 417 between Island Park Drive and Bronson Avenue in Ottawa, Ontario. The design parameters and recommendations have been developed based on interpretation of the factual data obtained from the boreholes advanced during the current investigation in the vicinity of the proposed noise barrier walls. The discussion and recommendations presented are intended to provide the designers with sufficient information to assess the feasible noise wall foundation alternatives, develop construction cost estimates, and identify items or issues to be addressed in the Contract Documents.

The foundation investigation report, discussion, and recommendations are intended for the use of the Ministry of Transportation, Ontario (MTO) and shall not be used or relied upon for any other purpose or by any other parties, including the construction contractor. The contractor must make their own interpretation based on the factual data in Part A (Foundation Investigation) of the report. Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project. Those requiring information on the aspects of construction must make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

6.2 General

The proposed alignments for the noise barrier walls are presented on Drawings 1 to 11.

It is understood that the noise barrier walls will be approximately 4 to 5 m high. Typically, the noise barrier walls are supported using conventional augured caissons, with a diameter of between 0.6 to 0.9 metre. However, it is understood the noise barrier walls may also be directly attached to the existing concrete retaining walls.

As an alternative to augered caissons, consideration could be given to supporting the noise barrier walls in this area on spread or strip footings founded on bedrock. Consideration should be given to whether the construction staging and space permits for an open-cut excavation and construction of a spread or strip footing, as it would not be economically feasible to install soldier piles or drive/embed sheetpiles to form temporary protection systems, given the shallow bedrock depth. Recommendations for support of the noise barrier wall on strip footings and using augered caissons are presented in the subsequent sections.

Based on the Site Overview Drawings provided by WSP, Table 9 outlines the proposed foundation type for the various noise barrier walls proposed for the current project.

Table 9: Proposed Foundation Type for each Noise Barrier Wall

Noise Barrier Wall	Approximate Highway 417 Stationing	Borehole(s)	Proposed Foundation Type Augured Caissons / Structure Mounted
NB2N	24+700 to 24+890	17-503, 17-505, 17-507A	Mounted to Wall 1N
NB3N	24+890 to 25+115	17-509, 17-511, 17-513	Augured Caissons or Spread Footings on Bedrock
NB4N	25+200 to 25+360	17-515, 17-517, 17-519	Mounted to Wall 2N
NB5N	25+425 to 25+500	17-521	Augured Caissons
NB6N	25+475 to 25+625	17-523, 17-525, 17-527	Augured Caissons
NB7N	25+675 to 25+925	17-529, 17-531, 17-533,17-535	Augured Caissons or Spread Footings on Bedrock
NB8N	26+950 to 27+015	19-1601	Augured Caissons
NB10N	27+125 to 27+225	17-549	Augured Caissons
NB12N	27+275 to 27+350	17-551, 17-552	Augured Caissons
NB14N	27+400 to 27+675	17-553, 17-554, 17-555,17-556, 17-557	Augured Caissons or Spread Footings on Bedrock
NB1S	24+725 to 25+140	17-504, 17-506, 17-508, 17-510,17-512, 17-514	Augured Caissons or Spread Footings on Bedrock
NB2S	25+175 to 25+325	17-516, 17-518	Augured Caissons
NB3S	25+380 to 25+575	17-520, 17-522, 17-524	Augured Caissons
NB4S	25+510 to 25+610	17-524, 17-526	Augured Caissons
NB5S	25+460 to 25+775	17-528, 17-528A&B, 17-530	Augured Caissons or Spread Footings on Bedrock
NB6S	25+725 to 25+925	17-530, 17-532, 17-534	Augured Caissons or Spread Footings on Bedrock
NB7S	25+975 to 26+175	17-536, 17-538, 17-539	Augured Caissons
NB8S	26+250 to 25+490	17-540, 17-541, 17-542, 17-543	Augured Caissons
NB9S	26+540 to 26+800	17-544, 17-545, 17-546, 17-547, 17-548	Augured Caissons

6.3 Noise Barrier Wall Foundation Design

6.3.1 Consequence and Site Understanding Classification

In accordance with Section 6.5 of the CHBDC and its Commentary and given the level of foundation investigation completed to date as presented in Sections 3.0 and 4.0, in comparison to the degree of site understanding in Section 6.5 of CHBDC, the level of confidence for design is considered to be a “typical degree of site and prediction model understanding” for these sites. Accordingly, the appropriate corresponding ULS and SLS consequence factor, Ψ, and geotechnical resistance factors from Tables 6.1 and 6.2 of the CHBDC have been used for design, as indicated in the following sections.

6.3.2 Augured Caisson Foundations

Geotechnical design parameters for design of the caisson foundations for the proposed noise barrier walls are provided in Table A following the text of this report, based on the subsurface conditions encountered in the boreholes in the vicinity of the proposed noise barrier walls. The stratigraphy presented in Table A has been

simplified for the purposes of the noise barrier wall foundation design. The parameters presented in Table A are based on field and laboratory test data as well as accepted correlations (NAVFAC 1986, Bowles, 1984 and Kulhawy and Mayne, 1990) and the analysis was tempered by engineering judgment based on experience in similar soils.

Where both undrained shear strength (S_u) and effective friction angle, (ϕэ) have been given in Table A for a cohesive deposit, the caisson design should be checked for both the undrained and the drained conditions, and the greater of the two calculated caisson depths shall govern.

The frost penetration depth for the City of Ottawa is 1.8 m as per OPSD 3090.101. The resistance within the upper 1.8 m below ground surface should be neglected to account for frost action. In addition, for foundation design, full resistance will be mobilized only where the ground surface in front of and behind the caissons is level (i.e., the width of soil in front of and behind the caissons is equal to or greater than eight caisson diameters). If the width of soil in front of and/or behind the caissons is insufficient for development of the full resistance (i.e., if there is sloping ground adjacent to the noise barrier wall), the magnitude of resistance may be determined by interpolating between zero resistance at ground surface and full resistance at the depth where the slope face is at a distance of eight caisson diameters away from the caissons.

The factored ultimate geotechnical lateral resistance in bedrock is provided as f_{horiz} in Table A. In order to rely on this resistance in design, the caissons must extend a minimum of 1 m into bedrock.

The deflections under lateral loading may be calculated using subgrade reaction theory where the coefficient of horizontal subgrade reaction, k_h, is based on the equations given below.

For cohesionless soils:

$$k_s = n_h \times \frac{z}{d}$$

where k_s is in kN/m^3

n_h is the constant of horizontal subgrade reaction, as given in Table A (kPa/m)
z is the depth (m)
d is the pile diameter/width (m)

For cohesive soils:

$$k_s = \frac{67 \times S_u}{d}$$

where S_u is the undrained shear strength of the soil (kPa); and

d is the pile diameter/width (m)

The coefficient of horizontal subgrade reaction when applied over a specific area provides a spring constant that is commonly used to model load-deformation response of a pile subjected to lateral loading. The spring constant represents the stiffness of the ground and is controlled by the lateral resistance of the ground. The coefficient of horizontal subgrade reaction is not a fundamental soil property and varies with geometry of the foundation (for proper application, refer to NAVFAC DM7.02, pages 234-236, CFEM 1992, 3rd Edition, pages 312-315). The suggested values for coefficient of horizontal subgrade reaction are summarized in Table A.

The shear force and bending moment distribution in the caissons can also be established using parameters given in Table A.

It is understood that the caisson foundations for the OHS will be in close proximity to the caisson foundations for the proposed noise walls for this project with an edge to edge separation of approximately 0.3 m, in essence acting as a caisson group. For caissons arranged in closely spaced groups, the caisson-soil- caisson interaction causes the individual caisson in a group to be less effective than a single caisson in lateral resistance.

It is understood that the design location of the noise wall caissons can be adjusted so that caissons of the two structures do not align. Therefore, in order to reduce the possibility of group effects the noise wall foundations should be located so that the OHS foundations are located in the middle of a noise wall panel, maximizing the lateral separation between the two foundations.

6.3.3 Spread or Strip Footings on Limestone Bedrock

Nosie walls may be supported on shallow foundations supported on bedrock, where the depth to bedrock is less than about 3 metres below ground surface.

6.3.3.1 Founding Elevations

As indicated in Section 4.5, based on the auger refusal depths (which may indicate the surface of the bedrock), Table 10 outlines sections where the depth to bedrock may be less than 3 m.

Table 10: Location of Possible Shallow Bedrock Foundations

Noise Barrier Wall	Approximate Highway 417 Stationing	Boreholes	Auger Refusal Elevations (m)	Auger Refusal Depths (m)
NB3N	24+890 to 25+115	17-509, 17-511	70.9 to 68.8	1.0 to 1.3
NB7N	25+675 to 25+925	17-535, 17-537	69.3 to 69.1	1.6 to 1.2
NB14N	27+400 to 27+675	17-556, 17-557	70.9 to 70.8	3.0 to 2.0
NB5S	25+460 to 25+775	17-528, 17-528A&B	72.0 to 71.6	3.3 to 2.9
NB6S	25+725 to 25+925	17-532, 17-534	69.4 to 68.7	2.2 to 1.5

Based on the boreholes drilled for other structures on this project, the bedrock is expected to consist of limestone.

It is noted that the bedrock surface depths/elevations presented in the borehole records are based on an interpretation of auger refusal and may not reflect the actual site conditions, and furthermore the bedrock surface may vary between the boreholes. Where the overburden is relatively thinner, consideration could be given to supporting the noise barrier wall on spread or strip footings. As discussed in Section 6.1, use of shallow foundations to support the noise barrier wall will likely only be economical where the construction staging permits an open-cut excavation (i.e., if temporary protections systems will be required to form the required excavations, it is likely more economical to support the noise barrier wall on caissons that are augered and cored/churn drilled to socket into the bedrock).

As shallow foundations will likely need to be anchored to obtain sufficient lateral/uplift resistance, it is recommended that the spread or strip footings for support of the noise barrier walls be founded at bedrock surface. Section 4.5 Auger Refusal presents the depth of auger refusal, which may indicate the bedrock surface, at the boreholes which are shown in plan on Drawings 1 to 11.

6.3.3.2 Geotechnical Resistances

Based on the results of this investigation and the concurrent investigations for the bridge replacements (where rock was cored), spread footings placed on the surface of the properly prepared bedrock may be designed based on a factored ultimate geotechnical resistance of 2,000 kPa. The factored serviceability geotechnical resistance

for 25 mm of settlement will be greater than the factored ultimate geotechnical resistance; as such, the factored ultimate geotechnical resistance will govern for this foundation type, assuming a spread or strip footings up to approximately 1 m width.

The factored geotechnical resistances provided above are given for loads that will be applied perpendicular to the surface of the footings. Where the load is not applied perpendicular to the footing, inclination of the load should be taken into account in accordance with Section 6.10.4 of the CHBDC.

The footing subgrade should be inspected by a Foundation Engineer, in accordance with Ontario Provincial Special Specification (OPSS) 902 (Excavating and Backfilling Structures) and MTO Special Provision (SP) No. 109S12, Amendment to OPSS 902, August 2018, to check that all soils have been removed and that “competent” bedrock has been reached. If this foundation type is adopted, it will be necessary to clean, scale and remove all loose fractured rock within the area of the footing to ensure proper concrete bond to the bedrock.

6.3.3.3 Resistance to Lateral Loads

Resistance to lateral forces / sliding resistance between the new concrete footings and the subgrade should be calculated in accordance with Section 6.10.5 of the CHBDC. For cast-in-place concrete footings constructed directly on bedrock, the sliding resistance may be calculated based on the coefficient of friction, tan δ, which can be taken as follows:

- Cast-in-place footing to limestone bedrock tan $\delta = 0.7$

If necessary, the sliding resistance between the concrete footing and the bedrock can be supplemented to resist lateral/wind loading by dowelling into the bedrock. The horizontal resistance of the dowels will be dependent on the strength of the bedrock, grout and steel. The dowels should have a minimum bond length within the bedrock of 1 m, and the structural strength of the dowels and compressive strength of the grout should not be exceeded. For uplift of the dowels, a value of 250 kPa may be assumed for the factored ultimate geotechnical grout-to-rock bond stress for design. The actual bond stress along the rock-grout interface may vary from the design value given and it should therefore be verified in the field by pull-out testing. If dowelling into bedrock is adopted for the noise barrier wall foundations, an NSSP should be included in the Contract Documents to specify the installation, materials and testing of the dowels; an example is provided in Appendix D. The dowels should be comprised of corrosion-resistant steel based on the bedrock and groundwater conditions.

6.3.3.4 Frost Protection

Spread footings placed on fresh limestone bedrock frost protection cover is not required. Footings placed on fractured limestone bedrock will require 1.8 metres of earth cover for frost protection. Alternatively, where the earth cover is less than 1.8 metres in depth, insulation could be considered. Extruded Polystyrene (EPS) insulation is subject to creep under sustained loading and lower bearing resistances (maximum 100 kPa) will need to be considered if the insulation is placed under the footing. Insulating the outside of the footing is achievable but requires special details that are difficult to construct. If lowered bearing resistances are not acceptable for design, excavation of the bedrock to provide a lower underside of footing elevation (and therefore increased earth cover depth) may also be considered.

6.3.4 Structure Mounted Walls

6.3.4.1 Existing Conditions

Based on the drawings provided by WSP, noise barrier walls NB2N and NB4N are to be founded on the existing concrete retaining walls (Wall) 1N and 2N respectively.

The Highway 417 Island Park Cres. Preliminary General Arrangement Drawings 1 and 2 for NB2N dated January 2019, indicate that the top of footing for existing Wall 1N is at approximately Elevation 71.0 m. Based on the boreholes advanced in the vicinity of Wall 1N, the existing footing is founded in the native glacial till.

The Ottawa Queensway Retaining Wall at Holland Avenue Overpass General Arrangement (GA) Drawing, dated November 2018, indicates that Wall 2N is founded on piles, extending from the Holland Avenue Overpass for an approximate length of 84.0 m, and on spread footings for the remaining length of wall (about 33 m).

The underside of pile cap elevation noted on the GA drawing ranges between Elevations 66.0 and 68.0 m. It has been assumed that the piles would have been driven to refusal on the underlying limestone bedrock. The underside of the spread footings are indicated to be between Elevations 68.0 and 69.0 m. The existing borehole data in the area of the Holland Avenue Bridge indicates that the bedrock surface is at an approximate elevation of 62.0 m. Based on the current boreholes advanced in the vicinity of Wall 2N, the existing spread footings are founded on the native glacial till.

6.3.4.2 Geotechnical Resistance for Structure Mounted Noise Barrier Walls

Based on existing GA Drawings and the existing borehole data, Wall 1N is founded on native glacial till. The design for NB2N should therefore be based on a factored geotechnical resistance of 450 kPa at Ultimate Limit States (ULS) and a Serviceability Limit States (SLS) of 200 kPa for the Wall 1N footings.

For the portion of Wall 2N that is founded on spread footings, the design for NB3N should also be based on a factored geotechnical resistance of 450 kPa at ULS and a SLS resistance of 200 kPa for the Wall 2N footings. For the portion of Wall 2N founded on piles, the minimum geotechnical resistance should be taken as the structural capacity of the pile.

6.4 Cement Type and Steel Corrosion Potential

Six samples of groundwater, from monitoring wells installed in Boreholes 17-507, 17-514, 17-523, 17-526, 17-533, and 17-538, were submitted to Maxxam for basic chemical analysis related to potential sulphate attack on buried concrete elements and corrosion of buried ferrous elements.

The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater at the site. The sulphate results in Table 8 were compared with Table 3 of Canadian Standards Association Standards A23.1-14 (CSA A23.1) and generally indicate a low degree of sulphate attack potential on concrete structures at the locations of all tested samples except for samples collected from Station 25+500 to 26+200 which are indicated to have a moderate potential for sulphate attack. Therefore, concrete made with Type MS Portland cement is considered acceptable for all substructures between Station 25+500 and 26+200, and concrete made with Type GU Portland cement is considered acceptable within the rest of the study area.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment. Generally, the results provided in Table 8 indicate an elevated potential for corrosion of exposed ferrous metal within the study area, which should be taken into consideration in the design of substructures.

6.5 Construction Considerations

The noise barrier walls should be constructed in accordance with OPSS.MUNI 760 *Construction Specification for Noise Barrier Systems* dated April 2019, and Special Provision (SP) 760F01 dated March 2018. A copy of SP 760F01 is provided in Appendix D.

6.5.1 Void Remediation

As indicated in Section 4.4, a void was encountered at Borehole 17-549 at a depth of 4.0 m below the existing grade; likely due to the presence of an abandoned utility line. The void extends to a depth of about 5.7 m below the existing ground surface or about 1.7 metres below the encountered bottom of the fill.

Should the void be encountered during caisson installation, it should be backfilled with flowable grout with a compressive strength of 2 to 4 MPa. The grout should be allowed to properly cure prior to installing the noise wall caissons.

6.5.2 Control of Soil and Groundwater – Caissons

Caisson construction is anticipated to require auguring/excavation through the existing fill, and the glacial till deposits. The existing fill and overburden deposits contain granular layers (potentially saturated) which may be susceptible to disturbance during caisson construction (i.e., water-bearing non-cohesive layers). Wet non-cohesive soil layers and pockets should be expected to run or flow into the drilled hole during or after auguring for foundations. The use of a temporary liner to advance the holes for caissons at the noise barrier walls is recommended, in order to reduce disturbance and ground loss during drilling and concrete placement.

It is recommended that a Non-Standard Special Provision (NSSP) be included in the Contract Documents to warn the Contractor of these conditions. Suggested wording for an NSSP for control of overburden soils is provided in Appendix D.

6.5.3 Obstructions in Overburden

Cobbles and boulders were encountered or inferred within the fill and glacial till deposits. Appropriate equipment and methods will need to penetrate through such obstructions, if encountered. It is recommended that an NSSP be included in the Contract Documents to warn the Contractor of this condition. Suggested wording for an NSSP alerting the Contractor to the presence of these obstructions in the overburden materials is provided in Appendix D.

7.0 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 of 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.

LICENSED PROFESSIONAL ENGINEER
K. T. C. POWER
100130652
2019/12/09
PROVINCE OF ONTARIO

Kenton C. Power, P.Eng., M.A.Sc.
Geotechnical Engineer

REGISTERED PROFESSIONAL ENGINEER
F. J. HEFFERNAN
DEC 9, 2019
PROVINCE OF ONTARIO

William Cavers, P.Eng.
Associate, Senior Geotechnical Engineer

Fintan J. Heffernan, P.Eng.
Designated MTO Foundations Contact

KP/WC/FJH/hdw
https://golderassociates.sharepoint.com/sites/18579g/foundations/6 - reports/1500 noise wall/3-final nbw/1655214-1500-001-rev0-final noise walls2019-12-06.docx

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Table A: Geotechnical Design Parameters for Noise Barrier Walls – Site No. 417-09, 417-10 and 417-22

Noise Barrier Wall	Approximate Stationing[1]	Relevant Borehole(s)	Deposit Description	Approximate Deposit Elevation[2] (m)	Soil Design Parameters[3,4]							Design Groundwater Elevation (m)	Auger Refusal Elevation (m)
					S_u (kPa)	ϕэ (°)	K_p[5,6]	n_h (kPa/m)	f_{horz}	γ (kN/m^3)	γэ (kN/m^3)		
NB2N[7]	24+700 to 24+890	17-503, 17-505, 17-507A	FILL - Gravelly sand to sand TILL – Silty sand	76.6 to 73.3	-	28 32	2.77 3.25	4,400 8,000	-	19 21	9.2 11.2	72.0	71.1 to 68.1
NB3N	24+890 to 25+115	17-509, 17-511, 17-513	FILL - Gravelly sand to sand TILL – Silty sand Limestone Bedrock	71.9 to 70.5 70.9 to 67.2	-	28 32 -	2.77 3.25 -	4,400 8,000 -	- - 2,000	19 21 -	9.2 11.2 -	69.0	70.9 to 67.2
NB4N[7]	25+200 to 25+360	17-515, 17-517, 17-519	FILL - Gravelly sand to sand TILL – Silty sand	73.3 to 67.8 67.8 to 66.1	-	28 32	2.77 3.25	4,400 8,000	-	19 21	9.2 11.2	70.0	66.8 to 66.1
NB5N	25+425 to 25+500	17-521	FILL - Gravelly sand to sand	75.6 to 66.0	-	28	2.77	4,400	-	19	9.2	72.4	66.0
NB6N	25+475 to 25+625	17-523(MW), 17-525, 17-527	FILL - Gravelly sand to sand TILL – Silty sand	75.9 to 68.5 68.5 to 67.5	-	28 32	2.77 3.25	4,400 8,000	-	19 21	9.2 11.2	72.4	72.1 to 67.5
NB7N	25+675 to 25+925	17-529, 17-531, 17-533(MW), 17-535, 17-537	FILL - Gravelly sand to sand TILL – Silty sand Limestone Bedrock	74.5 to 67.4 67.4 to 65.0	-	28 32 -	2.77 3.25 -	4,400 8,000 -	- - 2,000	19 21 -	9.2 11.2 -	67.3	70.3 to 65.0
NB8N	26+950 to 27+015	19-1601	FILL - Gravelly sand to sand	68.5 to 60.7		28	2.77	4,400	-	19	9.2	61.0	N/A
NB10N	27+125 to 27+225	17-549	FILL - Gravelly sand to sand **Void encountered during drilling at a depth of 4.0 m (elev. 63.2)	68.8 to 63.2	-	28	2.77	4,400	-	19	9.2	63.0	N/A
NB12N	27+275 to 27+350	17-551, 17-552	FILL - Gravelly sand to sand	71.0 to 63.8	-	28	2.77	4,400	-	19	9.2	63.0	65.2 to 63.8
NB14N	27+400 to 27+675	17-553, 17-554, 17-555, 17-556, 17-557	FILL - Gravelly sand to sand TILL – Gravelly silty sand Limestone Bedrock	73.6 to 66.2 68.6 to 66.1	-	28 32 -	2.77 3.25 -	4,400 8,000 -	- - 2,000	19 21 -	9.2 11.2 -	69.0	70.9 to 66.1
NB1S	24+725 to 25+140	17-504(MW), 17-506, 17-508, 17-510, 17-512, 17-514(MW)	FILL - Gravelly sand to sand TILL – Silty sand	75.9 to 69.9 69.9 to 66.6	-	28 32	2.77 3.25	4,400 8,000	-	19 21	9.2 11.2	69.4	70.4 to 66.6
NB2S	25+175 to 25+325	17-516, 17-518	FILL - Gravelly sand to sand TILL – Gravelly silty sand	72.4 to 65.7 65.7 to 64.4	-	28 32	2.77 3.25	4,400 8,000	-	19 21	9.2 11.2	69.0	67.8 to 64.4
NB3S	25+380 to 25+575	17-520, 17-522, 17-524	FILL - Gravelly sand to sand TILL – Gravelly silty sand	74.6 to 67.9 67.9 to 65.1	-	28 32	2.77 3.25	4,400 8,000	-	19 21	9.2 11.2	69.0	68.1 to 65.1
NB4S	25+510 to 25+610	17-524, 17-526(MW)	FILL - Gravelly sand to sand TILL – Gravelly silty sand	74.9 to 68.3 68.3 to 67.7	-	28 32	2.77 3.25	4,400 8,000	-	19 21	9.2 11.2	73.0	68.1 to 67.7
NB5S	25+460 to 25+775	17-528, 17-528A/B	FILL - Gravelly sand to sand Limestone Bedrock	74.6 to 71.6	-	28 -	2.77 -	4,400 -	- 2,000	19 -	9.2 -	73.0	72.0 to 71.6
NB6S	25+725 to 25+925	17-530, 17-532, 17-534	FILL - Gravelly sand to sand TILL – Gravelly silty sand Limestone Bedrock	71.5 to 67.7 67.7 to 64.2	-	28 32 -	2.77 3.25 -	4,400 8,000 -	- - 2,000	19 21 -	9.2 11.2 -	69.0	69.4 to 64.2
NB7S	25+975 to 26+175	17-536, 17-538(MW), 17-539	FILL - Gravelly sand to sand TILL – Gravelly silty sand	71.2 to 68.3 68.3 to 60.6	-	28 32	2.77 3.25	4,400 8,000	-	19 21	9.2 11.2	66.0	68.8 to 60.5
NB8S	26+250 to 25+490	17-540, 17-541, 17-542, 17-543(MW)	FILL - Gravelly sand to sand Fill – Clayey Silt to silty clay Fill - Gravelly sand to sand	76.2 to 75.4 75.4 to 71.8 71.8 to 64.7	- 100 -	28	2.77	4,400 2,000 4,400	-	19 18 19	9.2 8.2 9.2	69.0	71.4 to 64.7
NB9S	26+540 to 26+800	17-544, 17-545, 17-546, 17-547, 17-548(MW)	FILL - Gravelly sand to sand TILL – Gravelly silty sand	76.7 to 70.7 70.7 to 62.4	-	28 32	2.77 3.25	4,400 8,000	-	19 21	9.2 11.2	69.0	71.1 to 62.7

NOTES:

*Deposit thickness for design to be considered ½ of the fill thickness presented.

