November 2018

PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT

Middlesex Road 32 (Dorchester Road) E-N/S and N/S-W Ramps Highway 401 Interchange Improvements/ Structural Replacements GWP 3053-11-00, Assignment No. 2 (3011-E-0047) Ministry of Transportation, Ontario – West Region

Submitted to:
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REPORT

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PART A

PRELIMINARY FOUNDATION INVESTIGATION REPORT

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HIGHWAY 401 INTERCHANGE IMPROVEMENTS/STRUCTURAL REPLACEMENTS
GWP 3053-11-00, ASSIGNMENT No. 2 (3011-E-0047)
MINISTRY OF TRANSPORTATION, ONTARIO - WEST REGION

1.0 INTRODUCTION

Golder Associates Ltd. (Golder Associates) was retained by Dillon Consulting Limited (Dillon) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out foundation investigations as part of the preliminary design and 30% detailed design work for GWP 3030-11-00, 3054-11-00, 3053-11-00, 3070-11-00, 3059-11-00, and 3055-11-00. The project involves the preliminary design and 30% detailed design for ten (10) bridges and two (2) culverts, including improvements at five (5) interchanges, of Highway 401.

This report addresses the reconstruction/realignment of the Middlesex Road 32 (Dorchester Road) E-N/S and N/S-W ramps as part of GWP 3053-11-00.

The purpose of the foundation investigation is to explore the subsurface conditions at the location of the proposed ramp realignment by drilling boreholes and carrying out in situ testing and laboratory testing on selected samples. The terms of reference for the scope of work are outlined in Golder Associates' work plans 12-1132-0076-2001-CO2 dated November 7, 2016 and 12-1132-0076-2001-CO5 dated October 30, 2017. The work was carried out in accordance with our Quality Control Plan for Foundations Engineering dated November 2012.

2.0 SITE DESCRIPTION

2.1 General

The Highway 401 Middlesex Road 32 (Dorchester Road) Underpass is located south of the Village of Dorchester in the Municipality of Thames Centre, Ontario. The structure is located about 3.7 kilometres east and west of Westchester Bourne and Elgin Road, respectively. The location of the project is shown on the Key Plan, Figure 1.

For the purposes of this report, Highway 401 and Middlesex Road 32 are assumed to be oriented in an east-west direction and a north-south direction, respectively. This section of Highway 401 is currently a six lane divided highway oriented generally east northeast-west southwest. Highway 401 was constructed in a partial cut at this location. The highway surface is at approximate elevation 279 metres at the underpass location. Middlesex Road 32 has a pavement surface near elevation 285 metres. The existing underpass was constructed in 1955 and consists of a single span, concrete rigid frame structure with “tee” type girders. The area adjacent to the site consists of relatively flat-lying agricultural and commercial lands.

The Dorchester Swamp, a Class 1 Provincially Significant Wetland (PSW) regulated by the Upper Thames River Conservation Authority, is located to the east of the Dorchester Road Interchange. A drainage feature crosses Highway 401 at the east side of the interchange. The available topographic mapping indicates a small area of swamp south of the southeast quadrant.

2.2 Site Geology

This project lies within the physiographic region known as the Westminster Moraine. The physiographic mapping indicates that the Middlesex Road 32 Underpass site is situated on a till moraine.[1] Geological mapping indicates that the surficial material consists of the Erie Lobe of Port Stanley silty clay till and clayey silt till, in places covered by thin patches of lacustrine silt.[2]

The rock formation in the area of the site is described as medium brown, microcrystalline limestone of the Dundee Formation which belongs to the Hamilton Group of Middle Devonian Age.[3] The bedrock surface is estimated to be at about elevation 229 metres, some 50 metres below the approximate Highway 401 surface at the site.

[1] Chapman, L.J. and Putnam, D.F., 1984: The Physiography of Southern Ontario, Third Edition. Ontario Geological Survey, Special Volume 2.

[2] Dreimanis, A., 1963: Pleistocene Geology of the St. Thomas Area (East Half), Southern Ontario. Ontario Department of Mines, Preliminary Geological Map P.606, scale 1:50,000.

[3] Sanford, B.V., 1969: Geology, Toronto-Windsor Area, Ontario. Geological Survey of Canada, Map 1263A, scale 1:250,000.

3.0 INVESTIGATION PROCEDURES

The field work for the investigation was carried out between May 29 and June 6, 2017 and between December 15 and December 19, 2017 during which time twenty-seven boreholes were advanced at the approximate locations shown on the Borehole Location Plan, Drawing 1. The table below summarizes the borehole locations, ground surface elevations at the borehole locations and borehole depths.

Borehole	Location (m)		Ground Surface Elevation (m)	Depth (m)	Foundation Element	Location
	Northing	Easting				
BH-405	4,758,659	422,244	277.55	24.84	N/S-W Ramp	Toe
BH-406	4,758,678	422,306	274.41	7.32	N/S-W Ramp	Toe
BH-407	4,758,753	422,423	274.79	3.51	E-N/S Ramp	Shoulder
BH-408	4,758,732	422,476	270.70	4.27	E-N/S Ramp	Toe
BH-409	4,758,747	422,532	267.57	5.18	E-N/S Ramp	Toe
BH-410	4,758,745	422,582	267.25	4.42	E-N/S SCL	Shoulder
BH-411	4,758,765	422,630	265.41	3.51	E-N/S SCL	Toe
BH-412	4,758,765	422,683	264.42	5.03	E-N/S SCL	Shoulder
BH-413	4,758,791	422,729	260.83	5.03	E-N/S SCL	Beyond Toe
BH-414	4,758,803	422,852	262.92	12.80	E-N/S SCL	Existing
BH-415	4,758,827	422,915	260.94	11.13	E-N/S SCL	Beyond Toe
BH-416	4,758,830	422,978	262.70	11.28	E-N/S SCL	Shoulder
BH-417	4,758,758	422,226	285.04	1.55	N-W Ramp	Shoulder
BH-418	4,758,768	422,346	278.34	1.55	N/S-W Ramp	Toe
BH-419	4,758,794	422,224	284.36	1.55	E-N/S Ramp	Shoulder
BH-420	4,758,802	422,319	278.73	1.55	E-N/S Ramp	Toe
BH-421	4,758,754	422,630	265.96	5.03	E-N/S SCL	Shoulder
BH-422	4,758,773	422,737	263.74	8.08	E-N/