1. Approximate stationing and noise barrier wall number provided, as per WSP's Site Overview Drawings, dated April 8, 2019.
2. Approximate deposit elevations are provided relative to the final ground surface elevations along the sections of noise barrier walls. Should the location(s) of the wall(s) change, the deposit elevations must be reviewed and confirmed by the Foundations Consultants.
3. Design parameters:
   - s_u = undrained shear strength (kPa)
   - ϕ' = effective (drained) friction angle (degrees)
   - K_p = passive earth pressure coefficient
   - n_h = constant of horizontal subgrade reaction (kPa/m)
   - γ = bulk unit weight (kN/m^3)
   - γ' = effective unit weight (below the groundwater level) (kN/m^3)
4. The resistance in the upper 1.8 m below ground surface should be neglected to account for frost action.
5. The passive earth pressure coefficients provided assume a vertical foundation element, zero interface friction between the soil and the foundation element, and a horizontal backslope.
6. The total passive resistance below frost depth may be calculated based on the values of K_p provided, reduced by an appropriate factor considering the allowable wall movement (i.e., large strain required for mobilization of the full passive resistance), in accordance with Figure C6.16 of the CHBDC (2014).
7. Structure mounted walls

MINISTRY OF TRANSPORTATION, ONTARIO

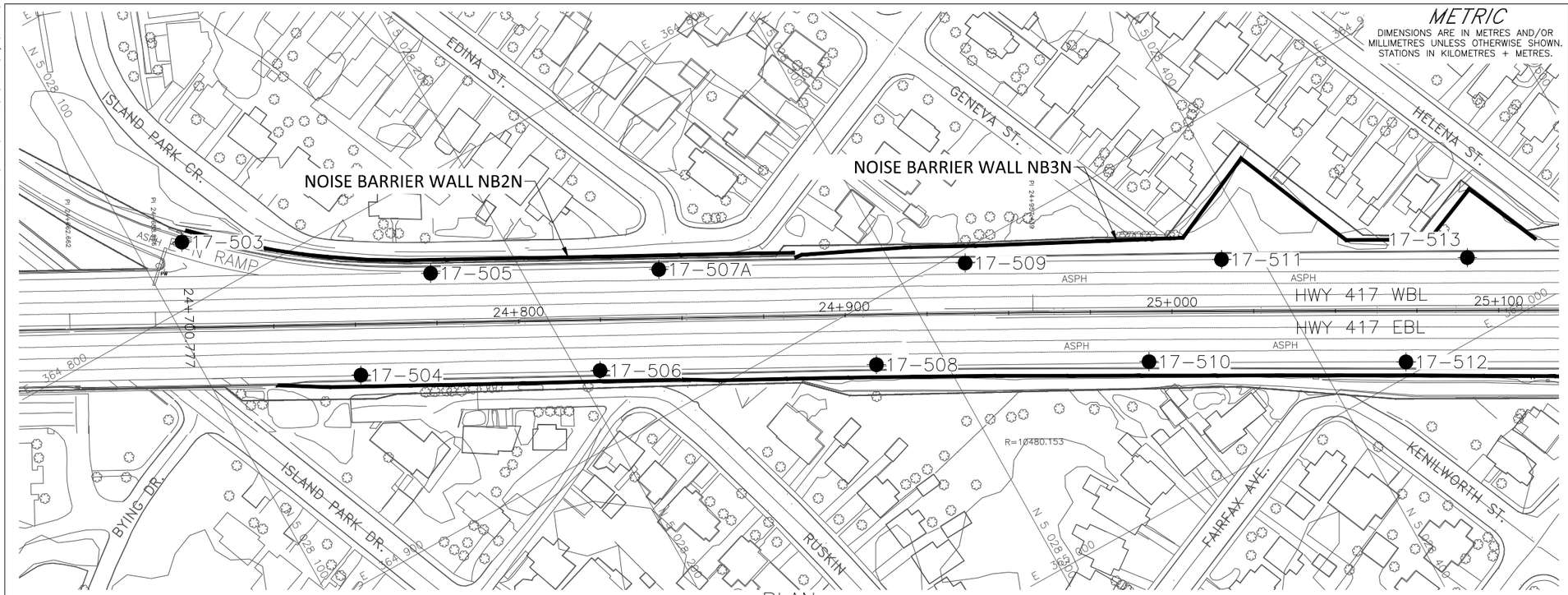
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 4173-15-00

SHEET

NOISE BARRIER WALL REPLACEMENT
NB1N, NB2N AND NB3N
HIGHWAY 417
BOREHOLE LOCATIONS AND SOIL STRATA
LAT. 45.391846 LONG. -75.732469

GOLDER



PLAN
SCALE
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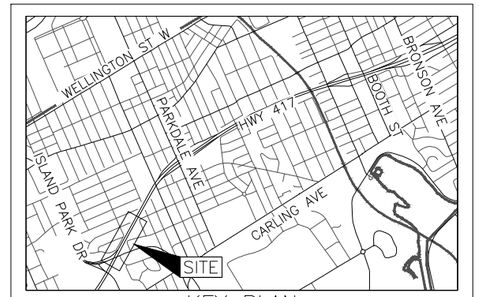
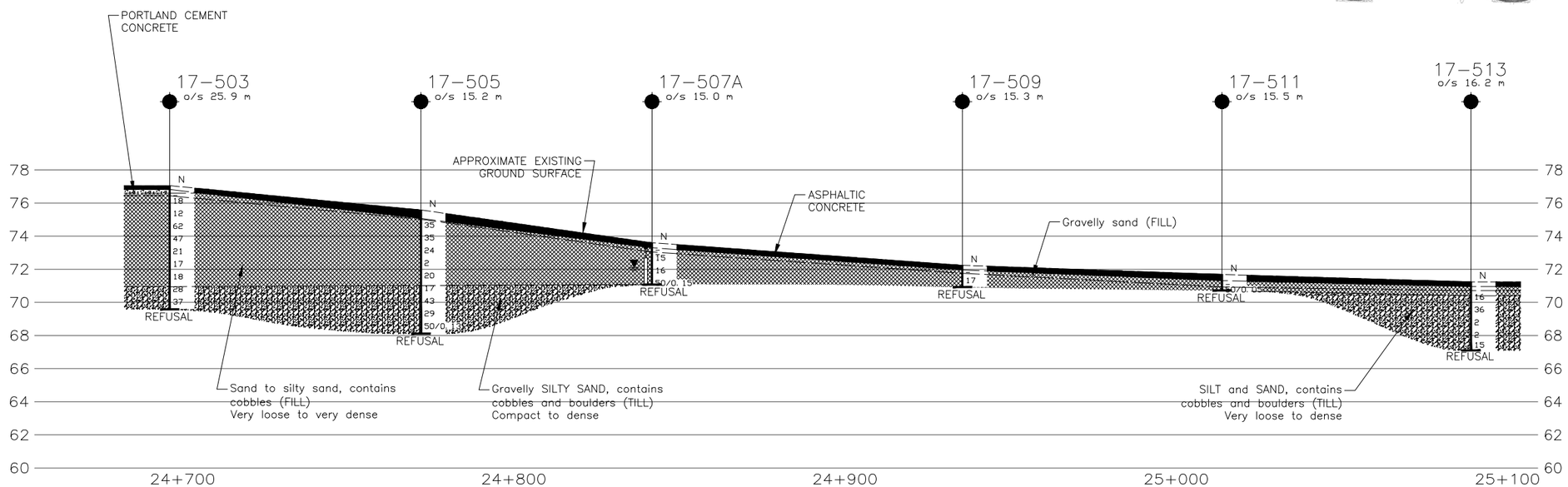


KEY PLAN
SCALE
500 0 500 1000 m

LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer, measured on OCTOBER 19, 2017
- Noise Barrier (NB) Walls

BOREHOLE CO-ORDINATES NAD83 (CSRS)/MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
17-503	77.1	5028113.6	364781.6
17-504	76.2	5028141.6	364843.8
17-505	75.6	5028175.4	364827.0
17-506	74.0	5028206.3	364878.2
17-507A	73.6	5028237.0	364859.9
17-508	72.5	5028281.1	364917.8
17-509	72.2	5028319.9	364903.8
17-510	71.9	5028354.4	364957.5
17-511	71.7	5028389.0	364941.0
17-512	71.4	5028423.1	364995.9
17-513	71.3	5028455.1	364977.1



PROFILE ALONG CENTRE-LINE HIGHWAY 417
SCALE
15 0 15 30 m
3 0 3 6 m

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
0	.	.	.

Geocres No. 31G5-312

HWY. 417	PROJECT NO. 1655214-1500		DIST. EASTERN
SUBM'D. SS	CHKD. KP	DATE: 12/11/2019	SITE: 417-09 & 417-10
DRAWN: JM	CHKD. KP	APPD. FJH	DWG. 1

PLOT DATE: December 11, 2019
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MINISTRY OF TRANSPORTATION, ONTARIO

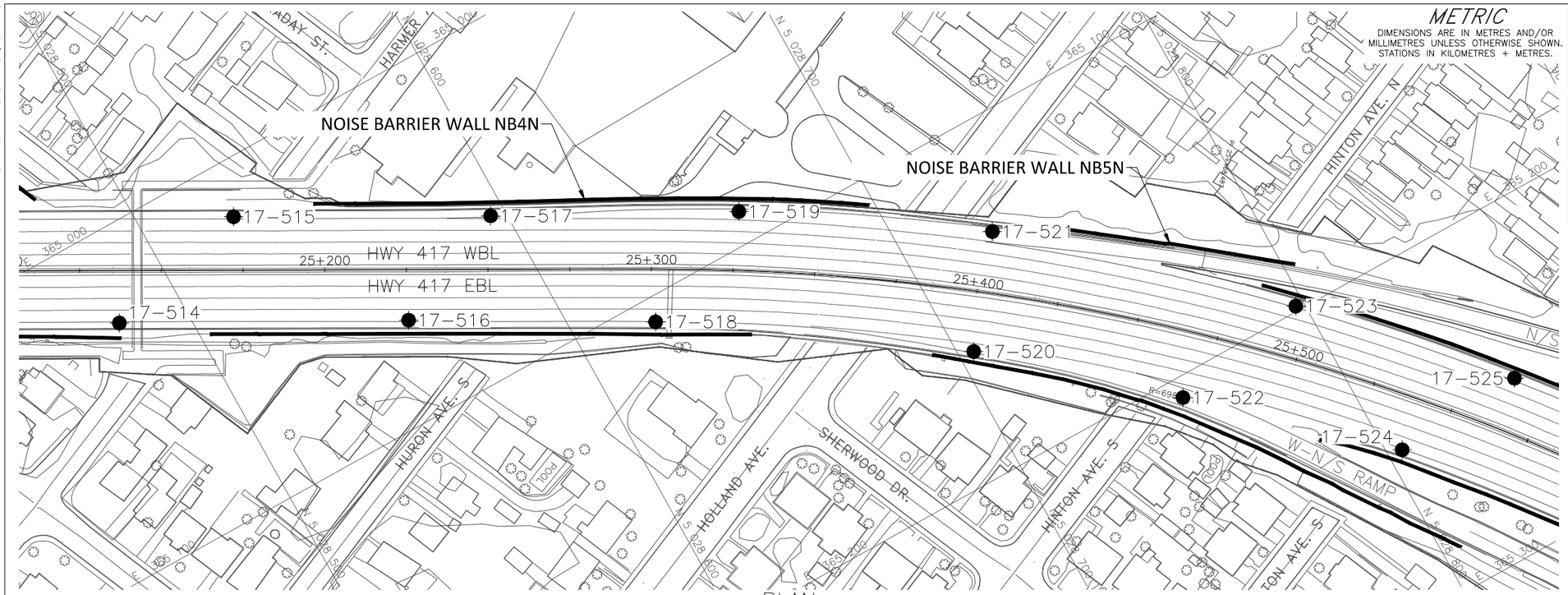
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 4173-15-00

SHEET

NOISE BARRIER WALL REPLACEMENT
NB4N AND NB5N
HIGHWAY 417
BOREHOLE LOCATIONS AND SOIL STRATA
LAT. 45.391846 LONG. -75.732469

GOLDER



PLAN

SCALE
15 0 15 30 m

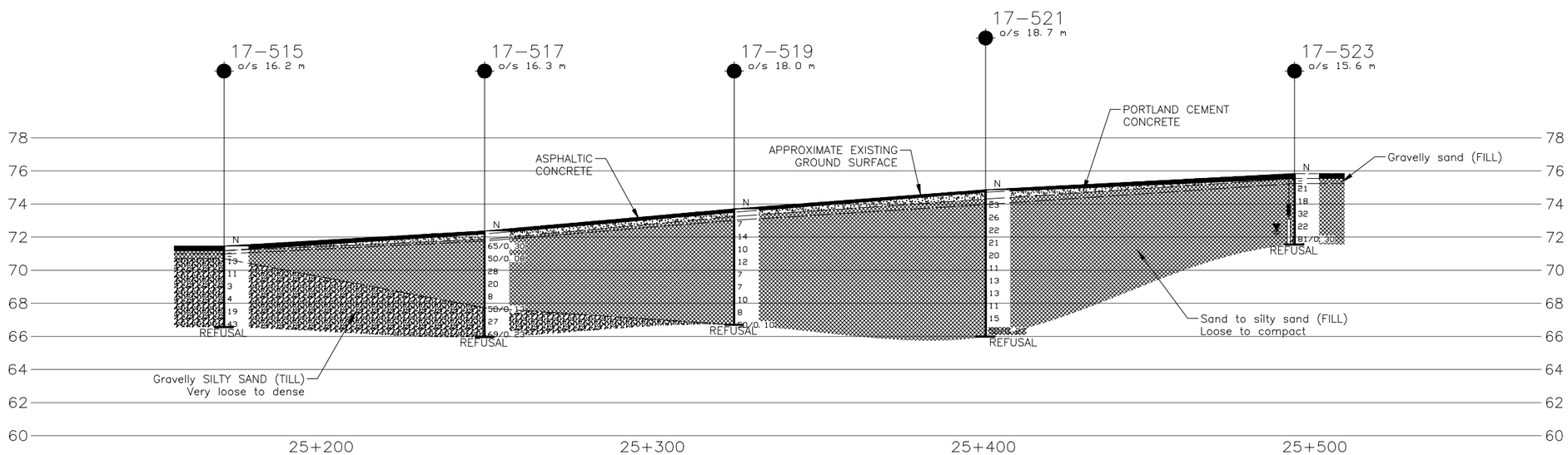
KEY PLAN
SCALE
500 0 500 1000 m

LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer, measured on OCTOBER 19, 2017
- Noise Barrier (NB) Walls

REGISTERED PROFESSIONAL ENGINEER F. J. HEFFERNAN PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER K.T.C. POWER 100130652 PROVINCE OF ONTARIO



PROFILE ALONG CENTRE-LINE HIGHWAY 417

SCALE
15 0 15 30 m
3 0 3 6 m

BOREHOLE CO-ORDINATES NAD83 (CSRS)/MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
17-514	71.3	5028480.3	365027.9
17-515	71.5	5028526.6	365016.5
17-516	72.1	5028558.1	365070.2
17-517	72.5	5028595.5	365054.5
17-518	72.6	5028623.9	365107.4
17-519	73.8	5028662.6	365090.3
17-520	73.3	5028704.6	365162.6
17-521	74.9	5028727.4	365133.4
17-522	74.0	5028753.7	365206.1
17-523	75.9	5028797.4	365198.5
17-524	74.8	5028804.5	365252.7
17-525	76.2	5028845.2	365250.3

NOTES

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NO.	DATE	BY	REVISION
0	.	.	.

Geocres No. 31G5-312

HWY. 417	PROJECT NO. 1655214-1500		DIST. EASTERN
SUBM'D. SS	CHKD. KP	DATE: 12/11/2019	SITE: 417-09 & 417-10
DRAWN: ZS	CHKD. KP	APPD. FJH	DWG. 2

PLOT DATE: December 11, 2019
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MINISTRY OF TRANSPORTATION, ONTARIO

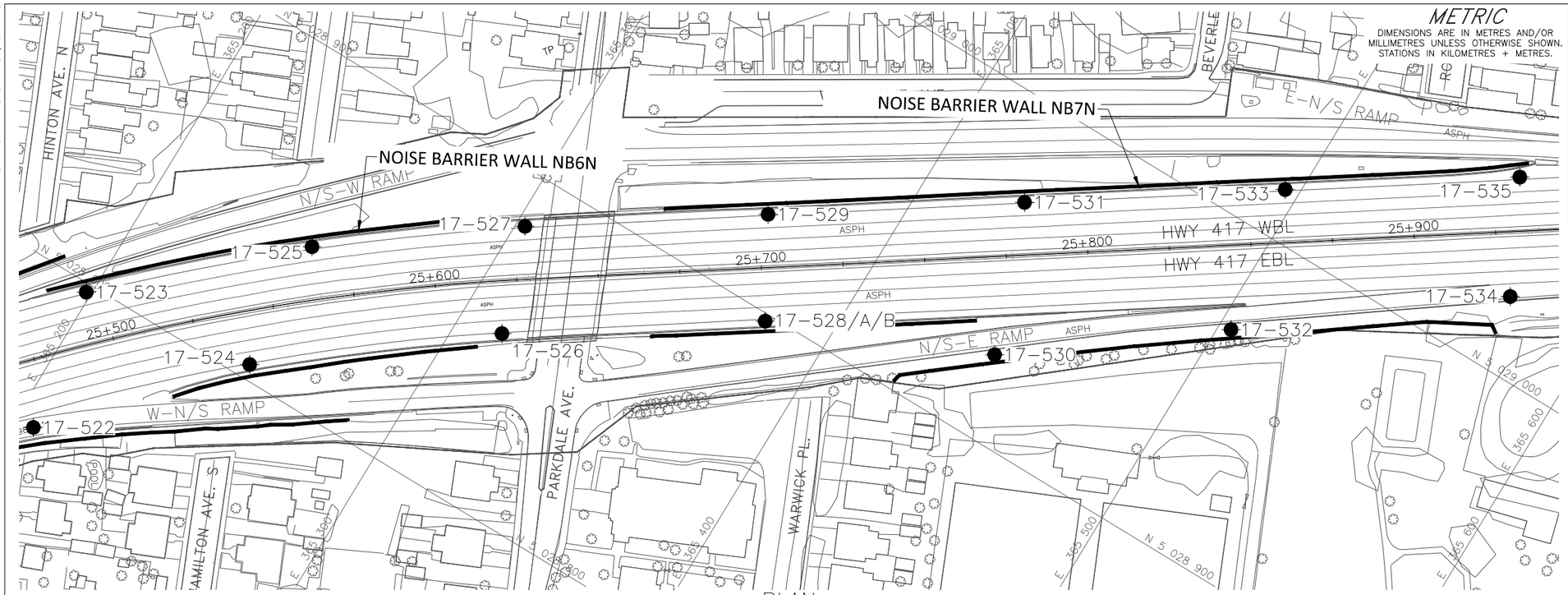
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 4173-15-00

SHEET

NOISE BARRIER WALL REPLACEMENT
NB6N AND NB7N
HIGHWAY 417
BOREHOLE LOCATIONS AND SOIL STRATA
LAT. 45.391846 LONG. -75.732469

GOLDER

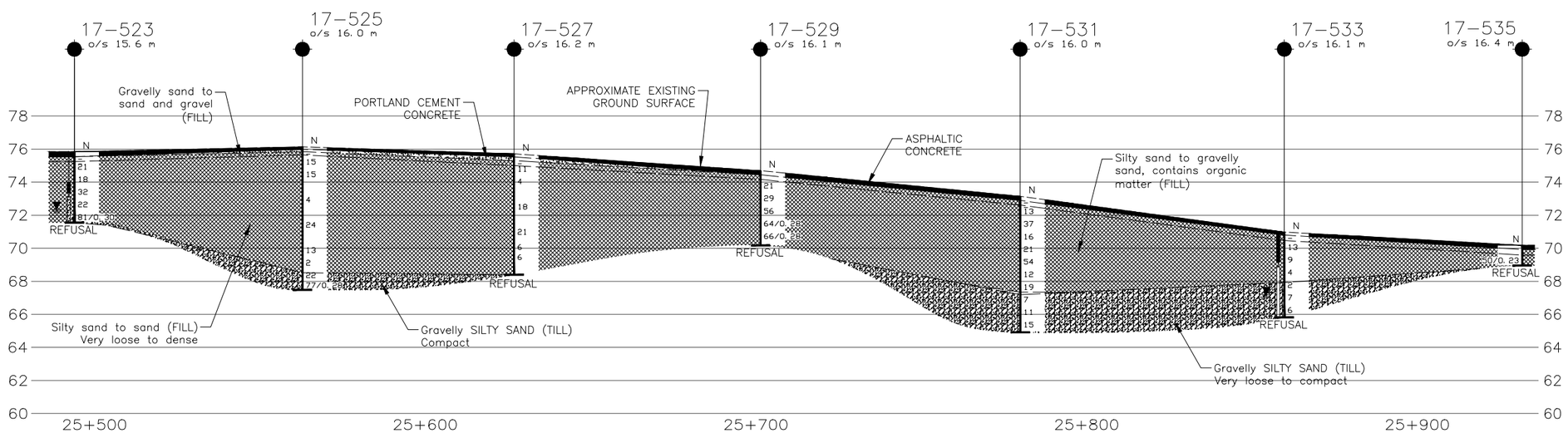


PLAN
SCALE
15 0 15 30 m

KEY PLAN
SCALE
500 0 500 1000 m

LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer, measured on OCTOBER 19, 2017
- Noise Barrier (NB) Walls



PROFILE ALONG CENTRE-LINE HIGHWAY 417
SCALE
15 0 15 30 m
3 0 3 6 m

BOREHOLE CO-ORDINATES NAD83 (CSRS)/MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
17-522	74.0	5028753.7	365206.1
17-523	75.9	5028797.4	365198.5
17-524	74.8	5028804.5	365252.7
17-525	76.2	5028845.2	365250.3
17-526	75.2	5028852.7	365313.8
17-527	75.8	5028884.4	365302.7
17-528	74.9	5028897.8	365380.6
17-529	74.8	5028926.2	365364.4
17-530	72.1	5028925.6	365446.0
17-531	73.2	5028970.1	365429.6
17-532	71.6	5028969.7	365503.8
17-533	71.1	5029014.9	365495.7
17-534	70.2	5029022.8	365571.6
17-535	70.3	5029055.5	365555.1

NOTES

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REGISTERED PROFESSIONAL ENGINEER F. J. HEFFERNAN PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER K.T.C. POWER 100130652 2019/12/09 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
0	.	.	.

Geocres No. 31G5-312

HWY. .	PROJECT NO. 1655214-1500		DIST. EASTERN
SUBM'D. SS	CHKD. KP	DATE: 12/11/2019	SITE: 417-09 & 417-10
DRAWN: ZS	CHKD. KP	APPD. FJH	DWG. 3

PLOT DATE: December 11, 2019
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MINISTRY OF TRANSPORTATION, ONTARIO

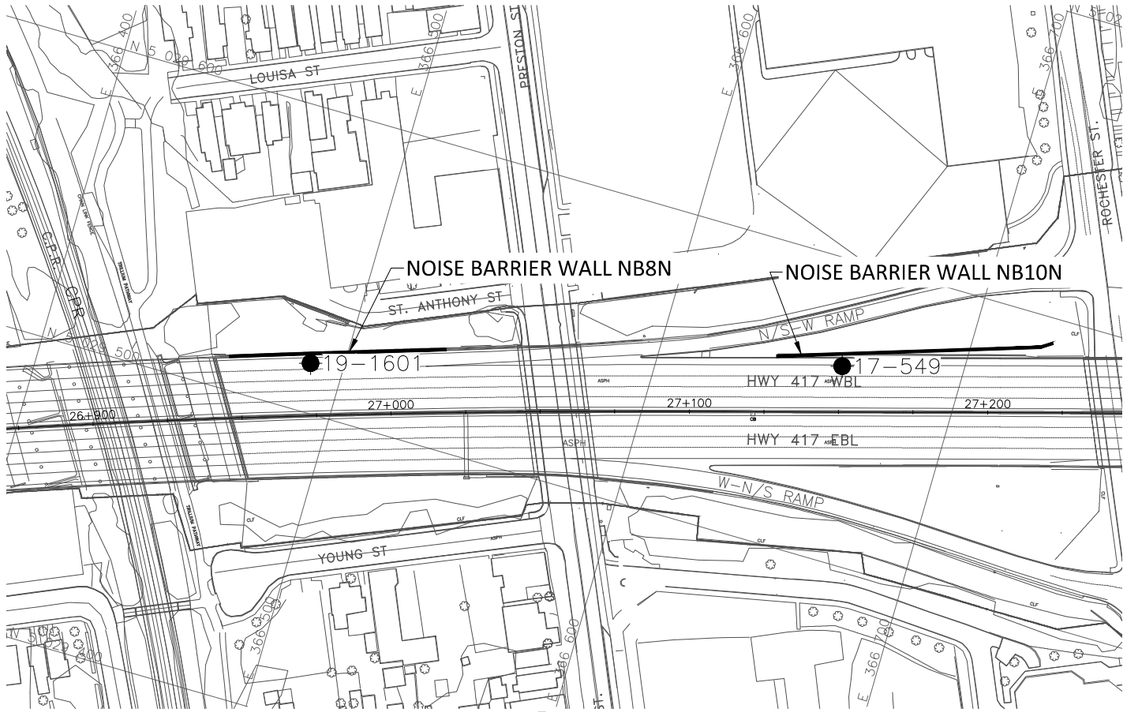
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 4173-15-00

SHEET

NOISE BARRIER WALL REPLACEMENT
NB8N
HIGHWAY 417
BOREHOLE LOCATIONS AND SOIL STRATA
LAT. 45.402876 LONG. -75.711993

GOLDER



PLAN
SCALE
20 0 20 40 m

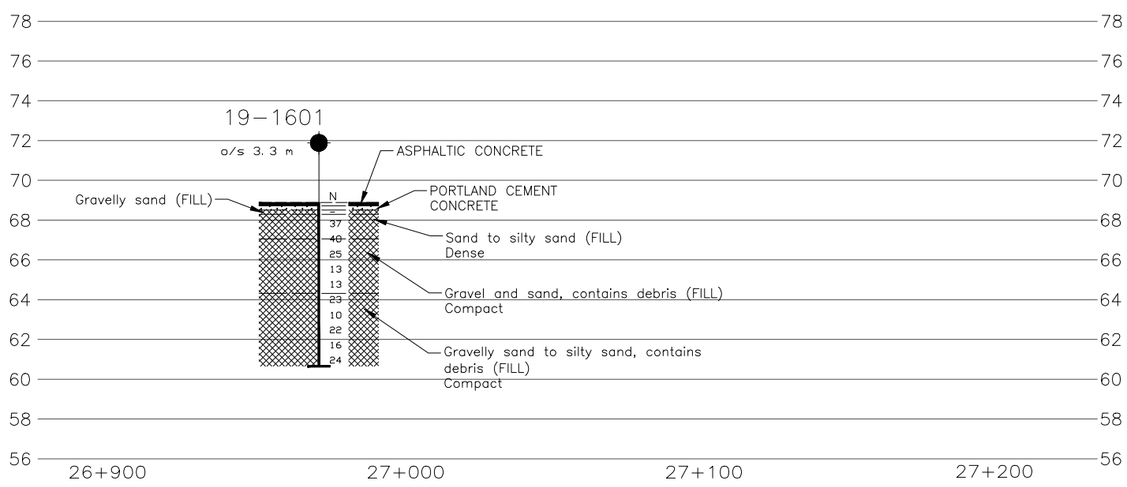
KEY PLAN
SCALE
500 0 500 1000 m

LEGEND

- Borehole – Current Investigation
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- Noise Barrier (NB) Walls

BOREHOLE CO-ORDINATES NAD83 (CSRS)/MTM ZONE 9

No.	ELEVATION	NORTHING	EASTING
19-1601	68.9	5029516.4	366488.9
17-549	67.2	5029564.8	366660.4



PROFILE ALONG CENTRE-LINE HIGHWAY 417
SCALE
15 0 15 30 m
3 0 3 6 m

NOTES

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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.

REGISTERED PROFESSIONAL ENGINEER F. J. HEFFERNAN OCT 9, 2019 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER K.T.C. POWER 100130652 2019/12/09 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
0	.	.	.

Geocres No. 31G5-312

HWY. 417	PROJECT NO. 1655214-1500		DIST. EASTERN
SUBM'D. SS	CHKD. KP	DATE: 12/11/2019	SITE: 417-09 & 417-10
DRAWN: ZS	CHKD. KP	APPD. FJH	DWG. 4

PLOT DATE: December 11, 2019
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MINISTRY OF TRANSPORTATION, ONTARIO

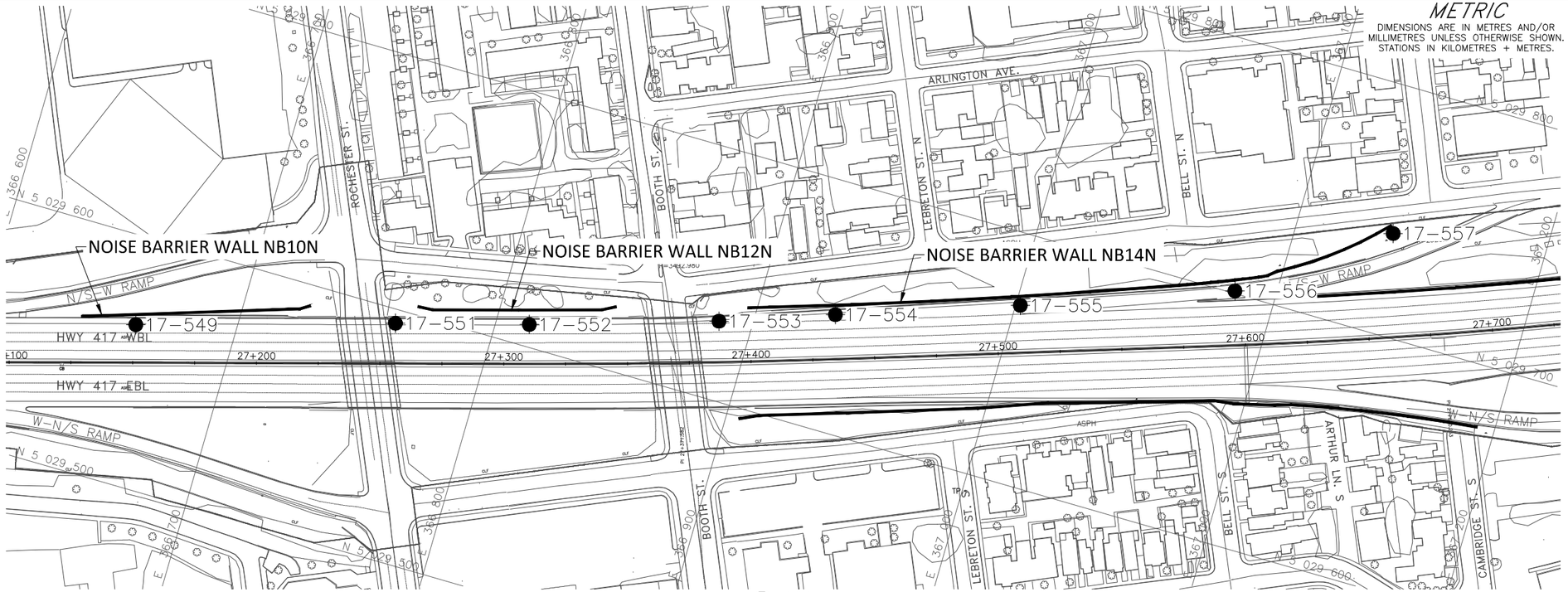
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 4173-15-00

SHEET

NOISE BARRIER WALL REPLACEMENT
NB10N, NB11N, NB12N, NB13N AND NB14N
HIGHWAY 417
BOREHOLE LOCATIONS AND SOIL STRATA
LAT. 45.391846 LONG. -75.732469

GOLDER



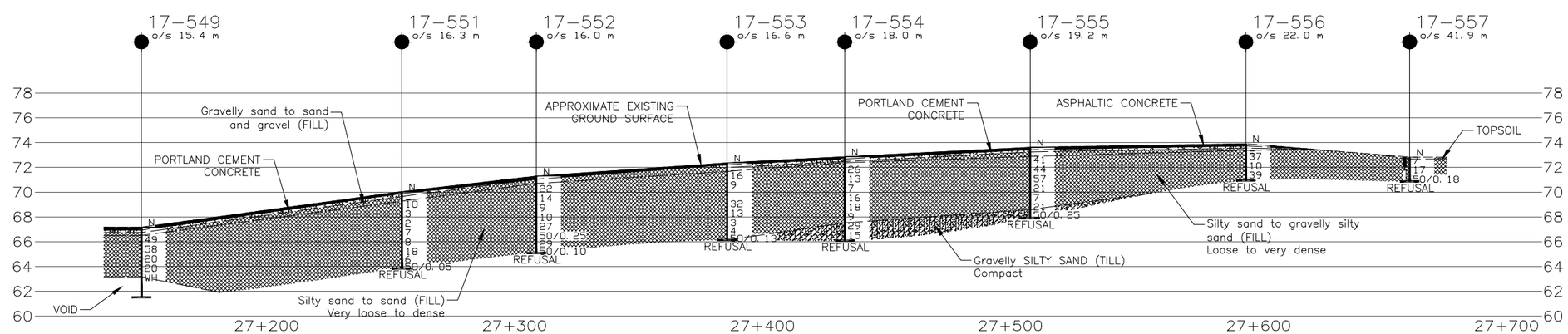
PLAN
SCALE
20 0 20 40 m

KEY PLAN
SCALE
500 0 500 1000 m

LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer, measured on OCTOBER 19, 2017
- Noise Barrier (NB) Walls

BOREHOLE CO-ORDINATES NAD83 (CSRS)/MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
17-549	67.2	5029564.8	366660.4
17-551	70.0	5029594.5	366761.2
17-552	71.3	5029609.0	366813.3
17-553	72.4	5029631.5	366886.6
17-554	72.9	5029647.1	366931.1
17-555	73.6	5029671.4	367001.9
17-556	73.9	5029701.1	367083.6
17-557	72.8	5029741.1	367138.6



PROFILE ALONG CENTRE-LINE HIGHWAY 417
SCALE
20 0 20 40 m
3 0 3 6 m

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
0	.	.	.

Geocres No. 31G5-312

HWY. 417	PROJECT NO. 1655214-1500		DIST. EASTERN
SUBM'D. SS	CHKD. KP	DATE: 12/11/2019	SITE: 417-22
DRAWN: ZS	CHKD. KP	APPD. FJH	DWG. 5

PLOT DATE: December 11, 2019
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MINISTRY OF TRANSPORTATION, ONTARIO

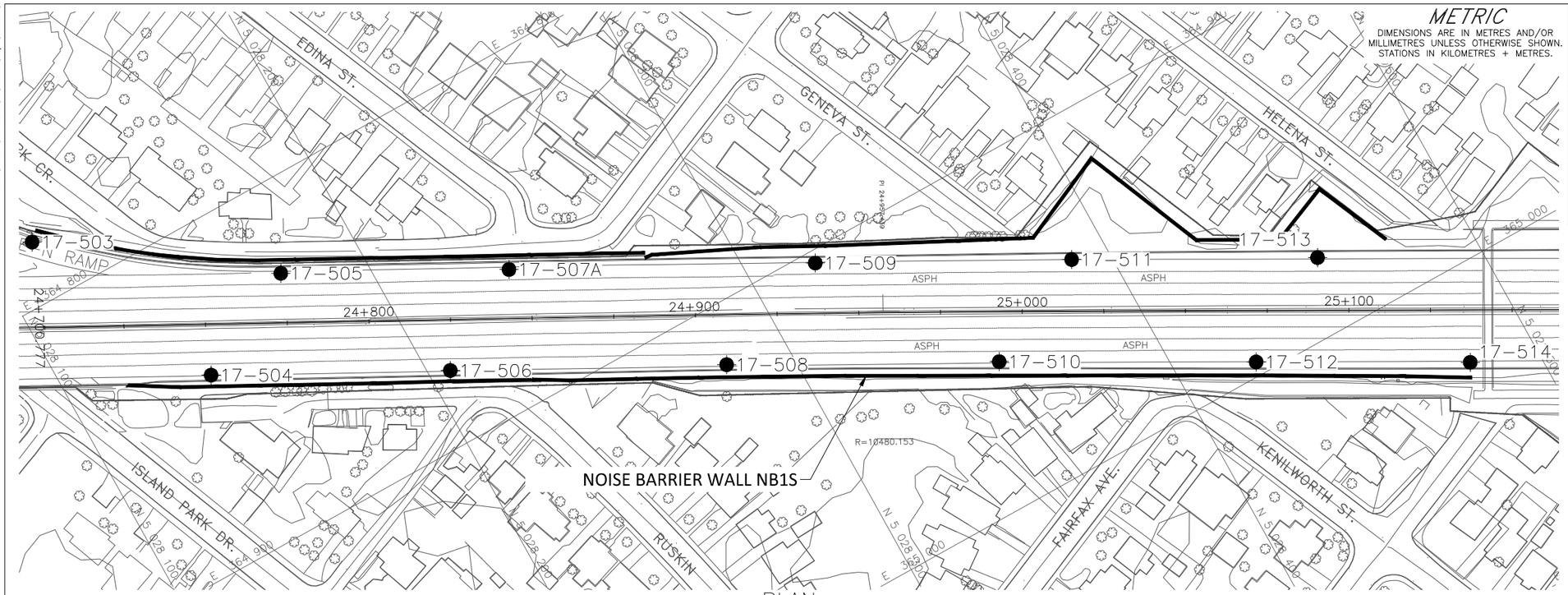
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 4173-15-00

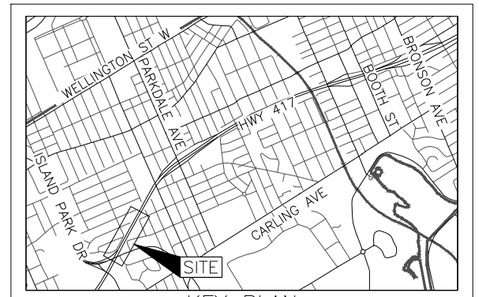
SHEET

NOISE BARRIER WALL REPLACEMENT
NB1S
HIGHWAY 417
BOREHOLE LOCATIONS AND SOIL STRATA
LAT. 45.391846 LONG. -75.732469

GOLDER



PLAN
SCALE
15 0 15 30 m

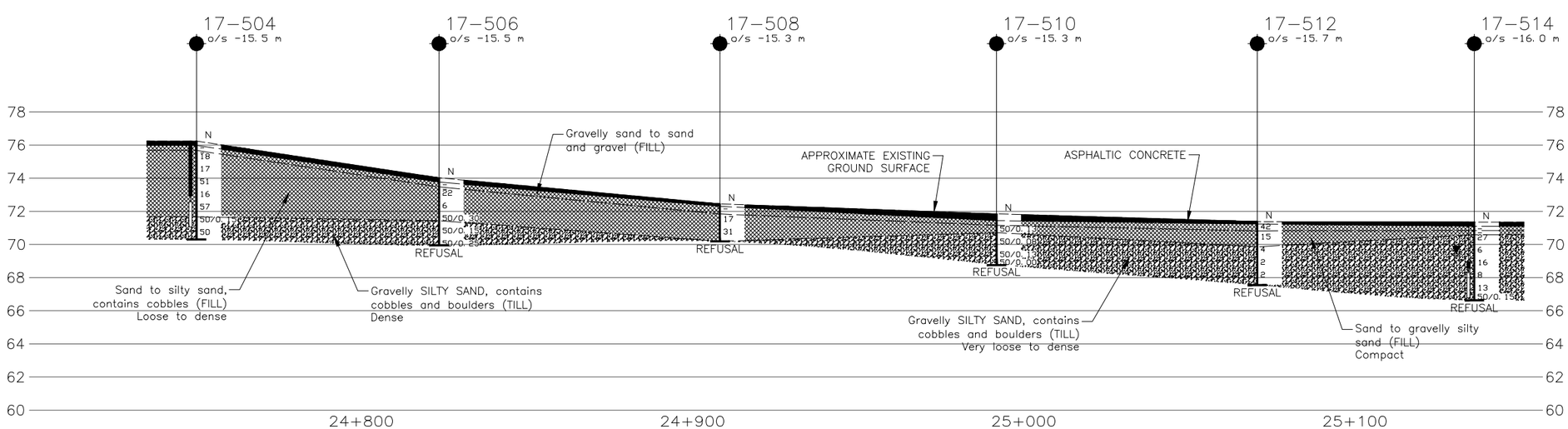


KEY PLAN
SCALE
500 0 500 1000 m

LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer, measured on OCTOBER 16, 2017
- Noise Barrier (NB) Walls

BOREHOLE CO-ORDINATES NAD83 (CSRS)/MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
17-503	77.0	5028113.6	364781.6
17-504	76.2	5028141.6	364843.8
17-505	75.6	5028175.4	364827.0
17-506	74.0	5028206.3	364878.2
17-507A	73.6	5028237.0	364859.9
17-508	72.5	5028281.1	364917.8
17-509	72.2	5028319.9	364903.8
17-510	71.8	5028354.4	364957.5
17-511	71.7	5028389.0	364941.0
17-512	71.4	5028423.1	364995.9
17-513	71.3	5028455.1	364977.1
17-514	71.3	5028480.3	365027.9



PROFILE ALONG CENTRE-LINE HIGHWAY 417
SCALE
15 0 15 30 m
3 0 3 6 m

NOTES

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REFERENCE

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NO.	DATE	BY	REVISION
0	.	.	.

Geocres No. 31G5-312

HWY. 417	PROJECT NO. 1655214-1500		DIST. EASTERN
SUBM'D. SS	CHKD. KP	DATE: 12/11/2019	SITE: 417-09 & 417-10
DRAWN: ZS	CHKD. KP	APPD. FJH	DWG. 6

PLOT DATE: December 11, 2019
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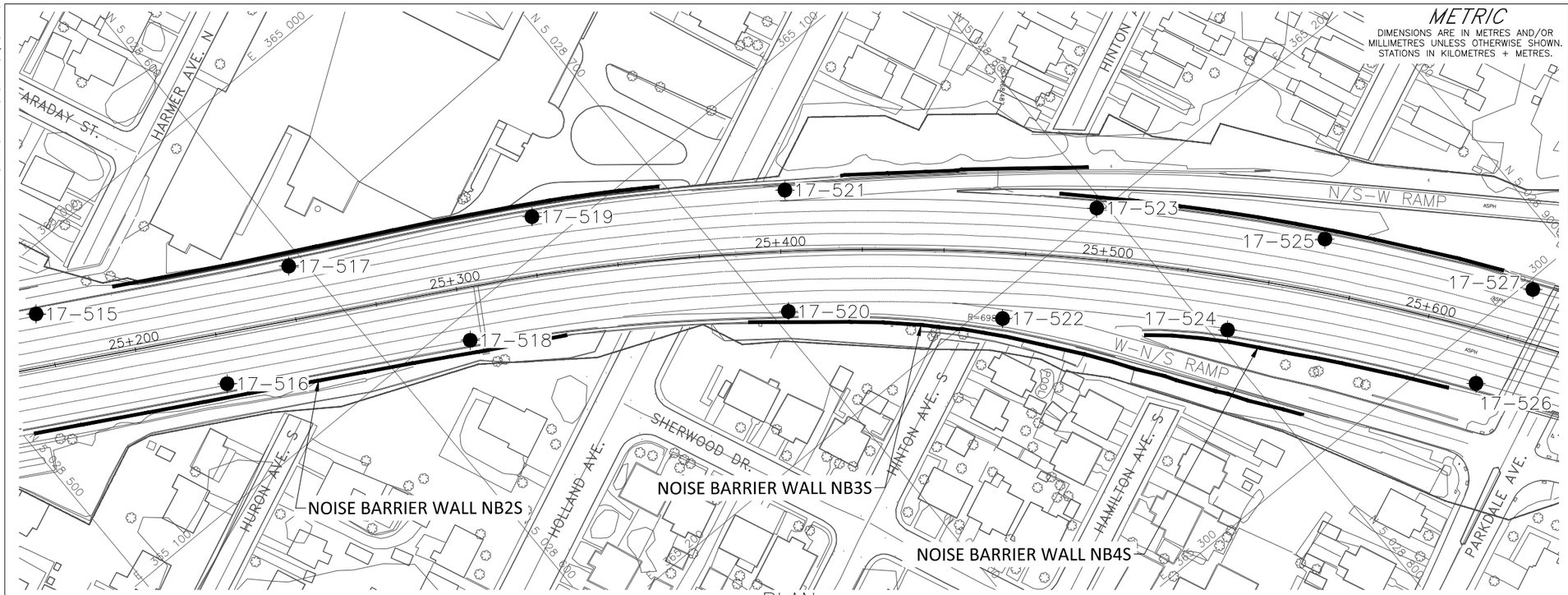
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

SCALE 15 0 15 30 m

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

CONT No.
GWP No. 4173-15-00

SHEET

NOISE BARRIER WALL REPLACEMENT
NB2S, NB3S AND NB4S
HIGHWAY 417
BOREHOLE LOCATIONS AND SOIL STRATA
LAT. 45.391846 LONG. -75.732469

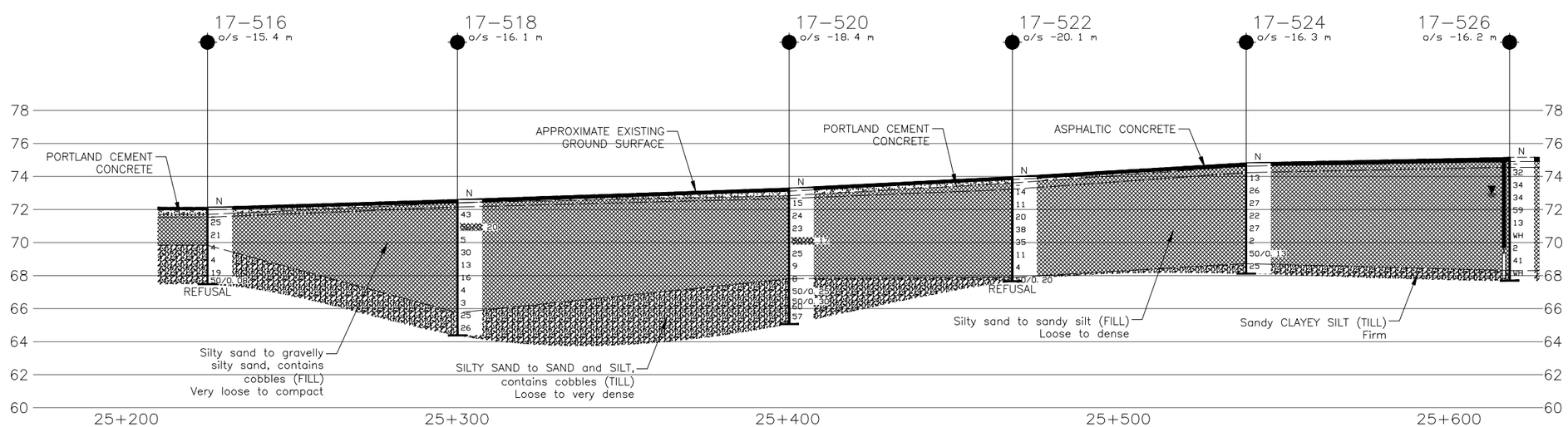
GOLDER

KEY PLAN
SCALE 500 0 500 1000 m

LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer, measured on OCTOBER 16, 2017
- Noise Barrier (NB) Walls

BOREHOLE CO-ORDINATES NAD83 (CSRS)/MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
17-515	71.5	5028526.6	365016.5
17-516	72.1	5028558.1	365070.2
17-517	72.5	5028595.5	365054.5
17-518	72.6	5028623.9	365107.4
17-519	73.8	5028662.6	365090.3
17-520	73.3	5028704.6	365162.6
17-521	74.9	5028727.4	365133.4
17-522	74.0	5028753.7	365206.1
17-523	75.9	5028797.4	365198.5
17-524	74.8	5028804.5	365252.7
17-525	76.2	5028845.2	365250.3
17-526	75.2	5028852.7	365313.8
17-527	75.8	5028884.4	365302.7



PROFILE ALONG CENTRE-LINE HIGHWAY 417

SCALE 15 0 15 30 m
3 0 3 6 m

NOTES

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NO.	DATE	BY	REVISION
0	.	.	.

Geocres No. 31G5-312

HWY. 417	PROJECT NO. 1655214-1500		DIST. EASTERN
SUBM'D. SS	CHKD. KP	DATE: 12/11/2019	SITE: 417-09 & 417-10
DRAWN: ZS	CHKD. KP	APPD. FJH	DWG. 7

PLOT DATE: December 11, 2019
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MINISTRY OF TRANSPORTATION, ONTARIO

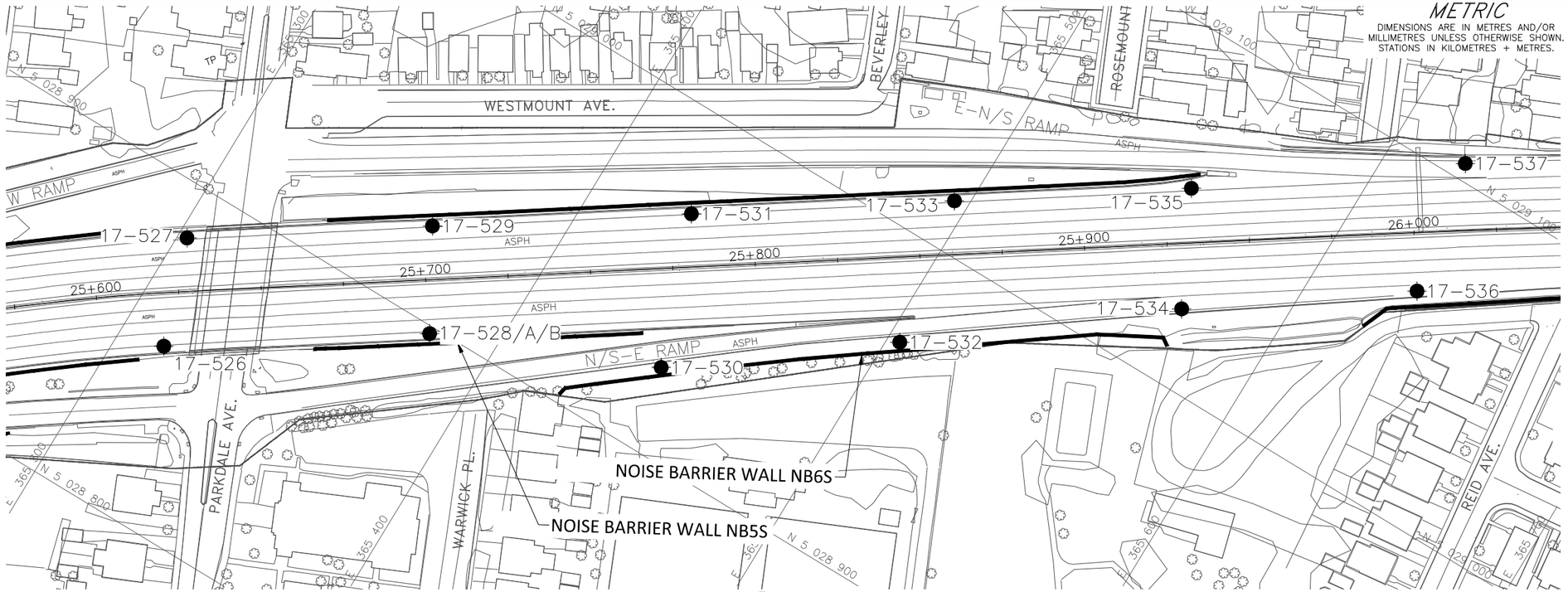
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 4173-15-00

SHEET

NOISE BARRIER WALL REPLACEMENT
NB5S AND NB6S
HIGHWAY 417
BOREHOLE LOCATIONS AND SOIL STRATA
LAT. 45.391846 LONG. -75.732469

GOLDER

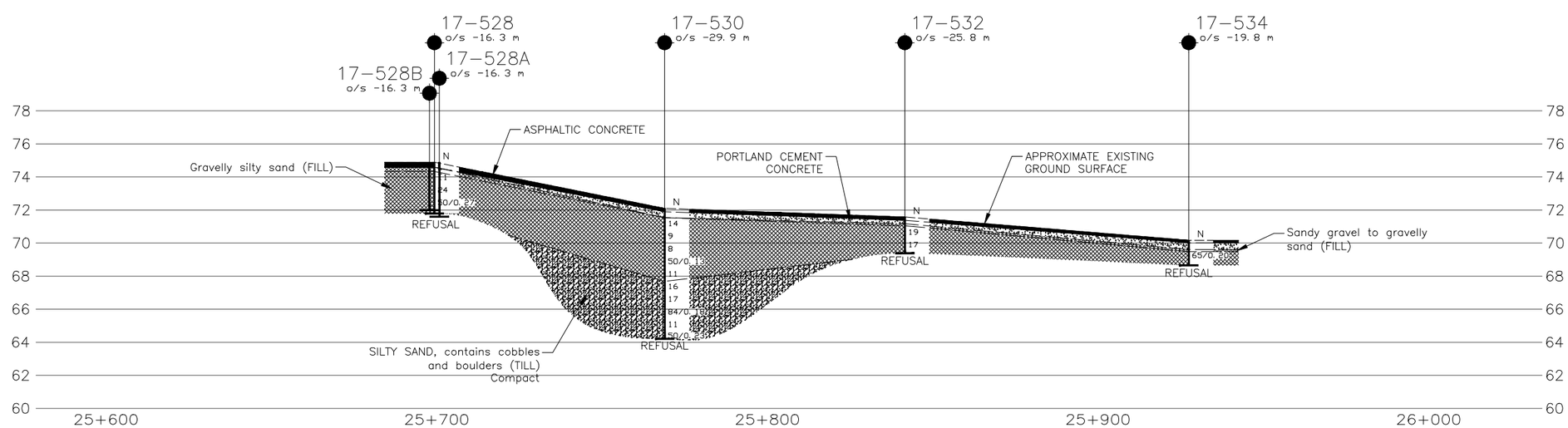


PLAN
SCALE
15 0 15 30 m

KEY PLAN
SCALE
500 0 500 1000 m

LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- Noise Barrier (NB) Walls



PROFILE ALONG CENTRE-LINE HIGHWAY 417
SCALE
15 0 15 30 m
3 0 3 6 m

BOREHOLE CO-ORDINATES NAD83 (CSRS)/MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
17-526	75.2	5028852.7	365313.8
17-527	75.8	5028884.4	365302.7
17-528	74.9	5028897.8	365380.6
17-529	74.8	5028926.2	365364.4
17-530	72.1	5028925.6	365446.0
17-531	73.2	5028970.1	365429.6
17-532	71.6	5028969.7	365503.8
17-533	71.1	5029014.9	365495.7
17-534	70.2	5029022.8	365571.6
17-535	70.3	5029055.5	365555.1
17-536	70.3	5029064.4	365629.8
17-537	70.9	5029105.1	365622.2

NOTES

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NO.	DATE	BY	REVISION
0	.	.	.

Geocres No. 31G5-312

HWY. 417	PROJECT NO. 1655214-1500		DIST. EASTERN
SUBM'D. SS	CHKD. KP	DATE: 12/11/2019	SITE: 417-09 & 417-10
DRAWN: ZS	CHKD. KP	APPD. FJH	DWG. 8

PLOT DATE: December 11, 2019
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MINISTRY OF TRANSPORTATION, ONTARIO

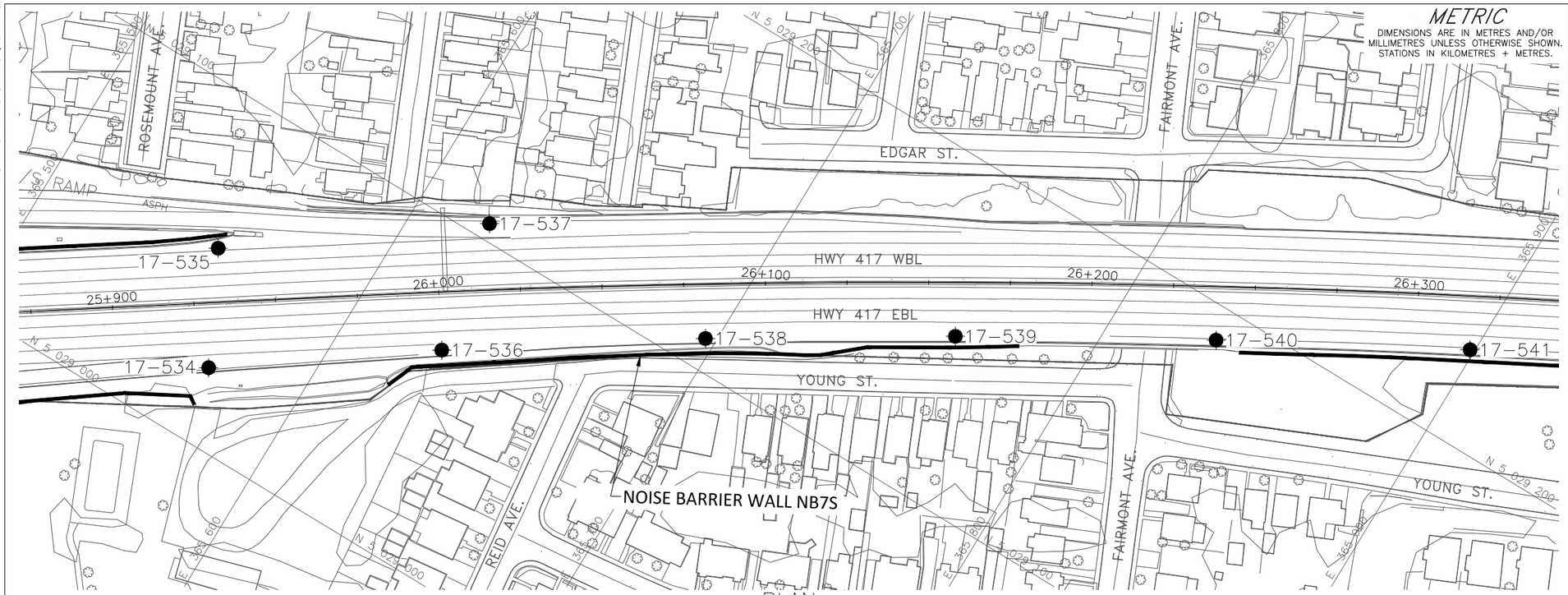
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 4173-15-00

SHEET

NOISE BARRIER WALL REPLACEMENT
NB7S
HIGHWAY 417
BOREHOLE LOCATIONS AND SOIL STRATA
LAT. 45.391846 LONG. -75.732469

GOLDER



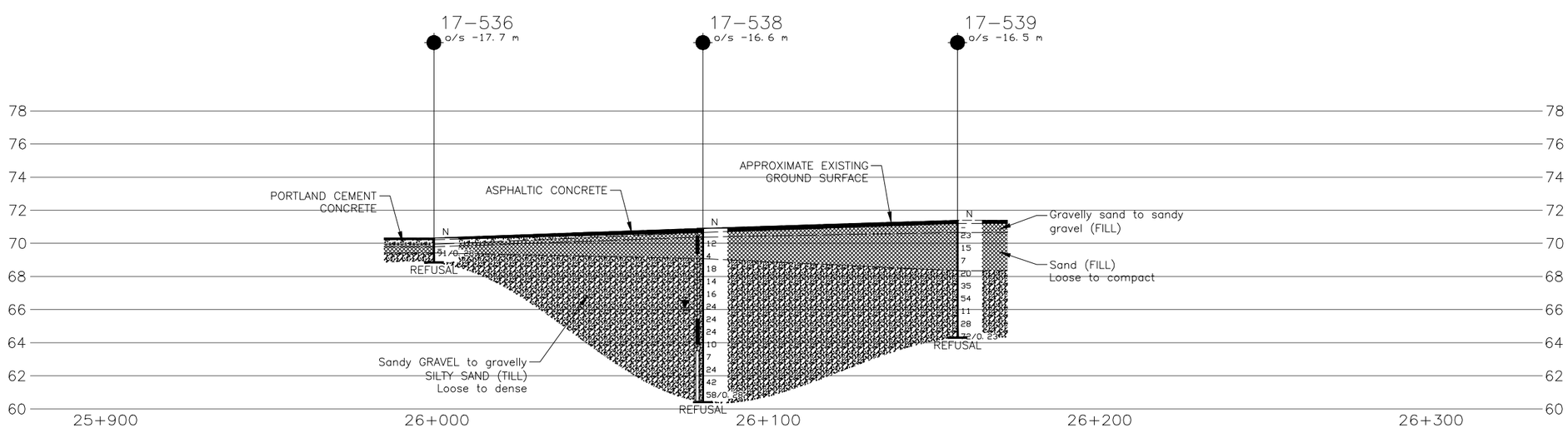
PLAN
SCALE
15 0 15 30 m

KEY PLAN
SCALE
500 0 500 1000 m

LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer, measured on OCTOBER 18, 2017
- Noise Barrier (NB) Walls

BOREHOLE CO-ORDINATES NAD83 (CSRS)/MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
17-534	70.2	5029022.8	365571.6
17-535	70.3	5029055.5	365555.1
17-536	70.3	5029064.4	365629.8
17-537	70.9	5029105.1	365622.2
17-538	70.9	5029109.4	365696.9
17-539	71.4	5029149.7	365761.9
17-540	72.2	5029190.2	365830.7
17-541	73.9	5029228.0	365898.7



PROFILE ALONG CENTRE-LINE HIGHWAY 417

SCALE
15 0 15 30 m
3 0 3 6 m

NOTES

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REFERENCE

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NO.	DATE	BY	REVISION
0	.	.	.

Geocres No. 31G5-312

HWY. 417	PROJECT NO. 1655214-1500		DIST. EASTERN
SUBM'D. SS	CHKD. KP	DATE: 12/11/2019	SITE: 417-09 & 417-10
DRAWN: ZS	CHKD. KP	APPD. FJH	DWG. 9

PLOT DATE: December 11, 2019
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MINISTRY OF TRANSPORTATION, ONTARIO

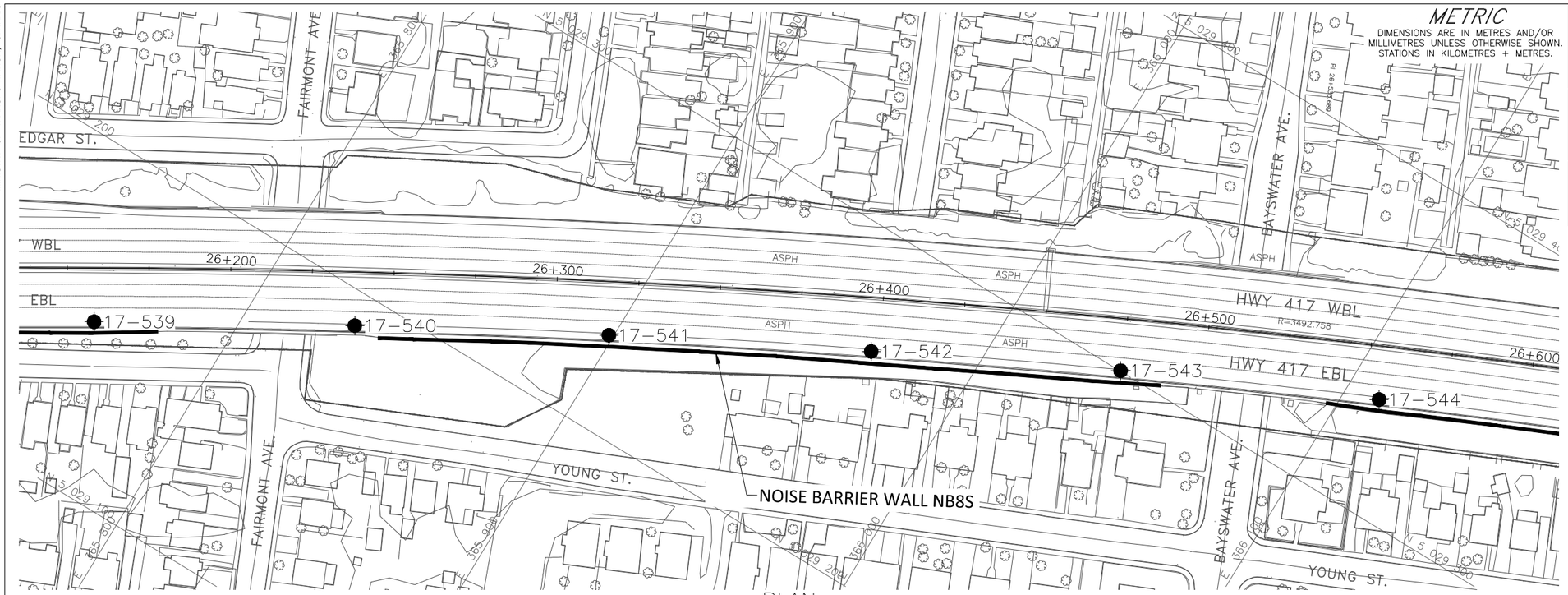
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 4173-15-00

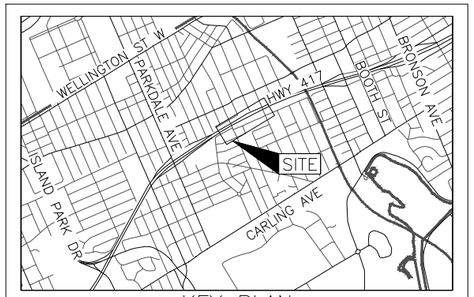
SHEET

NOISE BARRIER WALL REPLACEMENT
NB8S
HIGHWAY 417
BOREHOLE LOCATIONS AND SOIL STRATA
LAT. 45.391846 LONG. -75.732469

GOLDER



PLAN
SCALE
15 0 15 30 m

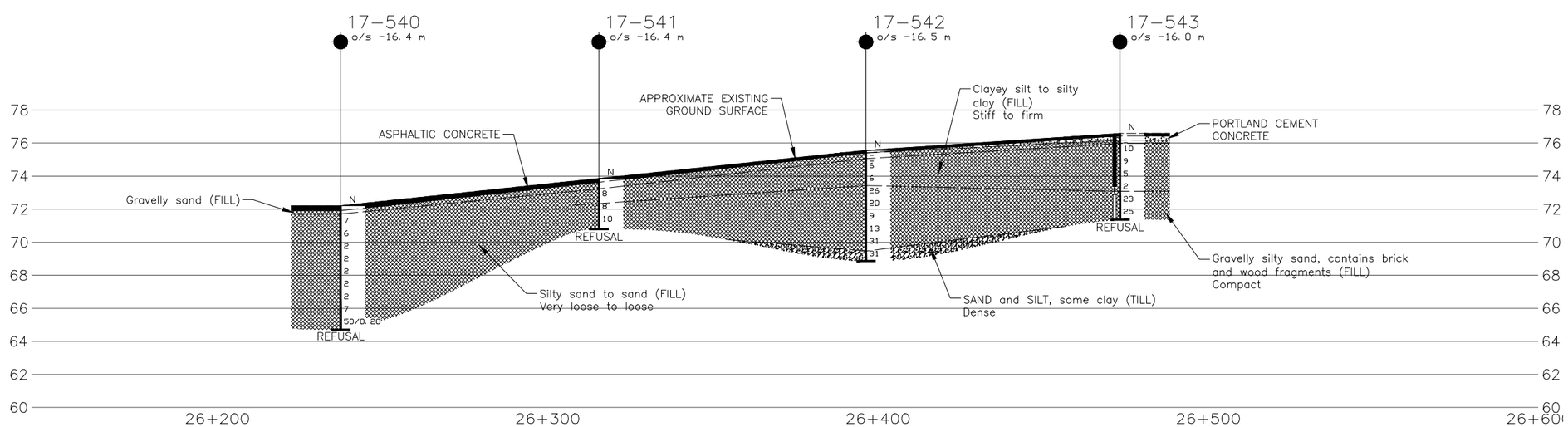


KEY PLAN
SCALE
500 0 500 1000 m

LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer, measured on OCTOBER 18, 2017
- Noise Barrier (NB) Walls

BOREHOLE CO-ORDINATES NAD83 (CSRS)/MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
17-539	71.4	5029149.7	365761.9
17-540	72.2	5029190.2	365830.7
17-541	73.9	5029228.0	365898.7
17-542	75.6	5029265.5	365969.9
17-543	76.6	5029300.2	366038.2
17-544	76.9	5029333.7	366110.4



PROFILE ALONG CENTRE-LINE HIGHWAY 417
SCALE
15 0 15 30 m
3 0 3 6 m

NOTES

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NO.	DATE	BY	REVISION
0	.	.	.

Geocres No. 31G5-312

HWY. 417	PROJECT NO. 1655214-1500		DIST. EASTERN
SUBM'D. SS	CHKD. KP	DATE: 12/11/2019	SITE: 417-09 & 417-10
DRAWN: ZS	CHKD. KP	APPD. FJH	DWG. 10

PLOT DATE: December 11, 2019
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MINISTRY OF TRANSPORTATION, ONTARIO

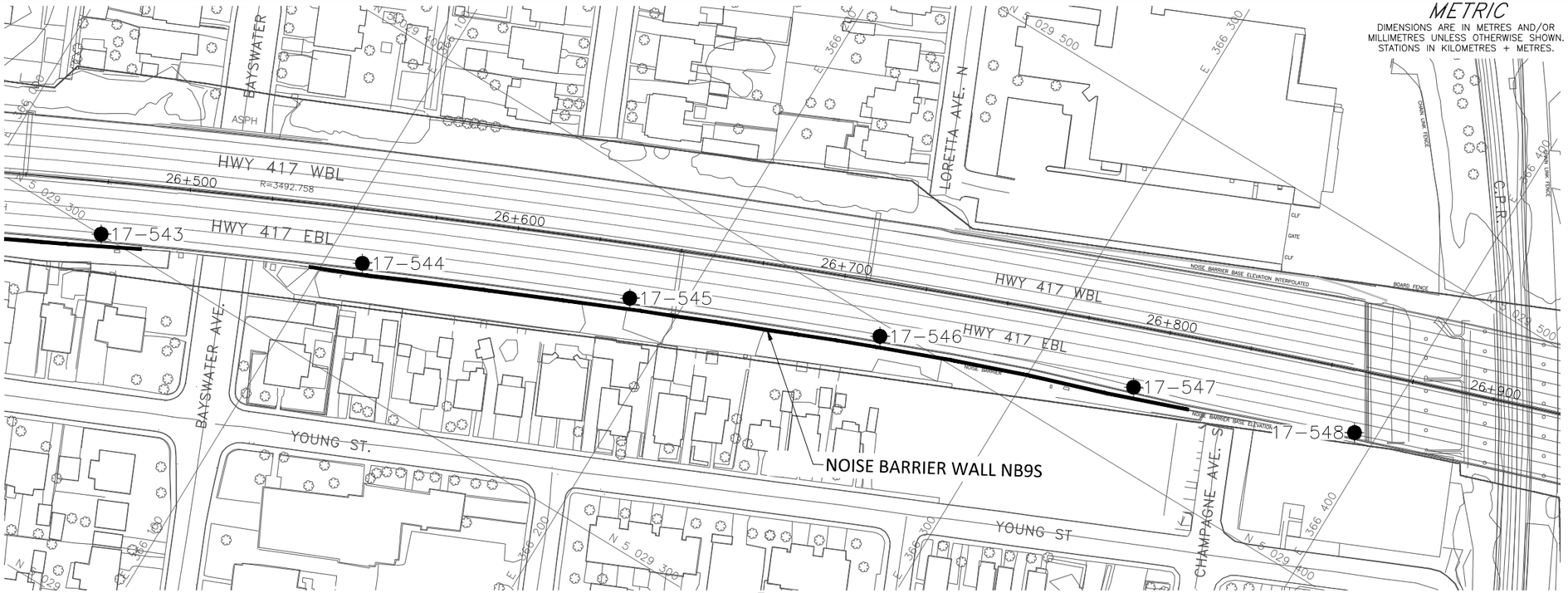
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 4173-15-00

SHEET

NOISE BARRIER WALL REPLACEMENT
NB9S
HIGHWAY 417
BOREHOLE LOCATIONS AND SOIL STRATA
LAT. 45.391846 LONG. -75.732469

GOLDER



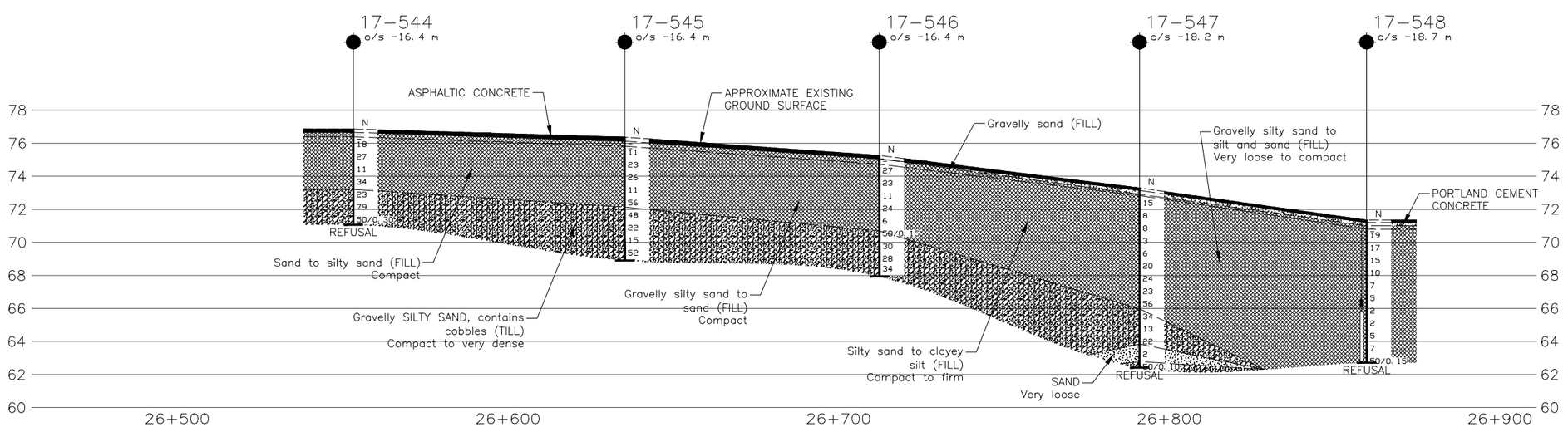
PLAN
SCALE
15 0 15 30 m

KEY PLAN
SCALE
500 0 500 1000 m

LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer, measured on OCTOBER 18, 2017
- Noise Barrier (NB) Walls

BOREHOLE CO-ORDINATES NAD83 (CSRS)/MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
17-543	76.6	5029300.2	366038.2
17-544	76.9	5029333.7	366110.4
17-545	76.4	5029366.8	366185.0
17-546	75.3	5029396.3	366255.8
17-547	73.3	5029423.0	366329.4
17-548	71.3	5029446.1	366393.7



PROFILE ALONG CENTRE-LINE HIGHWAY 417
SCALE
15 0 15 30 m
3 0 3 6 m

NOTES

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REFERENCE

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NO.	DATE	BY	REVISION
0	.	.	.

Geocres No. 31G5-312

HWY. 417	PROJECT NO. 1655214-1500		DIST. EASTERN
SUBM'D. SS	CHKD. KP	DATE: 12/11/2019	SITE: 417-09 & 417-10
DRAWN: ZS	CHKD. KP	APPD. FJH	DWG. 11

PLOT DATE: December 11, 2019
FILENAME: N:\Active\Spatial_IM\MTO\Hwy417RehabAllSeeing\09_PROJ\1655214_MTO_Hwy417BridgeReplacement\10_PROD\Phase1500_NoiseWalls\1655214-1500-BG-0001.dwg

APPENDIX A

Record of Boreholes, Current Investigation

List of Abbreviations and Symbols

Lithological and Geotechnical Rock Description Terminology

Record of Boreholes 17-503 to 17-549, 17-551 to 17-557, and 19-1601

LIST OF SYMBOLS

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
υ	Poisson's ratio
	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, 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

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

(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 = $(w_l - w_p)$
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	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 = σ'_p / σ'_{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 δ
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

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. 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.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; 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, 60º 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

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Compactness Condition	N Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils

Consistency	kPa	psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

IV. SOIL TESTS

w	water content
w_p	plastic limit
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
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	field vane (LV-laboratory vane test)
γ	unit weight

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

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 10	Trace	Trace sand
10 to 20	Some	Some sand
20 to 35	(ey) or (y)	Sandy
over 35	And	Sand and Gravel

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

Description	Bedding Plane Spacing
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

Description	Spacing
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

Term	Size*
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 90º 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		

RECORD OF BOREHOLE No 17-503

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028113.6; E 364781.6 NAD 83 MTM ZONE 9 (LAT. 45.390402; LONG. -75.733970)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 16, 2017

CHECKED BY KP

ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
77.1	GROUND SURFACE					77				
0.0 / 76.9	ASPHALTIC CONCRETE									
76.6	PORTLAND CEMENT CONCRETE									
	(SP) Gravelly sand (FILL) Grey Dry	1	GRAB	-						
0.6	(SP) Sand, trace gravel and silt (FILL) Compact to very dense Brown Moist to wet	2	SS	18		76				
		3	SS	12				○		
		4	SS	62		75				
		5	SS	47		74				
		6	SS	21		73		○		
		7	SS	17		72				
71.8										
5.3	(SM) Gravelly silty sand, contains organic matter and concrete pieces (FILL) Compact Grey brown Moist to wet	8	SS	18						
71.0						71				
6.1	(SM) Gravelly SILTY SAND, trace clay, contains cobbles and boulders (TILL) Compact to dense Grey brown Moist	9	SS	28				○		27 43 22 8
		10	SS	37		70				
69.6										
7.5	END OF BOREHOLE AUGER REFUSAL									

$+^3, \times^3$: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 17-504

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028141.6; E 364843.8 NAD 83 MTM ZONE 9 (LAT. 45.390649; LONG. -75.733173)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 1, 2017

CHECKED BY KP

ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	SAMPLES: NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.2	GROUND SURFACE								
0.0 / 75.9	ASPHALTIC CONCRETE								
0.3 / 75.6	(SP) Gravelly sand (FILL) Grey Dry	1	GRAB	-					
75.4	(SP) Sand (FILL) Brown Dry	2	GRAB	-					
0.8 / 74.8	(SM) Silty sand, some gravel and clay (FILL) Compact Grey brown Dry	3	SS	18	76		○		11 54 23 12
1.4 / 73.1	(SM/CL) Silty sand to silty clay, some gravel, contains cobbles (FILL) Compact to very dense Grey brown Moist	4	SS	17	75				
		5	SS	51	74				
3.1 / 72.5	(SM/ML) Silty sand to sandy silt (FILL) Compact Grey brown Moist	6	SS	16	73		○		
3.7 / 71.6	(SP) Sand, some gravel (FILL) Very dense Brown Moist	7	SS	57	72				
4.6 / 70.3	(SM) Gravelly SILTY SAND, trace clay, contains cobbles and boulders (TILL) Very dense Grey brown Moist	8	SS	50/0.15	71				
		9	SS	50			○		20 48 23 9
5.9	END OF BOREHOLE								

NOTES:

1. Well screen was dry on October 16, 2017

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 17-505

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028175.4; E 364827.0 NAD 83 MTM ZONE 9 (LAT. 45.390955; LONG. -75.733383)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 1, 2017

CHECKED BY KP

ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.6	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
75.1											
0.6	(SP) Gravelly sand (FILL) Grey						75				
	(SM) Sand, some gravel, some silt, contains sandy silt layers (FILL) Dense to compact Brown Moist		1	SS	35						
							74		○		
			2	SS	35						
			3	SS	24		73				
72.5											
3.1	(SM) Silty sand, trace gravel, contains silty clay layers (FILL) Very loose Brown Wet		4	SS	2				○		
71.8							72				
3.8	(SM) Gravelly silty sand, contains concrete and asphalt pieces (FILL) Compact Dark grey Moist		5	SS	20						
71.0											
4.6	(SM) Gravelly SILTY SAND, contains cobbles and boulders (TILL) Compact to dense Grey brown Moist to wet		6	SS	17		71				
			7	SS	43		70		○		
			8	SS	29		69				
			9	SS	50/0.13						
68.1											
7.5	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No 17-506

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028206.3; E 364878.2 NAD 83 MTM ZONE 9 (LAT. 45.391228; LONG. -75.732726)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 2, 2017

CHECKED BY KP

SOIL PROFILE: ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.0	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
73.7											
0.3	(SP) Gravelly sand (FILL) Grey Dry		1	GRAB	-						
73.5											
73.2	(SP) Sand (FILL) Brown Dry		2	GRAB	-				○		
0.8	(SP) Sand, some gravel (FILL) Compact Brown Moist		3	SS	22		73				
72.6											
1.4	(SM-ML) Silty sand to sandy silt, some gravel (FILL) Loose Grey brown Moist		4	SS	6		72				
71.9											
2.1	(SP) Gravelly sand (FILL) Brown Moist		5	SS	50/0.30				○		
71.4											
2.6	(SM) Gravelly SILTY SAND, contains cobbles and boulders (TILL) Grey brown Moist		6	SS	50/0.15		71				
69.9			7	SS	50/0.25		70				
4.1	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No 17-507A

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028237.0; E 364859.9 NAD 83 MTM ZONE 9 (LAT. 45.391506; LONG. -75.732955)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 16, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE			kN/m³	GR SA SI CL
73.6	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
73.3											
73.0	(SP) Gravelly sand (FILL) Grey		1	GRAB	-						
0.6	(SM) Sand, some silt, trace gravel (FILL) Compact Brown Moist to wet		2	GRAB	-		73		○		
			3	SS	15						
			4	SS	16		72		○		7 80 12 1
71.1			5	SS	50/0.15						
2.5	END OF BOREHOLE AUGER REFUSAL										

NOTES:

1. Water level observed in well screen at a depth of 1.5 m below ground surface (Elev. 72.1 m), measured on October 19, 2017

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 17-508

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028281.1; E 364917.8 NAD 83 MTM ZONE 9 (LAT. 45.391898; LONG. -75.732211)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 10, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
72.5	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
0.2	(GP) Sandy gravel (FILL) Grey Moist		1	GRAB	-						
71.9							72				
0.6	(SM/ML) Silty sand, some clay (FILL) Compact to dense Grey brown Moist		2	SS	17				○		5 48 34 13
							71				
			3	SS	31						
70.4	Weathered Bedrock										
2.3	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No 17-509

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028319.9; E 364903.8 NAD 83 MTM ZONE 9 (LAT. 45.392248; LONG. -75.732385)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 15, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES									
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
72.2	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
71.9							72				
71.7	(SP) Gravelly sand (FILL) Grey brown Moist		1	GRAB	-						
0.5	(SP) Sand (FILL) Compact Brown Moist		2	SS	17				○		
71.2											
71.0	(CL) Sandy silty clay, contains organic matter (FILL) Brown Moist						71				
1.3	(GP) Sandy gravel (FILL) Grey brown Moist										
	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No 17-510

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028354.4; E 364957.5 NAD 83 MTM ZONE 9 (LAT. 45.392554; LONG. -75.731694)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 10, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
71.9	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
71.5	(SP) Gravelly sand (FILL) Grey										
71.2	(SP) Sand (FILL) Brown										
0.7	(SM) Gravelly silty sand (FILL) Brown Moist		1	SS	50/0.13		71				
70.8	(SM/GM) Gravelly SILTY SAND, contains cobbles and boulders (TILL) Grey		2	SS	50/0.08		70				
1.1			3	SS	50/0.13		69				
68.8			4	SS	50/0.00						
3.1	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No 17-511

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028389.0; E 364941.0 NAD 83 MTM ZONE 9 (LAT. 45.392867; LONG. -75.731901)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 24, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR	SA	SI	CL
71.7	GROUND SURFACE													
0.0	ASPHALTIC CONCRETE													
71.3														
0.4	(SM) Sand, some silt (FILL) Brown Moist		1	GRAB	-		71		○		1	84	12	3
70.9			2	SS	50/0.05									
70.7	(SM) Gravelly silty sand (FILL) Dark brown-brown Moist													
1.0	END OF BOREHOLE AUGER REFUSAL													

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

GOLDER

RECORD OF BOREHOLE No 17-512

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028423.1; E 364995.9 NAD 83 MTM ZONE 9 (LAT. 45.393169; LONG. -75.731197)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 10, 2017

CHECKED BY KP

SOIL PROFILE: ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
71.4	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
0.2	(GP) Sandy gravel (FILL) Dense Grey Moist		1	SS	42		71				
70.8 / 0.6	(SM) Silty sand (FILL) Compact Grey brown Moist		2	SS	15				○		
69.9 / 1.5	(SM/ML) SILTY SAND, some clay, trace gravel (TILL) Loose to very loose Grey Wet		3	SS	4		70				
			4	SS	2		69		○		7 50 31 12
			5	SS	2		68		○		
67.6 / 3.8	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No 17-513

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028455.1; E 364977.1 NAD 83 MTM ZONE 9 (LAT. 45.393458; LONG. -75.731432)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 24, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
71.3	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
71.0							71				
70.8	(SP) Gravelly sand (FILL) Grey										
0.5	(SP) Sand (FILL) Brown Moist										
70.5											
0.8	(SM) SILTY SAND, some gravel, some clay, contains cobbles (TILL) Very loose to dense Grey brown Moist to wet		1	SS	16						
							70				
			2	SS	36				○		
							69				
			3	SS	2				○		
			4	SS	2		68		○		19 50 21 10
			5	SS	15						
67.2											
4.1	END OF BOREHOLE SAMPLER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No 17-514

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028480.3; E 365027.9 NAD 83 MTM ZONE 9 (LAT. 45.393681; LONG. -75.730781)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE July 30, 2017

CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L (WATER CONTENT (%) 25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
71.3	GROUND SURFACE							
0.0	ASPHALTIC CONCRETE							
71.1	(SP) Gravelly sand (FILL) Grey Moist	1A	GRAB	-	71			
70.8	(SM) Silty sand, trace gravel (FILL) Grey brown Moist	1B	GRAB	-				
70.5	(SM) Gravelly SILTY SAND, trace clay, contains cobbles (TILL) Compact to loose Wet	2	SS	27	70	○		
		3	SS	6				
		4	SS	16	69	○		23 49 20 8
		5	SS	8	68			
		6	SS	13	67	○		
66.6		7	SS	50/0.15				
4.7	END OF BOREHOLE AUGER REFUSAL							

0.8

NOTES:

1. Water level observed in well screen at a depth of 1.9 m below ground surface (Elev. 69.4 m), measured on October 16, 2017

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

GROUND WATER CONDITIONS

STRAT PLOT

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 17-515

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028526.6; E 365016.5 NAD 83 MTM ZONE 9 (LAT. 45.394099; LONG. -75.730921)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 15, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
71.5	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
71.2											
71.0	(SP) Gravelly sand (FILL) Grey Dry		1	GRAB	-						
0.5			2	GRAB	-		71				
70.7	(SM) Silty sand (FILL) Brown Moist										
0.8	(SM) Gravelly SILTY SAND, trace clay, contains cobbles (TILL) Very loose to dense Brown to grey Moist to wet		3	SS	13				○		
			4	SS	11		70				
			5	SS	3		69		○		
			6	SS	4				○		
							68				
			7	SS	19						
			8	SS	43		67		○		23 42 26 9
66.6											
4.9	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No 17-516

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028558.1; E 365070.2 NAD 83 MTM ZONE 9 (LAT. 45.394377; LONG. -75.730231)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE July 30, 2017

CHECKED BY KP

SOIL PROFILE: ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
72.1	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE						72				
0.2	PORTLAND CEMENT CONCRETE										
71.7	(SP) Gravelly sand (FILL) Grey Dry		1A	GRAB	-						
0.6			1B	GRAB	-						
	(SP) Sand (FILL) Brown Moist		2	SS	25		71				
			3	SS	21				○		
69.8							70				
2.3	(SM) Gravelly SILTY SAND, trace clay, contains cobbles (TILL) Loose to compact Grey brown to grey Moist to wet		4	SS	4				⊕		
			5	SS	4		69		○		20 47 24 9
			6	SS	19		68				
67.4			7	SS	50/0.08						
4.7	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No 17-517

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028595.5; E 365054.5 NAD 83 MTM ZONE 9 (LAT. 45.394715; LONG. -75.730427)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 25, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
72.5	GROUND SURFACE										
0.0 / 72.3	ASPHALTIC CONCRETE										
0.2 / 72.0	PORTLAND CEMENT CONCRETE										
0.6	(SP) Gravelly sand (FILL) Grey Moist										
	(SP) Sand, trace silt, contains cobbles and boulders (FILL) Compact Brown Moist		1	SS	65/0.30						
			2	SS	50/0.08		71				
			3	SS	28		70		○		
69.4											
3.1	(SP) Sand, trace silt, contains wood fragments (FILL) Compact to loose Brown Moist		4	SS	20		69				
			5	SS	8		68				
67.8			6	SS	50/0.13						
4.7	(SM/ML) SILTY SAND, trace gravel, contains cobbles and boulders (TILL) Compact Grey Wet						67				
			7	SS	27				○		8 57 31 4
66.1			8	SS	69/0.23						
6.4	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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RECORD OF BOREHOLE No 17-518

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028623.9; E 365107.4 NAD 83 MTM ZONE 9 (LAT. 45.394966; LONG. -75.729748)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE July 30, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
72.6	GROUND SURFACE										
0.0 / 72.4	ASPHALTIC CONCRETE										
72.1	(SP) Gravelly sand (FILL) Grey										
0.5 / 71.3	(SP) Sand, trace silt and gravel (FILL) Dense Brown Moist		1	SS	43		72		○		
1.3	(SM) Silty sand, some gravel, trace clay, contains cobbles (FILL) Dense to very loose Grey brown Moist		2	SS	50/0.20		71				
			3	SS	5		70				
			4	SS	30		69		○		16 57 20 7
			5	SS	13						
			6	SS	16		68				
			7	SS	4		67		○		
			8	SS	3		66				
65.7											
6.9	(SM/ML) SAND and SILT, trace clay (TILL) Compact Grey Wet		9	SS	25				○		1 55 38 6
			10	SS	26		65				
64.4											
8.2	END OF BOREHOLE										

NOTES:

1. Borehole dry upon completion of drilling.

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

GOLDER

RECORD OF BOREHOLE No 17-519

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028662.6; E 365090.3 NAD 83 MTM ZONE 9 (LAT. 45.395315; LONG. -75.729962)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 23, 2017

CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
73.8	GROUND SURFACE							
0.0 / 73.6	ASPHALTIC CONCRETE							
73.3	PORTLAND CEMENT CONCRETE							
73.1 / 0.7	(SP) Gravelly sand (FILL) Grey Moist							
72.7 / 1.1	(SP) Sand (FILL) Loose Brown Moist	1	SS	7				
72.4 / 1.4	(CL) Sandy silty clay, trace gravel (FILL) Stiff Grey brown Moist	2	SS	14				
	(SP-SM) Sand, trace silt, contains silty sand seams (FILL) Compact to loose Brown Moist to wet	3	SS	10		○		
		4	SS	12				
		5	SS	7		○		1 88 8 3
		6	SS	7				
		7	SS	10		○		
		8	SS	8				
67.2 / 6.6	(SM) Silty sand, trace gravel (FILL) Grey brown Moist	9	SS	50/0.10		○		
66.8 / 7.0	PORTLAND CEMENT CONCRETE							
	END OF BOREHOLE AUGER REFUSAL							

GROUND WATER CONDITIONS

ELEVATION SCALE: 73, 72, 71, 70, 69, 68, 67

$+^3, \times^3$: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

RECORD OF BOREHOLE No 17-520

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028704.6; E 365162.6 NAD 83 MTM ZONE 9 (LAT. 45.395687; LONG. -75.729032)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE July 31, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
73.3	GROUND SURFACE										
0.0 / 73.1	ASPHALTIC CONCRETE										
0.2 / 72.8	PORTLAND CEMENT CONCRETE						73				
	(SP) Gravelly sand (FILL) Grey										
0.6	(SP) Sand, trace gravel, contains organic matter (FILL) Compact Brown Moist		1	SS	15						
71.9							72				
1.4	(SM) Gravelly silty sand, contains organic matter and cobbles (FILL) Compact Brown Moist		2	SS	24				○		
			3	SS	23		71				
			4	SS	50/0.17		70				
			5	SS	25				○		
68.9							69				
4.4	(SM) Silty sand, trace gravel, contains organic matter and brick fragments (FILL)		6	SS	9						
68.0							68				
5.5	(CL/CI) Silty clay, trace sand (FILL) Stiff Grey brown Moist		7	SS	8						
	(SM) SILTY SAND, some gravel, contains silty clay and sand seams (TILL) Loose to very dense Grey brown Moist to wet		8	SS	50/0.25		67		○		
			9	SS	50/0.30						
			10	SS	60		66				
			11	SS	57				○		
65.1											
8.2	END OF BOREHOLE										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

GOLDER

RECORD OF BOREHOLE No 17-521

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028727.4; E 365133.4 NAD 83 MTM ZONE 9 (LAT. 45.395895; LONG. -75.729403)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 15, 2017

CHECKED BY KP

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.9	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
0.1	PORTLAND CEMENT CONCRETE										
74.3											
0.6	(SP) Gravelly sand (FILL) Grey		1	GRAB	-						
74.0											
0.9	(SP) Sand, trace silt (FILL) Compact Brown Moist		2	SS	23		74				
			3	SS	26		73		○		
			4	SS	22		72				
			5	SS	21						
			6	SS	20		71		○		0 95 4 1
			7	SS	11		70				
			8	SS	13		69				
			9	SS	13				○		
			10	SS	11		68				
			11	SS	15		67				
			12	SS	50/0.27						
66.0											
8.9	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No 17-522

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028753.7; E 365206.1 NAD 83 MTM ZONE 9 (LAT. 45.396125; LONG. -75.728471)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE July 31, 2017

CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L (WATER CONTENT (%) 25 50 75)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.0	GROUND SURFACE							
0.0 / 73.8	ASPHALTIC CONCRETE							
73.6	PORTLAND CEMENT CONCRETE							
0.4 / 73.2	(SP) Gravelly sand (FILL) Grey Dry	1	GRAB	-				
0.8 / 72.5	(SM) Silty sand, some gravel, contains silt seams (FILL) Compact Grey brown Moist	2	SS	14	73			
1.5 / 71.0	(SM) Silty sand, contains wood pieces, concrete fragments and clayey silt seams (FILL) Compact Moist	3	SS	11	72	○		
		4	SS	20	71			
3.0 / 69.4	(SM) Silty sand, some clay, contains cobbles (FILL) Dense Grey brown Moist	5	SS	38				
		6	SS	35	70	○		5 56 26 13
4.6 / 68.7	(ML) Sandy silt (FILL) Compact Grey Moist	7	SS	11	69			
5.3 / 67.9	(SM) Gravelly silty sand (FILL) Loose Brown Moist	8	SS	4	68			
67.7	(SM) Gravelly SILTY SAND (TILL)	9	SS	50/0.20		○		
6.3	END OF BOREHOLE AUGER REFUSAL							

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

GOLDER

RECORD OF BOREHOLE No 17-523

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028797.4; E 365198.5 NAD 83 MTM ZONE 9 (LAT. 45.396520; LONG. -75.728564)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 15, 2017

CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
75.9	GROUND SURFACE			
0.0 / 75.6	ASPHALTIC CONCRETE			
0.3 / 75.3	(SP) Gravelly sand (FILL) Grey Moist	1	GRAB	-
		2	GRAB	-
0.8	(SM) Sand, some silt (FILL) Brown Moist			
	(SM) Silty sand, contains silty clay seams (FILL) Compact Grey brown Moist	3	SS	21
1.5	(CL/SM) Silty clay to silty sand, some gravel (FILL) Compact Grey brown Moist	4	SS	18
2.3	(SP) Sand (FILL) Dense Brown Moist	5	SS	32
2.7	(CL) Silty clay, some sand, trace gravel (FILL) Stiff Grey brown Moist			
3.0	(SM/CL) Silty sand, some gravel, contains cobbles (FILL) Compact Grey brown Wet	6	SS	22
3.8	(SM) Silty sand, some gravel, contains clayey silt seams (FILL) Grey Moist	7	SS	81/0.30
4.3	END OF BOREHOLE AUGER REFUSAL			

NOTES:

1. Water level in well screen at a depth of 3.5 m below ground surface (Elev. 72.4 m), measured on October 19, 2017

GROUND WATER CONDITIONS

ELEVATION SCALE: 75, 74, 73, 72

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100)

SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED (20, 40, 60, 80, 100)

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

WATER CONTENT (%) (25, 50, 75)

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

RECORD OF BOREHOLE No 17-524

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028804.5; E 365252.7 NAD 83 MTM ZONE 9 (LAT. 45.396579; LONG. -75.727870)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE July 31, 2017

CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L (WATER CONTENT (%) 25 50 75)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
74.8	GROUND SURFACE										
0.0 / 74.6	ASPHALTIC CONCRETE										
0.2 / 74.2	(SP) Gravelly sand (FILL) Grey										
0.6 / 73.9	(SP) Sand (FILL) Brown Moist										
0.9	(SM) Gravelly silty sand, trace clay, contains organic matter, cobbles and asphalt pieces (FILL) Compact Brown Moist to wet	1	SS	13	74						
		2	SS	26	73						
		3	SS	27		○		24	44	23	9
		4	SS	22	72						
		5	SS	27	71						
70.4											
4.4	(SM) Silty sand, trace gravel, contains organic matter (FILL) Very loose Dark brown to black Moist	6	SS	2	70						
69.5											
5.3	(SM) Silty sand, trace gravel, contains organic matter, cobbles and boulders (FILL) Dense Dark brown to black Wet	7	SS	50/0.13	69						
68.7											
6.1	(SM) SILTY SAND (TILL) Compact Grey Moist	8	SS	25		○		4	69	24	3
68.1											
6.7	END OF BOREHOLE										

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

$+^3, \times^3$: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

RECORD OF BOREHOLE No 17-525

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028845.2; E 365250.3 NAD 83 MTM ZONE 9 (LAT. 45.396945; LONG. -75.727896)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 24, 2017

CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
76.2	GROUND SURFACE							
0.0	ASPHALTIC CONCRETE							
	PORTLAND CEMENT CONCRETE							
75.7	(SP) Gravelly sand (FILL) Grey Moist	1	GRAB	-				
0.5	(SM) Gravelly silty sand (FILL) Compact to very loose Brown Moist	2	SS	15				
		3	SS	15				
		4	SS	4				
		5	SS	24	20	43	24	13
		6	SS	13				
		7	SS	2				
68.6								
7.6	(GP) Sandy GRAVEL (TILL) Compact Grey Moist	8	SS	22				
68.0								
8.2	(SP) SAND, trace silt (TILL) Grey brown Moist	9	SS	77/0.28				
67.5								
8.7	END OF BOREHOLE							

NOTES:

1. Hole cannot continue due to auger out of alignment.

2. Borehole dry on completion of drilling.

GROUND WATER CONDITIONS

ELEVATION SCALE: 76, 75, 74, 73, 72, 71, 70, 69, 68

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED: 20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

WATER CONTENT (%): 25 50 75

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

$+^3, \times^3$: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 17-526

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028852.7; E 365313.8 NAD 83 MTM ZONE 9 (LAT. 45.397007; LONG. -75.727084)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE July 31, 2017

CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
75.2	GROUND SURFACE							
0.0 / 74.9	ASPHALTIC CONCRETE							
0.3 / 74.6	(SP) Gravelly sand (FILL) Grey	1A	GRAB	-				
0.6	(SP) Sand, some gravel (FILL) Compact to very dense Brown Moist	1B	GRAB	-				
		2	SS	32				
		3	SS	34				
		4	SS	34				
		5	SS	59				
		6	SS	13				
70.6								
4.6	(SP) Sand, some gravel (FILL) Very loose Brown Moist	7	SS	WH				
		8	SS	2				
69.1								
6.1	(SP) Sand, some gravel (FILL) Dense Brown Wet	9	SS	41				
68.3								
6.9	(ML) Sandy CLAYEY SILT, trace gravel (TILL) Firm Dark grey Wet	10	SS	WH	5	24	48	23
67.7								
7.5	END OF BOREHOLE							

NOTES:

1. Water level in well screen at a depth of 2.2 m below ground surface (Elev. 73.0 m), measured on October 16, 2017.

GROUND WATER CONDITIONS

ELEVATION SCALE: 75, 74, 73, 72, 71, 70, 69, 68

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED: 20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

WATER CONTENT (%): 25 50 75

UNIT WEIGHT γ kN/m³

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 17-527

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028884.4; E 365302.7 NAD 83 MTM ZONE 9 (LAT. 45.397293; LONG. -75.727221)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 24, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
75.8	GROUND SURFACE										
0.0 / 75.6	ASPHALTIC CONCRETE										
75.4	PORTLAND CEMENT CONCRETE										
0.4 / 75.1	(SP) Gravelly sand (FILL) Moist		1	GRAB	-						
0.7	(SP) Sand, some silt and gravel (FILL) Loose to compact Brown Moist		2	SS	11		75				
			3	SS	4		74				
							73				
			4	SS	18				○		
							72				
			5	SS	21		71				
			6	SS	6		70		○		
			7	SS	6		69				
68.5 / 7.3	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No 17-528

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028897.8; E 365380.6 NAD 83 MTM ZONE 9 (LAT. 45.397407; LONG. -75.726225)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 2, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
74.9	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
74.6											
74.3	(SP) Gravelly sand (FILL) Grey Moist		1	GRAB	-						
0.6	(SP) Sand, trace gravel (FILL) Brown Moist		2	GRAB	-						
73.9			3	SS	11		74				
1.0	(SM) Gravelly silty sand, contains organic matter (FILL) Compact Grey brown Moist		4	SS	24		73		o		
			5	SS	50/0.27		72				
71.8											
3.1	END OF BOREHOLE AUGER REFUSAL										

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No 17-528A

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028898.5; E 365381.8 NAD 83 MTM ZONE 9 (LAT. 45.397413; LONG. -75.726209)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY JM

DATUM Geodetic

DATE August 2, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P	w	w_L	γ kN/m³	GR SA SI CL
74.9	GROUND SURFACE												
0.0	ASPHALTIC CONCRETE												
74.6													
0.3	FILL Auger advanced to refusal without sampling. See Record of Borehole 17-528 for sampling record.						74 73 72						
71.6													
3.3	END OF BOREHOLE AUGER REFUSAL												

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: 20 40 60 80 100

WATER CONTENT (%): 25 50 75

$+^3, \times^3$: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

GOLDER

RECORD OF BOREHOLE No 17-528B

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028897.0; E 365379.6 NAD 83 MTM ZONE 9 (LAT. 45.397399; LONG. -75.726238)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY JM

DATUM Geodetic

DATE August 2, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	w_P	w	w_L	γ kN/m³	GR SA SI CL
74.9	GROUND SURFACE												
0.0	ASPHALTIC CONCRETE												
74.6													
0.3	FILL Auger advanced to refusal without sampling. See Record of Borehole 17-528 for sampling record.						74 73						
72.0							72						
2.9	END OF BOREHOLE AUGER REFUSAL												

WATER CONTENT (%): 25 50 75

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

GOLDER

RECORD OF BOREHOLE No 17-529

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028926.2; E 365364.4 NAD 83 MTM ZONE 9 (LAT. 45.397664; LONG. -75.726428)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 23-24, 2017

CHECKED BY KP

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.8	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
74.5											
74.3	(SP) Gravelly sand (FILL) Grey Moist										
74.1											
0.7	(SP) Sand (FILL) Brown Moist						74				
	(SM) Silty sand, some clay, trace gravel, contains concrete fragments and asphalt pieces (FILL) Compact to very dense Brown to dark brown Moist		1	SS	21						
			2	SS	29		73		○		9 48 29 14
			3	SS	56		72				
71.7											
3.1	(SM) Gravelly silty sand, contains asphalt and shale fragments, cobbles and boulders (FILL) Brown to dark brown Moist		4	SS	64/0.28						
			5	SS	66/0.28		71		○		
70.3											
4.5	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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RECORD OF BOREHOLE No 17-530

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028925.6; E 365446.0 NAD 83 MTM ZONE 9 (LAT. 45.397651; LONG. -75.725387)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 11, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
72.1	GROUND SURFACE										
0.0 / 71.9	ASPHALTIC CONCRETE						72				
0.2 / 71.5	PORTLAND CEMENT CONCRETE										
0.6	(SM) Silty sand, trace gravel, contains cobbles (FILL) Loose to dense Brown to grey Moist		1	SS	14		71				
			2	SS	9		70				
			3	SS	8				○		
			4	SS	50/0.13		69				
			5	SS	11		68				
67.7											
4.4	(SM) SILTY SAND, trace gravel, contains cobbles and boulders (TILL) Compact Grey Wet		6	SS	16		67				
			7	SS	17				○		
			8	SS	84/0.18		66				
			9	SS	11		65		○		
64.2			.28	SS	50/0.23						
7.9	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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RECORD OF BOREHOLE No 17-531

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028970.1; E 365429.6 NAD 83 MTM ZONE 9 (LAT. 45.398053; LONG. -75.725590)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 19, 2017

CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
73.2	GROUND SURFACE							
0.0	ASPHALTIC CONCRETE							
72.9	(SP) Gravelly sand (FILL) Grey Moist	A	GRAB	-				
72.7	(SP) Sand (FILL) Brown Moist	B	GRAB	-				
72.4	(SM) Silty sand Compact Brown Moist	1	SS	13				
0.8	(SM) Gravelly sand, some silt, trace clay, contains organic matter (FILL) Compact to very dense Brown to dark brown Moist	2	SS	37				
72.0		3	SS	16				
1.2		4	SS	21	21	54	18	7
		5	SS	54				
68.6	(SM) Silty sand, trace gravel, contains organic matter (FILL) Compact Brown to dark brown Moist	6	SS	12				
4.6		7	SS	19				
67.4	(SM) Silty sand, trace gravel, contains organic matter (TOPSOIL) Compact Dark brown to black							
6.0	(SM) Gravelly SILTY SAND (TILL) Loose to compact Brown to grey brown Moist to wet	8	SS	7				
		9	SS	11				
		10	SS	15				
65.0	END OF BOREHOLE							
8.2								

Elevation scale: 73, 72, 71, 70, 69, 68, 67, 66, 65

Dynamic cone penetration resistance plot: 20 40 60 80 100

Shear strength kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)

Plastic limit w_P — Natural moisture content w — Liquid limit w_L; Water content (%): 25 50 75

Unit weight γ kN/m³

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

GOLDER

RECORD OF BOREHOLE No 17-532

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5028969.7; E 365503.8 NAD 83 MTM ZONE 9 (LAT. 45.398043; LONG. -75.724642)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 11, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
71.6	GROUND SURFACE										
0.0 / 71.4	ASPHALTIC CONCRETE										
71.2	PORTLAND CEMENT CONCRETE										
0.5	(SP) Gravelly sand (FILL) Grey Moist						71				
70.6 / 1.0	(SM) Silty sand, trace gravel (FILL) Brown Moist		1	SS	19						
	(SM) Gravelly silty sand, contains asphalt pieces and brick fragments (FILL) Compact Brown Moist		2	SS	17		70		○		
69.4 / 2.2	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

RECORD OF BOREHOLE No 17-533

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029014.9; E 365495.7 NAD 83 MTM ZONE 9 (LAT. 45.398451; LONG. -75.724740)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 20, 2017

CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L (WATER CONTENT (%) 25 50 75)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
71.1	GROUND SURFACE				71			
0.0 / 70.9	ASPHALTIC CONCRETE							
0.2 / 70.6	(SP) Gravelly sand (FILL) Grey Moist	1	GRAB	-				
0.5 / 69.6	(SM) Silty sand, trace gravel (FILL) Compact Brown Moist	2	SS	13	70			
1.5 / 68.0	(SM) Sand, some gravel and silt, trace clay (FILL) Loose Grey brown Wet	3	SS	9	69			
		4	SS	4		○		19 57 17 7
3.1 / 65.9	Gravelly SILTY SAND (TILL) Very loose to loose Grey Wet	5	SS	2	68			
		6	SS	7	67			
		7	SS	6	66	○		
5.2	END OF BOREHOLE AUGER REFUSAL							

NOTES:

1. Water level in well screen at a depth of 3.8 m below ground surface (Elev. 67.3 m), measured on October 19, 2017.

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

$+^3, \times^3$: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

GOLDER

RECORD OF BOREHOLE No 17-534

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029022.8; E 365571.6 NAD 83 MTM ZONE 9 (LAT. 45.398515; LONG. -75.723770)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 11, 2017

CHECKED BY KP

SOIL PROFILE: ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
70.2	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
0.2	PORTLAND CEMENT CONCRETE						70				
69.6											
	(GP) Sandy gravel (FILL) Brown Moist										
0.7	(SM) Silty sand, some gravel, contains cobbles and boulders (FILL) Grey brown Moist		1	SS	65/0.20		69				
68.7											
1.5	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

GOLDER

RECORD OF BOREHOLE No 17-535

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029055.5; E 365555.1 NAD 83 MTM ZONE 9 (LAT. 45.398811; LONG. -75.723977)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 19, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	w_P	w	w_L	γ kN/m³	GR SA SI CL
70.3	GROUND SURFACE						70						
0.0 / 70.1	ASPHALTIC CONCRETE												
0.3 / 69.7	(SP) Gravelly sand (FILL) Grey Moist												
0.6 / 69.4	(SP) Sand (FILL) Brown Moist												
0.9 / 69.1	(SM) Silty sand, trace to some gravel (FILL) Brown Moist		1	SS	50/0.23				○				
1.2	END OF BOREHOLE AUGER REFUSAL												

WATER CONTENT (%) 25 50 75

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

GOLDER

RECORD OF BOREHOLE No 17-536

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029064.4; E 365629.8 NAD 83 MTM ZONE 9 (LAT. 45.398884; LONG. -75.723022)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 11, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P — w — w_L WATER CONTENT (%) (25 50 75)	γ kN/m³	GR SA SI CL
70.3	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
0.1	PORTLAND CEMENT CONCRETE										
69.9	(SP) Gravelly sand (FILL) Grey Moist		1	GRAB	-		70				
0.5	(SP) Sand (FILL) Brown Moist		2	SS	91/0.28				○		
69.4	(SM) Gravelly SILTY SAND (TILL) Brown Moist						69				
0.9											
68.8	END OF BOREHOLE AUGER REFUSAL										
1.5											

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

GOLDER

RECORD OF BOREHOLE No 17-537

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029105.1; E 365622.2 NAD 83 MTM ZONE 9 (LAT. 45.399251; LONG. -75.723114)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 20, 2017

CHECKED BY KP

SOIL PROFILE: ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
70.9	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
70.7	(SP) Gravelly sand (FILL) Grey Moist										
70.5 / 0.4	(SP/GP) Sand and gravel, trace silt, contains asphaltic concrete pieces (FILL) Compact Brown Moist		1	SS	16		70		○		38 53 6 3
69.3			2	SS	50/0.08						
1.6	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

RECORD OF BOREHOLE No 17-538

SHEET 1 OF 2

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029109.4; E 365696.9 NAD 83 MTM ZONE 9 (LAT. 45.399283; LONG. -75.722159)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 11, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES										
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
70.9	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
70.6											
70.4	(SP) Gravelly sand (FILL) Grey Moist										
0.5	(SP) Sand (FILL) Compact Brown Wet		1	SS	12		70				
69.1			2	SS	4		69				
1.8	(SM) Gravelly SILTY SAND, some clay, contains cobbles (TILL) Loose to dense Grey Wet		3	SS	18		68		○		
			4	SS	14		67				
			5	SS	16						
			6	SS	24	▼	66		○		21 46 23 10
			7	SS	24		65				
			8	SS	24		64				
			9	SS	10						
			10	SS	7		63				
			11	SS	24		62		○		
			12	SS	42		61				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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RECORD OF BOREHOLE No 17-538

SHEET 2 OF 2

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029109.4; E 365696.9 NAD 83 MTM ZONE 9 (LAT. 45.399283; LONG. -75.722159)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 11, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P	w	w_L	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---												
60.6			13	SS	58/0.28								
	Probable Weathered Bedrock												
10.5	END OF BOREHOLE AUGER REFUSAL												

NOTES:

1. Water level in well screen at 4.8 m below ground surface (Elev. 66.1 m), measured on October 18, 2017.

WATER CONTENT (%) 25 50 75

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 17-539

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029149.7; E 365761.9 NAD 83 MTM ZONE 9 (LAT. 45.399640; LONG. -75.721324)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 12, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
71.4	GROUND SURFACE										
0.0 / 71.2	ASPHALTIC CONCRETE										
0.2 / 70.7	(GP) Sandy gravel (FILL) Grey Moist		1	GRAB	-		71				
0.7 / 68.3	(SM) Sand, some silt, trace gravel and clay (FILL) Compact to loose Brown Moist		2	SS	23		70		○		9 65 19 7
			3	SS	15						
			4	SS	7		69				
3.1 / 66.3	(GP) Sandy GRAVEL, trace silt (TILL) Compact to very dense Grey brown Moist		5	SS	20		68				
			6	SS	35				○		
			7	SS	54		67				
5.1 / 64.3	(SM) SILTY SAND, some gravel, contains cobbles and boulders (TILL) Compact Grey brown Moist		8	SS	11		66		○		
			9	SS	28		65				
			10	SS	72/0.23						
7.1	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

GOLDER

RECORD OF BOREHOLE No 17-540

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029190.2; E 365830.7 NAD 83 MTM ZONE 9 (LAT. 45.399998; LONG. -75.720440)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 12, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
72.2	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
71.9							72				
71.7	(SP) Gravelly sand (FILL) Grey Moist										
0.5	(SM) Silty sand (FILL) Loose Brown Moist		1	SS	7						
							71				
			2	SS	6				○		
69.9							70				
2.3	(SP) Sand (FILL) Very loose to loose Brown Moist		3	SS	2						
			4	SS	2		69				
			5	SS	2				○		
							68				
			6	SS	2						
							67				
			7	SS	2						
			8	SS	7		66		○		
			9	SS	50/0.20						
							65				
64.7											
7.5	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

GOLDER

RECORD OF BOREHOLE No 17-541

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029228.0; E 365898.7 NAD 83 MTM ZONE 9 (LAT. 45.400333; LONG. -75.719567)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 12, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
73.9	GROUND SURFACE										
0.0 / 73.7	ASPHALTIC CONCRETE										
0.2 / 73.3	(SP) Gravelly sand (FILL) Grey Moist										
0.6 / 72.4	(SM) Silty sand, trace gravel (FILL) Loose Brown Moist		1	SS	8		73				
1.5 / 71.8	(CL/SM) Silty clay to silty sand (FILL) Loose Grey brown Moist		2	SS	8		72		○		
2.1 / 70.8	(SM) Silty sand, trace gravel (FILL) Compact Brown Moist		3	SS	10		71				
3.1	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

GOLDER

RECORD OF BOREHOLE No 17-542

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029265.5; E 365969.9 NAD 83 MTM ZONE 9 (LAT. 45.400664; LONG. -75.718654)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 2, 2017

CHECKED BY KP

ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.6	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
0.2	(SP) Gravelly sand (FILL) Grey Moist		1	GRAB	-						
75.1	(SM) Silty sand (FILL) Brown Moist		2	GRAB	-		75				
74.8	(Cl) Silty clay, some sand (FILL) Stiff Grey brown Moist		3	SS	6						
0.8			4	SS	6		74				
73.5	(SM) Silty sand, some gravel, contains cobbles (FILL) Loose to dense Grey brown Moist to wet		5	SS	26		73				
2.1			6	SS	20		72				
			7	SS	9						
			8	SS	13		71				
			9	SS	31		70				
69.5	(SM/ML) SAND and SILT, some clay, trace gravel (TILL) Dense Grey Moist		10	SS	31		69				5 44 37 14
68.9	END OF BOREHOLE										
6.7											

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

RECORD OF BOREHOLE No 17-543

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029300.2; E 366038.2 NAD 83 MTM ZONE 9 (LAT. 45.400970; LONG. -75.717777)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 2/3, 2017

CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L (WATER CONTENT (%) 25 50 75)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
76.6	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
76.2	PORTLAND CEMENT CONCRETE										
76.0	(SP) Gravelly sand (FILL) Grey Moist	1	GRAB	-							
0.6	(SM) Sand, some silt (FILL) Loose Brown Moist	2	SS	10	76						
75.4	(CL) Clayey silt and sand (FILL) Grey brown Moist	3	SS	9	75			0	36	35	29
		4	SS	5	74						
73.1		5	SS	2							
3.5	(SM) Gravelly silty sand, contains brick fragments and wood pieces (FILL) Compact Dark brown to brown Moist	6	SS	23	73						
71.4		7	SS	25	72						
5.2	END OF BOREHOLE AUGER REFUSAL										

NOTES:

1. Well screen dry on October 18, 2017.

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

$+^3, \times^3$: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

GOLDER

RECORD OF BOREHOLE No 17-544

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029333.7; E 366110.4 NAD 83 MTM ZONE 9 (LAT. 45.401266; LONG. -75.716851)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 3, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
76.9	GROUND SURFACE										
0.0 / 76.7	ASPHALTIC CONCRETE										
76.4	(SP) Gravelly sand (FILL) Grey Dry		1	GRAB	-						
0.5 / 76.1	(SP) Sand, trace clay (FILL) Brown Dry		2	GRAB	-						
0.8	(SM) Sand, some silt (FILL) Compact to dense Brown Moist		3	SS	18		76		○		
			4	SS	27		75				
			5	SS	11		74				
			6	SS	34				○		
73.2 / 3.7	(GM/SM) GRAVEL and SAND, some silt, trace clay, contains cobbles and clayey silt seams (TILL) Compact to very dense Grey brown Moist		7	SS	23		73				
			8	SS	79		72				
			9	SS	50/0.30				○		42 35 16 7
71.1 / 5.8	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 17-545

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029366.8; E 366185.0 NAD 83 MTM ZONE 9 (LAT. 45.401557; LONG. -75.715893)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 3, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
76.4	GROUND SURFACE										
0.0 / 76.1	ASPHALTIC CONCRETE										
0.3 / 75.8	(SP) Gravelly sand (FILL) Grey Dry		1	GRAB	-		76				
0.6			2	GRAB	-						
75.3	(SM) Sand, some silt (FILL) Compact Brown Dry		3	SS	11				○		
1.1 / 75.0	(CL/CI) Silty clay (FILL) Grey brown Moist						75				
1.4 / 74.3	(SP) Sand (FILL) Compact Brown Moist		4	SS	23						
2.1 / 73.5	(SM) Silty sand, contains clayey silt seams (FILL) Compact Grey Moist		5	SS	26		74				
2.9 / 72.7	(CH) Clay (FILL) Grey brown Stiff Moist		6	SS	11		73		⊢○⊣		
3.7 / 71.8	(SM) Silty sand, some gravel, contains cobbles and boulders (FILL) Very dense Grey Moist		7	SS	56		72				
4.6	(SM/ML) SAND and SILT, some clay, trace gravel, contains clayey silt seams, contains cobbles (TILL) Compact to very dense Grey brown Wet		8	SS	48						
			9	SS	22		71		○		
			10	SS	15		70				
			11	SS	52				○		
68.9							69				
7.5	END OF BOREHOLE										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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RECORD OF BOREHOLE No 17-546

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029396.3; E 366255.8 NAD 83 MTM ZONE 9 (LAT. 45.401816; LONG. -75.714986)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 7, 2017

CHECKED BY KP

ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	SAMPLES: NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.3	GROUND SURFACE								
0.0 / 75.1	ASPHALTIC CONCRETE								
0.2 / 74.8	(SP) Gravelly sand (FILL) Grey Moist	1	GRAB	-	75				
0.5 / 74.0	(SP) Sand, some gravel (FILL) Compact Brown Moist	2	SS	27			○		
1.3 / 73.2	(SM) Gravelly silty sand, contains organic matter (FILL) Compact Dark brown Moist	3	SS	23	74				
2.1 / 71.6	(SM) Silty sand, some gravel, contains organic matter (FILL) Compact Brown to dark brown Moist	4	SS	11	73				
		5	SS	24	72		○		
3.7 / 71.0	(CL) Clayey silt, trace sand (FILL) Firm Grey brown Moist	6	SS	6					
4.3 / 70.7	(ML) Sandy silt, some gravel, contains ash (FILL) Dark brown Moist to wet				71				
4.6	(SM) Gravelly SILTY SAND, contains cobbles and boulders (TILL) Dense to compact Grey brown Moist	7	SS	50/0.15					
		8	SS	30	70		○		
		9	SS	28	69				
68.0		10	SS	34			○		
7.3	END OF BOREHOLE				68				

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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RECORD OF BOREHOLE No 17-547

SHEET 1 OF 2

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029423.0; E 366329.4 NAD 83 MTM ZONE 9 (LAT. 45.402050; LONG. -75.714042)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 3, 2017

CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
73.3	GROUND SURFACE							
0.0	ASPHALTIC CONCRETE							
72.9	PORTLAND CEMENT CONCRETE							
0.5	(SP) Gravelly sand (FILL) Grey							
	(SP) Sand (FILL) Compact to loose Brown Moist	1	SS	15				
		2	SS	8				
71.2								
2.1	(SM) Gravelly silty sand, contains organic matter (FILL) Loose to very loose Grey brown Moist	3	SS	8				
		4	SS	3				
69.2		5	SS	6				
4.1	(SM) Gravelly silty sand, contains ash and wood fragments (FILL) Loose Dark brown Moist							
68.7								
4.6	(SM/ML) Sand and silt, some gravel, trace clay (FILL) Compact to very dense Grey brown Moist to wet	6	SS	20				
		7	SS	24	13	41	37	9
		8	SS	23				
		9	SS	56				
65.7								
7.6	(SM) Gravelly SILTY SAND, contains cobbles (TILL) Dense to compact Grey brown Wet	10	SS	34				
		11	SS	13				
63.8		12	SS	22				
9.5	(SP) SAND Very loose Grey brown Wet							

Columns: SOIL PROFILE (ELEV / DEPTH, DESCRIPTION, STRAT PLOT); SAMPLES (NUMBER, TYPE, "N" VALUES); GROUND WATER CONDITIONS; ELEVATION SCALE (73, 72, 71, 70, 69, 68, 67, 66, 65, 64); DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) (20 40 60 80 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) (25 50 75); UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%)

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 17-547

SHEET 2 OF 2

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029423.0; E 366329.4 NAD 83 MTM ZONE 9 (LAT. 45.402050; LONG. -75.714042)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 3, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
62.8	(SP) SAND Very loose Grey brown Wet		13	SS	2		63		○		
10.5 62.4	(SM) Gravelly SILTY SAND, contains cobbles and boulders (TILL) Grey Wet		14	SS	50/0.10						
10.9	END OF BOREHOLE AUGER REFUSAL										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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RECORD OF BOREHOLE No 17-548

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029446.1; E 366393.7 NAD 83 MTM ZONE 9 (LAT. 45.402252; LONG. -75.713217)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 7, 2017

CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
71.3	GROUND SURFACE								
0.0	ASPHALTIC CONCRETE								
71.0	PORTLAND CEMENT CONCRETE								
70.8	(SP) Gravelly sand (FILL) Grey Dry	1	GRAB	-					
70.5		2	GRAB	-					
0.8	(SP) Sand, some gravel (FILL) Dark brown Dry	3	SS	19					
	(SP) Sand (FILL) Compact to very loose Brown Moist	4	SS	17					
		5	SS	15					
		6	SS	10					
		7	SS	7					
		8	SS	5					
		9	SS	2		1	95	3	1
65.2									
6.1	(SP) Sand, contains wood fragments (FILL) Very loose Brown Moist	10	SS	2					
64.4									
6.9	(SP) Sand, some gravel (FILL) Loose Brown Moist	11	SS	5					
		12	SS	7					
62.7		13	SS	50/0.15					
8.6	END OF BOREHOLE AUGER REFUSAL								

NOTES:

1. Well screen dry on October 18, 2017.

SOIL PROFILE | STRAT PLOT | SAMPLES | GROUND WATER CONDITIONS | ELEVATION SCALE

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED: 20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

WATER CONTENT (%): 25 50 75

ELEVATION SCALE: 71, 70, 69, 68, 67, 66, 65, 64, 63

$+^3, \times^3$: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No 17-549

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029564.8; E 366660.4 NAD 83 MTM ZONE 9 (LAT. 45.403297; LONG. -75.709796)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 14, 2017

CHECKED BY KP

ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
67.2	GROUND SURFACE										
0.0 / 67.0	ASPHALTIC CONCRETE						67				
66.8	PORTLAND CEMENT CONCRETE										
66.5 / 0.7	(SP) Gravelly sand (FILL) Grey Moist		1	GRAB	-						
	(SP) Sand, trace gravel, trace silt (FILL) Dense to very dense Brown Moist		2	SS	49		66	○			
65.2			3	SS	58						
2.0	(SM) Silty sand, some gravel (FILL) Compact Brown Moist						65				
64.6			4	SS	20						
2.6	(CL) Clayey silt (FILL) Very stiff Grey brown Moist										
63.7			5	SS	20		64				
3.5	(SM) Gravelly silty sand (FILL) Brown Moist										
63.4											
63.2 / 4.0	(SM) Silty sand, trace to some gravel, contains asphaltic concrete pieces (FILL) Dark brown Moist		6	SS	WH		63				
	Void										
61.5							62				
5.7	END OF BOREHOLE										

NOTES:

1. Void encountered during drilling at a depth of 4.0 m.

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No 17-551

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029594.5; E 366761.2 NAD 83 MTM ZONE 9 (LAT. 45.403555; LONG. -75.708506)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 18, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
70.0	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
69.6	PORTLAND CEMENT CONCRETE										
0.4	(SP) Gravelly sand (FILL) Grey		1	GRAB	-						
69.2	Moist										
0.8	(SP) Sand, some silt (FILL) Very loose to compact Moist		2	SS	10		69				
			3	SS	3		68		○		
			4	SS	2						
			5	SS	7		67				
			6	SS	8		66				
			7	SS	18		65				
			8	SS	6				○		
63.8			9	SS	50/0.05		64				
6.2	END OF BOREHOLE AUGER REFUSAL										

NOTES:

1. Borehole dry on completion fo drilling.

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No 17-552

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029609.0; E 366813.3 NAD 83 MTM ZONE 9 (LAT. 45.403681; LONG. -75.707838)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 13, 2017

CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L (WATER CONTENT (%) 25 50 75)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
71.3	GROUND SURFACE							
0.0 / 71.0	ASPHALTIC CONCRETE							
0.3 / 70.7	(SP) Gravelly sand (FILL) Grey Moist				71			
0.6	(SM) Gravelly sand, some silt, contains wood fragments and cobbles (FILL) Compact Brown Moist	1	SS	22				
		2	SS	14	70	○		30 52 16 2
69.0 / 2.3	(SM) Silty sand, some gravel, contains organic matter, brick fragments (FILL) Loose to compact Brown Moist	3	SS	9	69			
		4	SS	10	68			
67.5 / 3.8	(SM) Gravelly silty sand, contains organic matter, concrete, cobbles and boulders (FILL) Compact Brown Moist to wet	5	SS	27	67	○		
		6	SS	50/0.25				
		7	SS	29	66			
65.2	PORTLAND CEMENT CONCRETE	8	SS	50/0.10		○		
6.2	END OF BOREHOLE AUGER REFUSAL							

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

NOTES:

1. Borehole dry upon completion of drilling.

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No 17-553

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029631.5; E 366886.6 NAD 83 MTM ZONE 9 (LAT. 45.403877; LONG. -75.706899)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 18, 2017

CHECKED BY KP

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
72.4	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
72.0	PORTLAND CEMENT CONCRETE										
0.4	(SP) Gravelly sand (FILL) Grey Moist		1	GRAB	-		72				
71.7 / 0.7	(SM) Sand, some silt, contains silty clay seams (FILL) Very loose to dense Brown Moist		2	SS	16						
			3	SS	9		71		○		
							70				
			4	SS	32		69				
			5	SS	13						
			6	SS	3		68		○		
			7	SS	4		67				
66.2			8	SS	50/0.13						
6.2	END OF BOREHOLE AUGER REFUSAL										

NOTES:

1. Borehole dry upon completion of drilling.

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No 17-554

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029647.1; E 366931.1 NAD 83 MTM ZONE 9 (LAT. 45.404013; LONG. -75.706329)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 18, 2017

CHECKED BY KP

SOIL PROFILE: ELEV / DEPTH	DESCRIPTION	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
72.9	GROUND SURFACE									
0.0 / 72.7	ASPHALTIC CONCRETE									
72.5	PORTLAND CEMENT CONCRETE									
0.5	(SP) Gravelly sand (FILL) Brown to grey brown									
	(SM) Sand, trace silt, contains silty clay seams (FILL) Compact to loose Brown Moist	1	SS	26		72				
		2	SS	13		71				
		3	SS	7						
		4	SS	16		70		○		0 90 8 2
		5	SS	18		69				
68.3 / 4.6	(SM) Silty sand, trace gravel, contains ash, metal, wood, ceramic, and organic matter (FILL) Loose Black Moist	6	SS	9		68				
67.6 / 5.3	(SM) Gravelly SAND, some silt, contains cobbles (TILL) Compact Grey brown to grey Moist to wet	7	SS	29		67		○		27 54 14 5
		8	SS	15						
66.1 / 6.8	END OF BOREHOLE AUGER REFUSAL									

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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RECORD OF BOREHOLE No 17-555

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029671.4; E 367001.9 NAD 83 MTM ZONE 9 (LAT. 45.404226; LONG. -75.705422)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 13, 2017

CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
73.6	GROUND SURFACE								
0.0 / 73.4	ASPHALTIC CONCRETE								
73.2	PORTLAND CEMENT CONCRETE								
0.4 / 72.9	(SP) Gravelly sand (FILL) Grey Moist	1	GRAB	-					
0.7	(SP) Sand, trace silt, contains organic matter and brick fragments (FILL) Compact to very dense Brown to dark brown Moist	2	SS	41	73	○			
		3	SS	44	72				
		4	SS	57	71				
		5	SS	21		○			
69.8 / 3.8	(SM) Gravelly silty sand, contains organic matter and sand seams (FILL) Loose to compact Brown to dark brown Moist to wet	6	SS	7	70				
		7	SS	21	69				
68.6 / 5.0	(SM) Gravelly SILTY SAND, contains cobbles and boulders (TILL) Compact Grey brown to grey Wet	8	SS	50/0.25	68	○			
67.9 / 5.7	END OF BOREHOLE AUGER REFUSAL								

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 17-556

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029701.1; E 367083.6 NAD 83 MTM ZONE 9 (LAT. 45.404485; LONG. -75.704374)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 13, 2017

CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
73.9	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
73.6	PORTLAND CEMENT CONCRETE										
0.5	(SM) Gravelly sand (FILL) Grey Dry		1	GRAB	-						
			2	GRAB	-						
	(SM) Sand, some silt (FILL) Dense to compact Dry		3	SS	37		73		○		
			4	SS	10		72				
71.2			5	SS	39				○		4 85 10 1
70.9	(SP) Gravelly sand (FILL) Grey brown Moist						71				
3.0	END OF BOREHOLE AUGER REFUSAL										

NOTES:

1. Borehole dry upon completion of drilling.

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

GOLDER

RECORD OF BOREHOLE No 17-557

SHEET 1 OF 1

METRIC

PROJECT 1655214-1500

G.W.P. 4173-15-00

LOCATION N 5029741.1; E 367138.6 NAD 83 MTM ZONE 9 (LAT. 45.404840; LONG. -75.703666)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE April 18, 2017

CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE
72.8	GROUND SURFACE				
0.0	(SM) Silty sand (TOPSOIL)				
0.2	Dark brown Moist	1	SS	7	
	(SP) Sand, trace silt, contains asphaltic concrete pieces (FILL) Loose to compact Dark grey Moist	2	SS	17	72
71.3					
1.5	(ML) Sandy silt (FILL) Dark grey Moist	3	SS	50/0.18	71
70.8					
2.0	END OF BOREHOLE AUGER REFUSAL				

NOTES:

1. Well screen dry on October 16, 2017.

SOIL PROFILE | STRAT PLOT | SAMPLES | GROUND WATER CONDITIONS | ELEVATION SCALE

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED: 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 25 50 75

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

$+^3, \times^3$: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\SPATIAL_IM\MTO\HWY417REHAB&WIDENING\02_DATA\GINT\1655214.GPJ GAL-GTA.GDT 12/3/19 JM

RECORD OF BOREHOLE No 19-1601

SHEET 1 OF 1

METRIC

PROJECT 1655214-1600

G.W.P. 4173-15-00

LOCATION N 5029516.4; E 366488.9 NAD 83 MTM ZONE 9 (LAT. 45.402876; LONG. -75.711993)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE August 1-2, 2019

CHECKED BY KCP

SOIL PROFILE: ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
68.9	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
68.5	PORTLAND CEMENT CONCRETE										
68.3	(SW) Gravelly sand (FILL) Grey Dry		1	GS	-						
0.6	(SW) Sand (FILL) Dense Brown Moist		2	SS	37		68				
67.1			3	SS	40		67				
1.8	(GM/SM) Gravel and sand, some silt, contains brick fragments (FILL) Compact Dark brown to black		4	SS	25				○		47 38 (15)
			5	SS	13		66				
			6	SS	13		65				
64.3											
4.6	(SM/GM) Gravelly sand, some silt and clay, contains seams of sandy silty clay, brick, mortar, ash, wood andcoal (FILL) Compact Dark brown to black Moist		7	SS	23		64		○		32 38 13 17
			8	SS	10		63				
			9	SS	22						
			10	SS	16		62				
			11	SS	24		61		○		24 44 21 11
60.7											
8.2	END OF BOREHOLE										

NOTE

1. Borehole dry upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

APPENDIX B

Laboratory Test Results, Current Investigation

Figure B1A – Grain Size Distribution Test Results – Section 1: Fill

Figure B1B – Grain Size Distribution Test Results – Section 1: Fill

Figure B2 – Grain Size Distribution Test Results – Section 1: Glacial Till

Figure B3 – Grain Size Distribution Test Results – Section 1: Glacial Till

Figure B4 – Plasticity Chart – Section 1: Glacial Till

Figure B5 – Grain Size Distribution Test Results – Section 2: Fill

Figure B6 – Plasticity Chart – Section 2: Clayey Silt to Clay Fill

Figure B7 – Grain Size Distribution Test Results – Section 2: Glacial Till

Figure B8 – Grain Size Distribution Test Results – Section 3: Fill

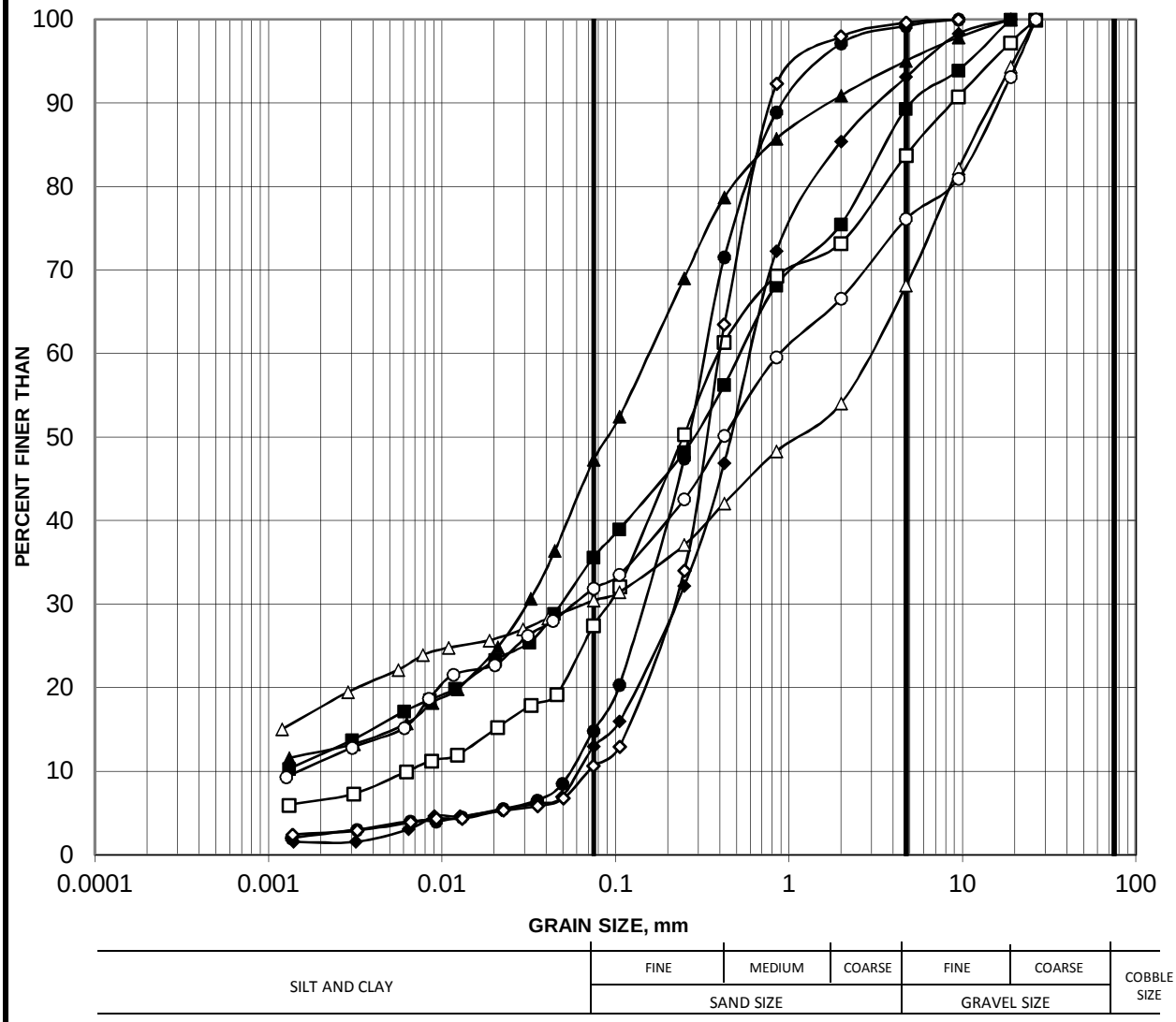
Figure B9 – Plasticity Chart – Section 3: Clayey Silt Fill

Figure B10 – Grain Size Distribution Test Results – Section 3: Glacial Till

GRAIN SIZE DISTRIBUTION

FIGURE B1A

SECTION 1: FILL



Borehole	Sample	Depth (m)
17-504	3	0.76-1.37
17-507	4	1.52-2.13
17-508	2	0.76-1.37
17-511	1	0.46-0.61
17-518	4	3.05-3.66
17-519	5	3.81-4.42
19-1601	7	4.57-5.18
19-1601	11	7.62-8.23

Project: 1655214 /1500

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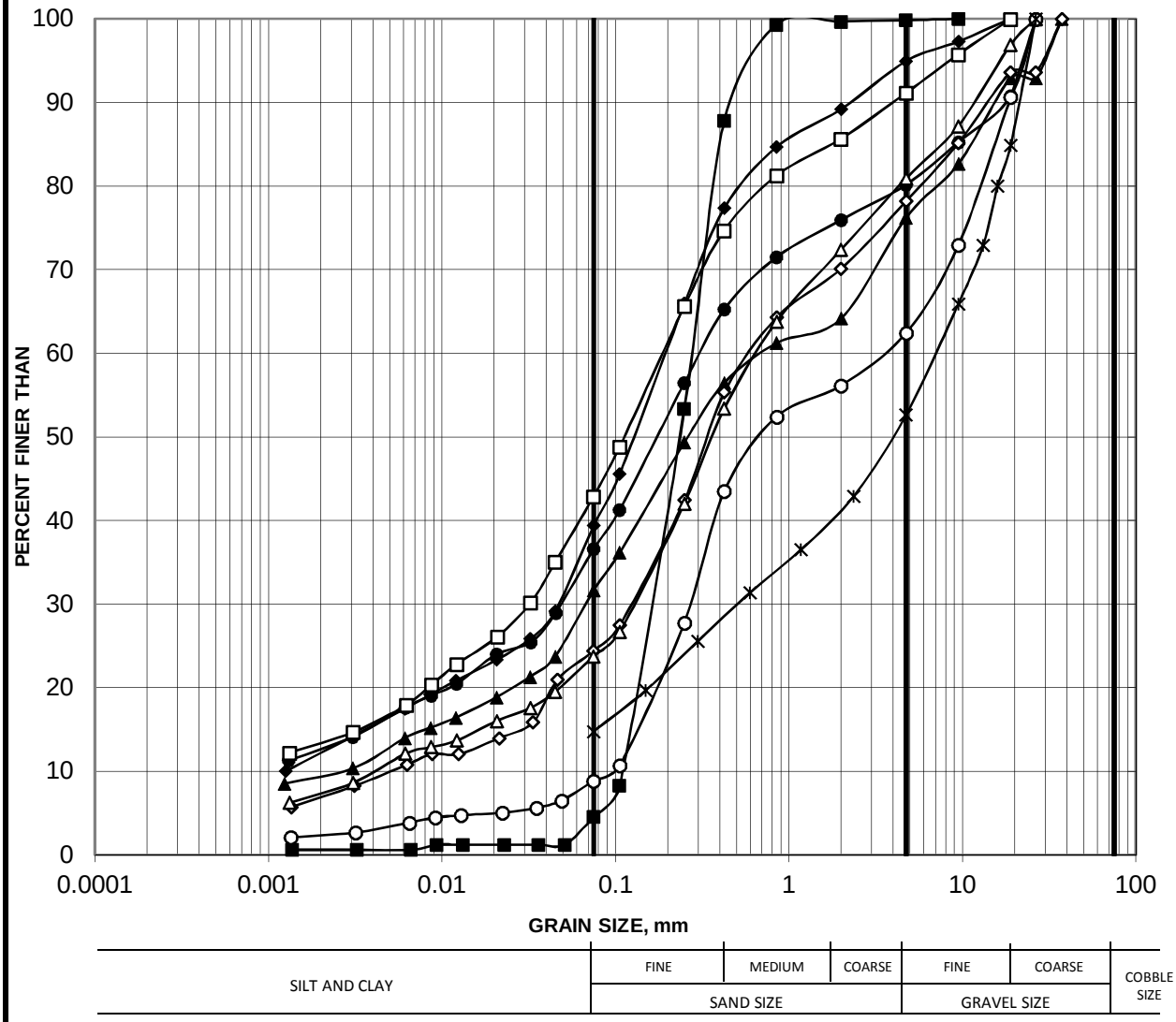
Created by: KP

Checked by: MI

GRAIN SIZE DISTRIBUTION	FIGURE B1B

SECTION 1: FILL



Borehole	Sample	Depth (m)
17-521	6	3.81-4.42
17-522	6	3.81-4.42
17-524	3	2.29-2.90
17-525	5	4.57-5.18
17-529	2	1.52-2.13
17-531	4	3.05-3.66
17-533	4	2.29-2.90
17-537	1	0.76-1.37
19-1601	4	2.29-2.90

Created by: KP
Checked by: MI

Project: 1655214 /1500

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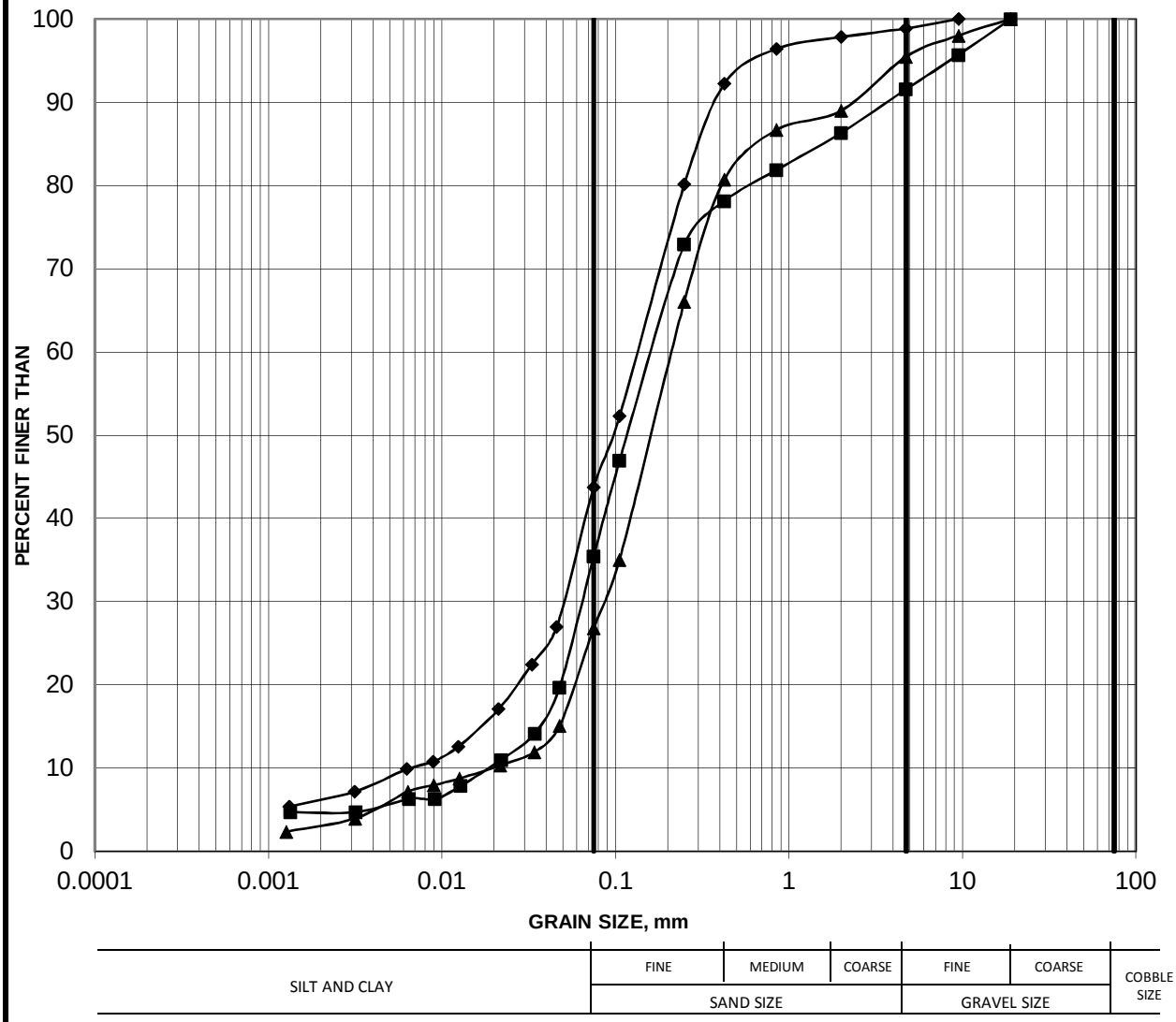
GRAIN SIZE DISTRIBUTION	FIGURE B2

SECTION 1: GLACIAL TILL



Borehole	Sample	Depth (m)
17-517	7	5.33-5.94
17-518	9	6.86-7.47
17-524	8	6.10-6.71

Project: 1655214 /1500

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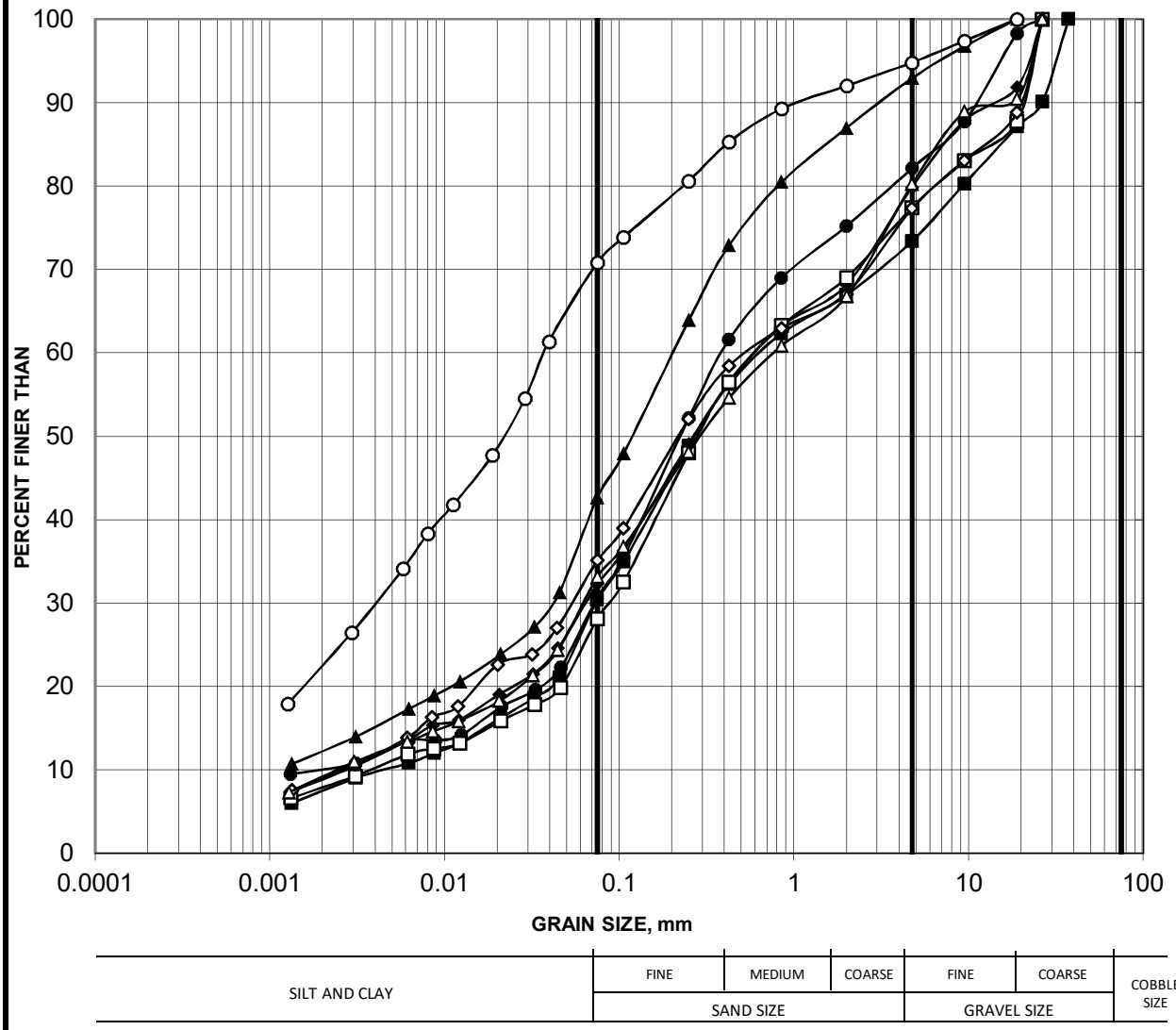
Created by: MI
Checked by: CW

GRAIN SIZE DISTRIBUTION	FIGURE B3

SECTION 1: GLACIAL TILL



Borehole	Sample	Depth (m)
17-503	9	6.10-6.71
17-504	9	5.33-5.94
17-512	4	2.29-2.90
17-513	4	3.05-3.66
17-514	4	1.52-2.13
17-515	8	4.57-5.18
17-516	5	3.05-3.66
17-526	10	6.86-7.47

Project: 1655214 /1500

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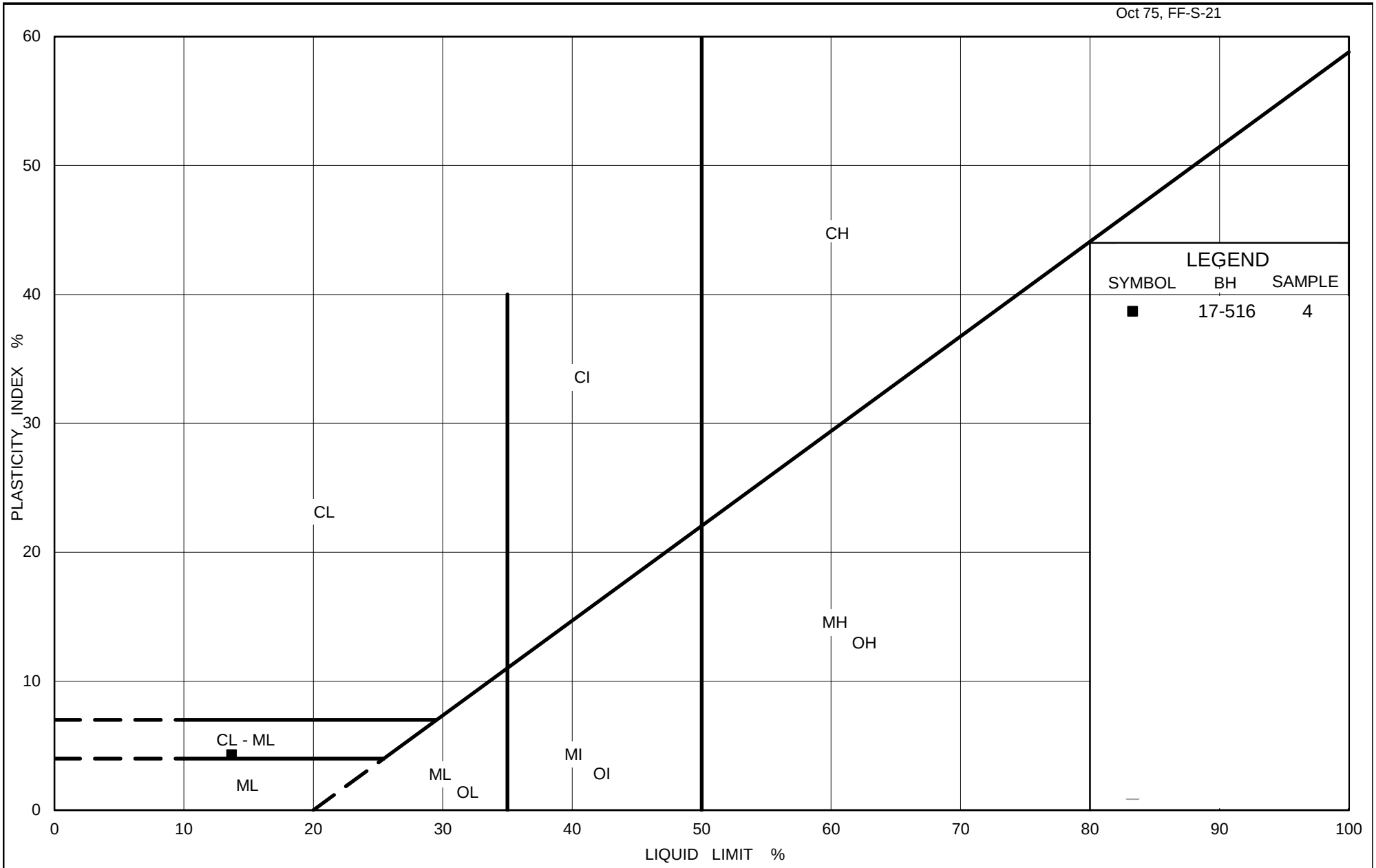
Created by: MI

Checked by: CW



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Ontario

PLASTICITY CHART
GLACIAL TILL

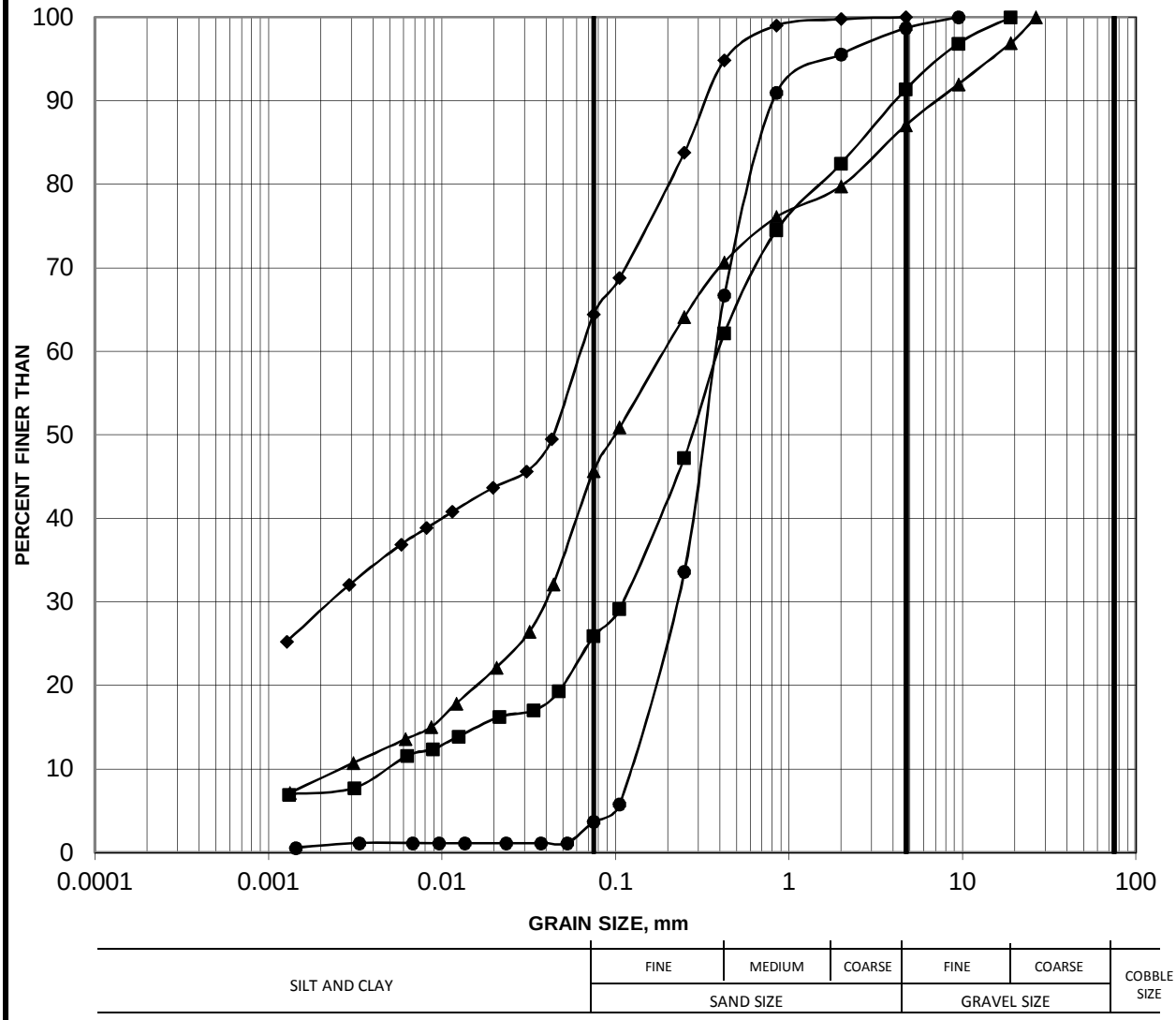
FIG No. B4

Project No. 1655214/1500

Compiled By : MI Checked By : CW

GRAIN SIZE DISTRIBUTION	FIGURE B5

SECTION 2: FILL



Borehole	Sample	Depth (m)
17-539	2	0.76-1.37
17-543	3	1.52-2.13
17-547	7	5.33-5.94
17-548	9	5.33-5.94

Project: 1655214 /1500

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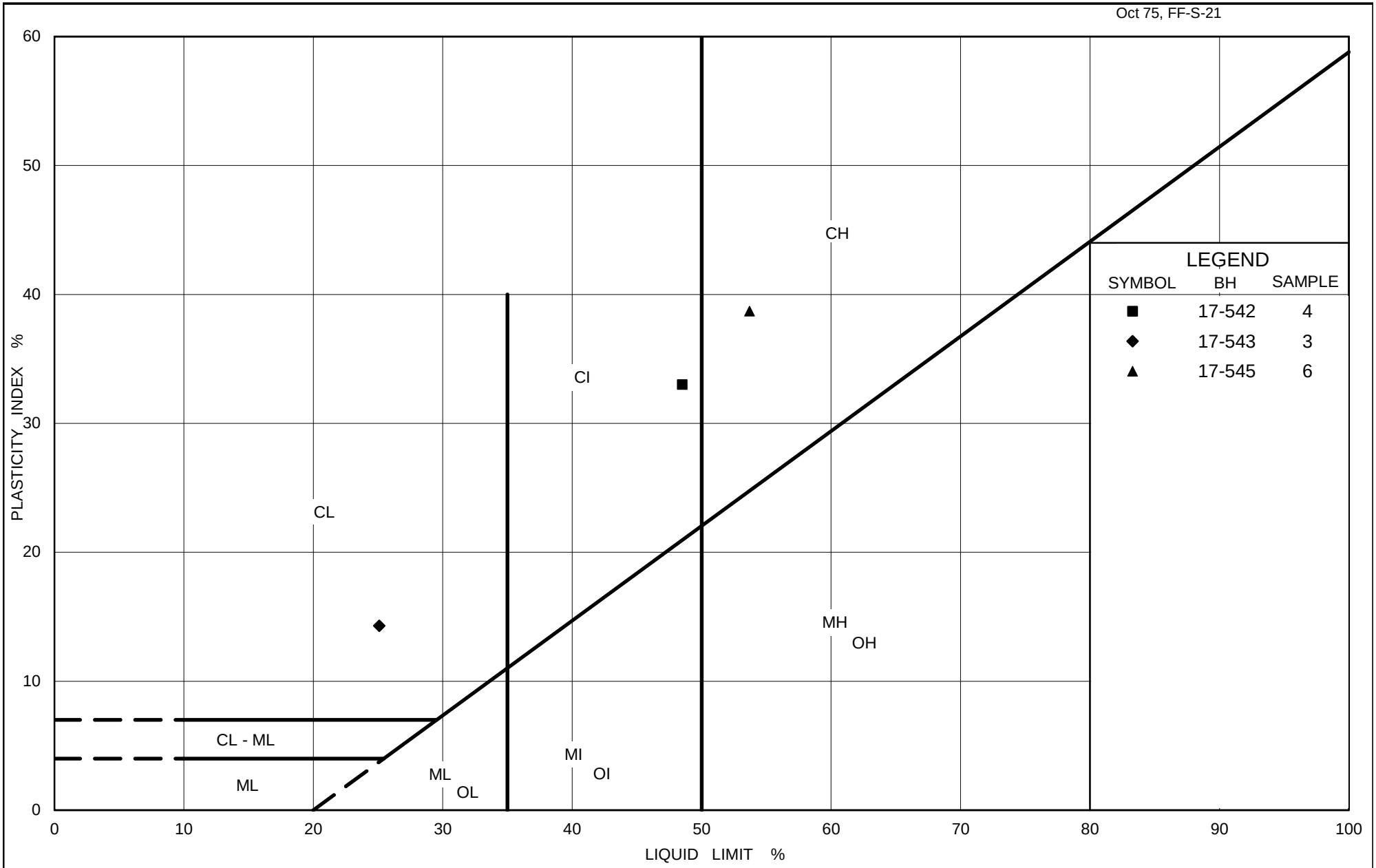
Created by: MI
Checked by: CW



Ministry of Transportation

Ontario

PLASTICITY CHART
CLAYEY SILT TO SILTY CLAY FILL

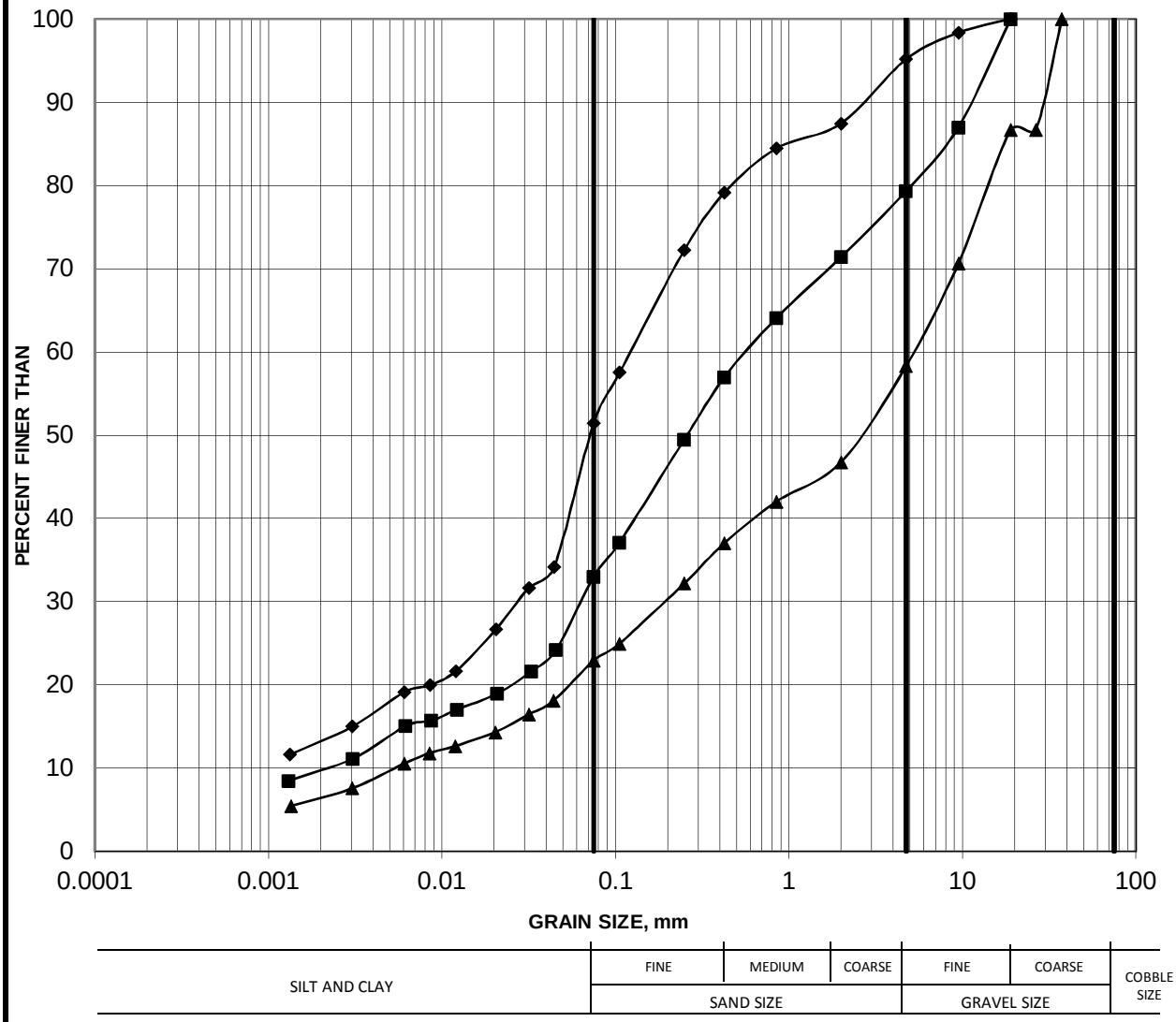
FIG No. B6

Project No. 1655214/1500

Compiled By : MI Checked By : CW

GRAIN SIZE DISTRIBUTION	FIGURE B7

SECTION 2: GLACIAL TILL



Borehole	Sample	Depth (m)
17-538	6	4.57-5.18
17-542	10	6.10-6.71
17-544	9	5.33-5.79

Project: 1655214 /1500

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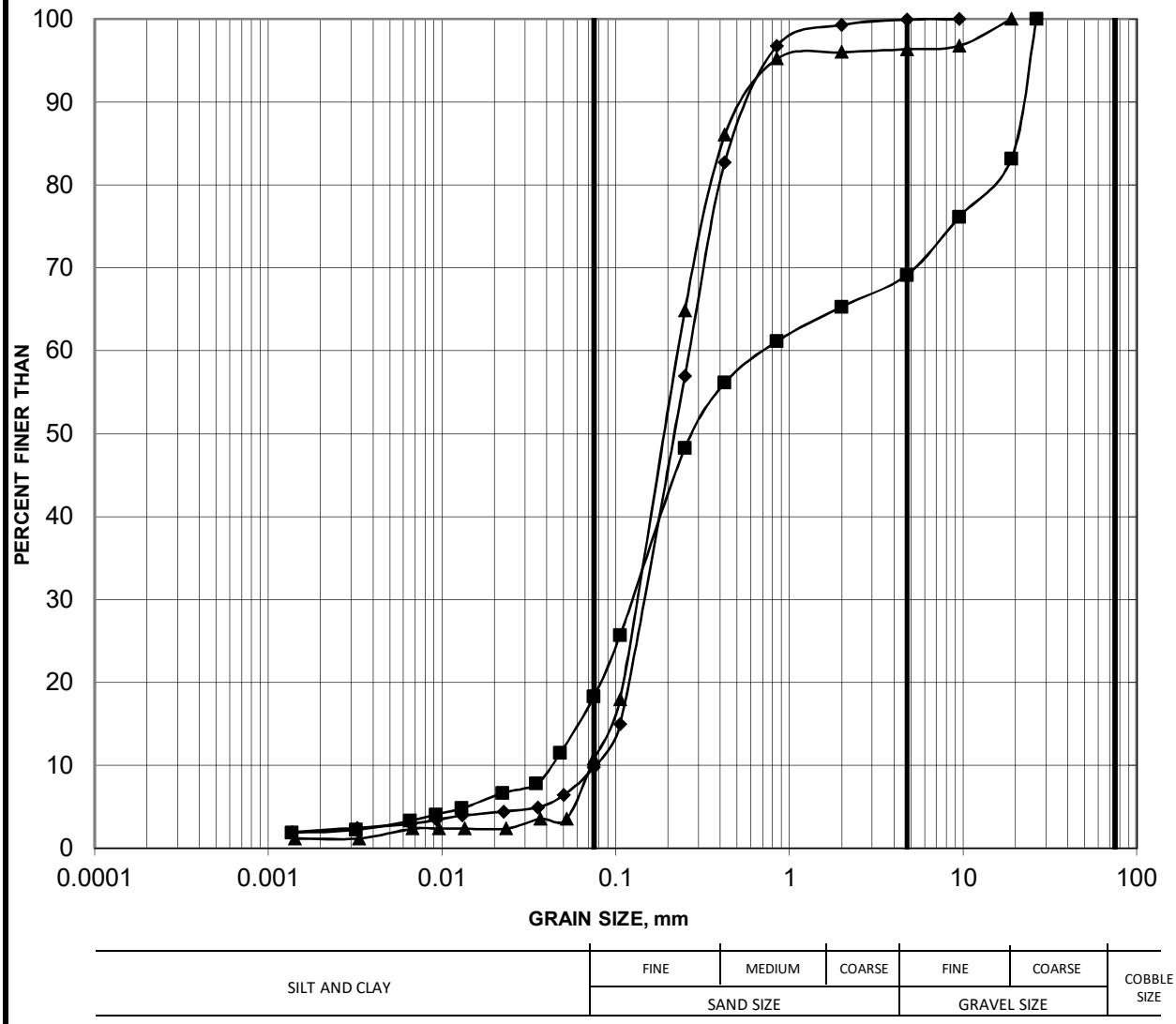
Created by: MI
Checked by: CW

GRAIN SIZE DISTRIBUTION	FIGURE B8

SECTION 3: FILL



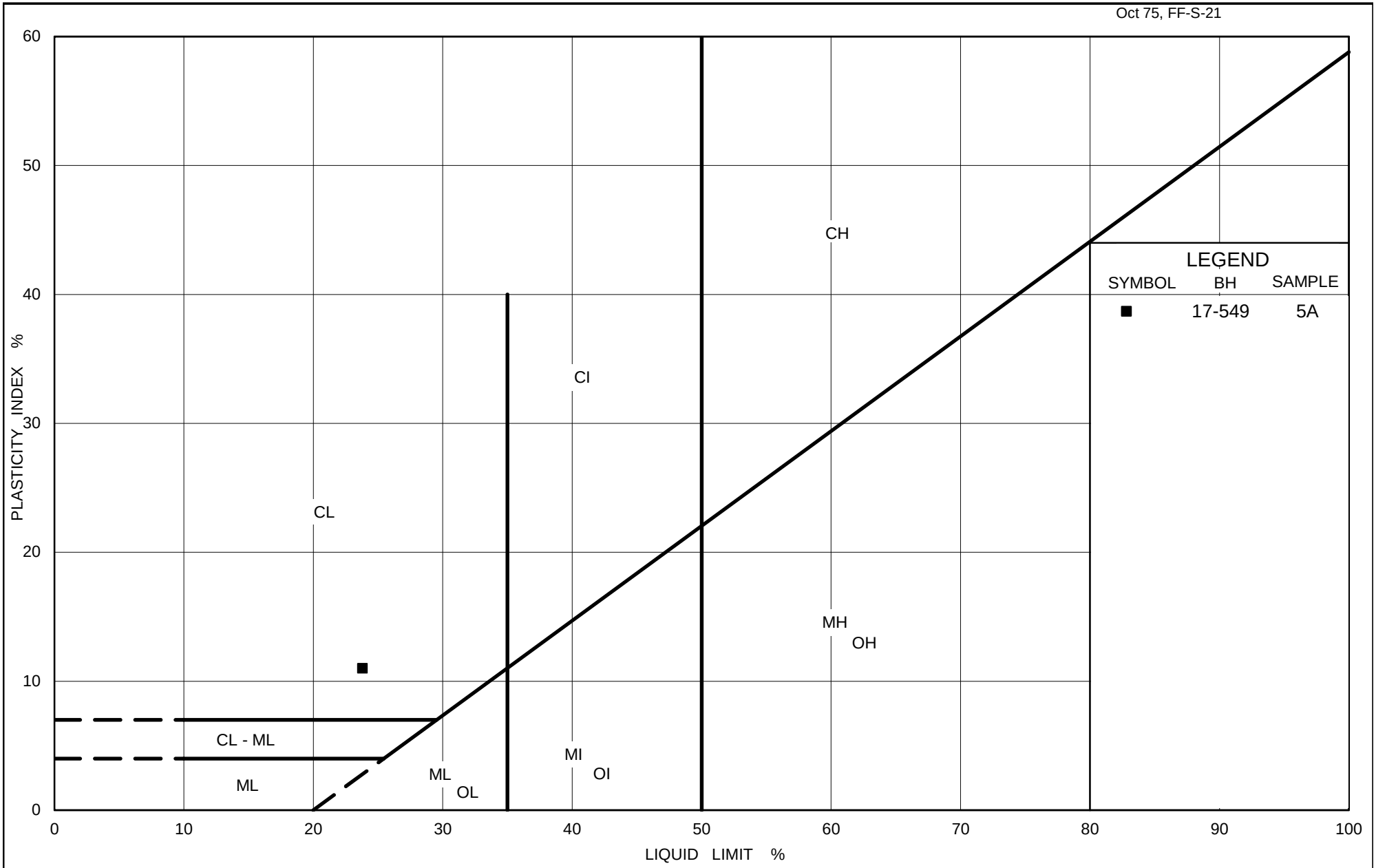
Borehole	Sample	Depth (m)
17-552	2	1.52-2.13
17-554	4	3.05-3.66
17-556	5	2.29-2.74

Project: 1655214 /1500

Golder Associates

Created by: MI

Checked by: CW



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Ontario

PLASTICITY CHART
FILL CLAYEY SILT

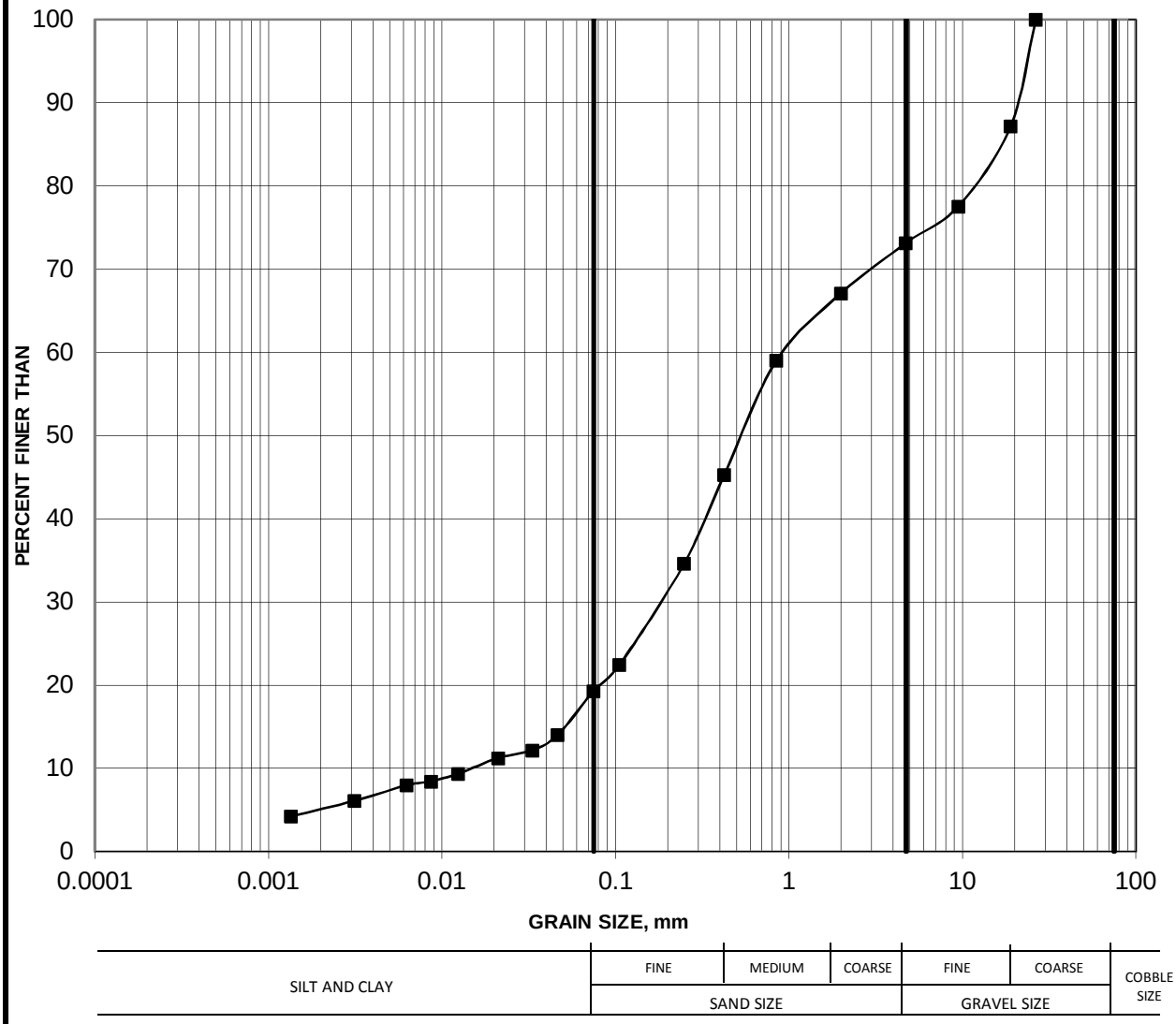
FIG No. B9

Project No. 1655214/1500

Compiled By : MI Checked By : CW

GRAIN SIZE DISTRIBUTION	FIGURE B10

SECTION 3: GLACIAL TILL



Borehole	Sample	Depth (m)
17-554	7	5.33-5.94

Project: 1655214 /1500

Golder Associates

Created by: MI
Checked by: CW

APPENDIX C

Results of Chemical Analysis

Maxxam Job Number B7O7573

Maxxam Job #: B7O7573
Report Date: 2017/11/09

Golder Associates Ltd
Client Project #: 1655214/1500
Sampler Initials: CM

RESULTS OF ANALYSES OF WATER

Maxxam ID		FMG077			FMG078		FMG079		FMG080		
Sampling Date		2017/10/19			2017/10/19		2017/10/19		2017/10/19		
COC Number		n/a			n/a		n/a		n/a		
	UNITS	**17-507A**	**RDL**	**QC Batch**	**17-514**	**RDL**	**17-523**	**RDL**	**17-526**	**RDL**	**QC Batch**
Calculated Parameters											
Resistivity	ohm-cm	750		5250327	160		58		160		5250327
Inorganics											
Conductivity	umho/cm	1300	1.0	5252193	6300	1.0	17000	1.0	6300	1.0	5252193
pH	pH	8.88		5252195	7.85		7.58		7.87		5252195
Dissolved Sulphate (SO4)	mg/L	45	1.0	5254040	130	1.0	220	1.0	120	1.0	5251398
Dissolved Chloride (Cl)	mg/L	140	2.0	5254037	1800	15	5500	50	1700	15	5251390

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		FMG081	FMG082		
Sampling Date		2017/10/19	2017/10/19		
COC Number		n/a	n/a		
	UNITS	**17-533**	**17-538**	**RDL**	**QC Batch**
Calculated Parameters					
Resistivity	ohm-cm	70	70		5250327
Inorganics					
Conductivity	umho/cm	14000	14000	1.0	5252193
pH	pH	7.89	7.88		5252195
Dissolved Sulphate (SO4)	mg/L	190	310	1.0	5251398
Dissolved Chloride (Cl)	mg/L	4400	4300	40	5251390

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam Analytics International Corporation o/a Maxxam Analytics 32 Colonnade Rd, Unit #1000, Nepean, ON K2E 7J6 Phone: 613 274-0573 Fax: 613 274-0574 Website: www.maxxam.ca

APPENDIX D

Non-Standard Special Provisions

Boulders/Obstructions During Excavation for Noise Barrier Wall Foundations

Control of Overburden Soils During Noise Barrier Wall Foundation Installation

Dowels into Rock

Noise Barrier System Special Provision - No. 760F01

BOULDERS/OBSTRUCTIONS DURING EXCAVATION FOR NOISE BARRIER WALL FOUNDATIONS – Item No.

Special Provision

The soils at the site are glacially-derived and should be expected to contain cobbles and boulders and the fill and glacial till may contain harder pieces / fragments, and / or slabs. Appropriate equipment and procedures will be required to penetrate obstructions (cobbles and boulders), hard pieces / fragments, and / or slabs that are encountered during excavation for noise barrier wall foundations.

Basis of Payment

Payment at the contract price for the above tender item shall include full compensation for all labour and materials to complete the work.

END OF SECTION

CONTROL OF OVERBURDEN SOILS DURING NOISE BARRIER WALL FOUNDATION INSTALLATION - Item No.

Special Provision

Excavations for the Noise Barrier Wall foundations will be advanced through granular fill materials (where present), various interlayers of granular native material through/into clayey silt till containing lenses or layers of potentially saturated cohesionless soils. The granular soils could slough (if dry) or flow (if water-bearing) into unsupported auger holes during caissons installation. Appropriate construction procedures and equipment will be required to minimize ground loss during drilling, caisson installation and concrete placement.

Basis of Payment

Payment at the lump sum contract price for this tender item shall be full compensation for all labour, equipment and materials for completion of the work.

END OF SECTION

DOWELS INTO ROCK - Item No.

Non-Standard Special Provision

1.0 Scope of Work

Where required at the piers, the Contractor shall provide dowels into the bedrock at the foundations for the spread footings founded on bedrock for the noise barrier walls.

2.0 Construction

Concrete shall be of the same strength as the footing concrete and placed in accordance with OPSS 904. All reinforcing steel supplied shall be in accordance with OPSS.PROV 1440 (dowel bars conforming to CAN/CSA G30.18, Grade 400).

Where dowels are to be placed in rock, hole shall be drilled to the required depth and size. Hole diameter shall be two times the nominal diameter of the dowel. Each hole shall be cleaned out, grouted and the dowel set in place. Grout shall be of the same strength as the footing concrete or at least 25 MPa at 28 days.

If hole contains water, the Contractor shall remove the water, otherwise a tremie procedure shall be used to completely fill the hole with grout. The dowel shall be forced into the hole after the grout has been placed and while it is still fresh.

3.0 Rock Dowel Testing

All proposed testing procedures shall be in general conformance with ASTM D3689-07, ASTM D1143-07 and ASTM D4435-08. Field testing must be carried out in the presence of, and the results reviewed and approved by, the Contract Administrator.

4.0 Performance Tests

Performance testing shall be carried out at two dowels at each foundation element to confirm that the design load of the rock dowels can be achieved. The Contract Administrator will select the rock dowels to be tested.

Performance test shall be by axial tensioning using a hydraulic jack with a capacity of at least 1.5 times the ultimate strength of the dowels.

Rock dowels shall be loaded and unloaded in 3 cycles and measurements of the displacement of the dowel shall be carried out at each load increment (step) in accordance with the following schedule:

Cycle-Step	1-1	1-2	1-3	2-1	2-2	2-3	2-4
% Design Load	50	75	25	50	75	100	25

Cycle-Step	3-1	3-2	3-3	3-4	3-5
% Design Load	50	75	100	110	25

The design load shall be taken as 360 kN for 35M dowels, 252 kN for 30M dowels, 180 kN, for 25M dowels, and 108 kN for 20M dowels.

Displacement measurements shall be carried out at each load increment using calibrated displacement

gauges capable of measuring movements of 0.0025 cm. Measurements shall be referenced to an independent fixed referenced pint.

Rock dowels which fail to meet the acceptance criteria shall be replaced at the Contractor's expense and re-tested. If a rock dowel fails, three (3) additional rock dowels shall be tested at the same abutment and pier footing as directed by the Contract Administrator.

Acceptance criteria for the rock dowels will be in accordance with the Post-Tensioning Institute (1985) as follows:

- The dowels are acceptable if the total elastic movement is greater than 80 percent of the theoretical elastic elongation of the free stressing and is less than the theoretical elongation of the free stressing length plus 50 percent of the bond length.

5.0 Basis of Payment

Payment at the lump sum contract price for this tender item shall be full compensation for all labour, equipment and materials for completion of the work.

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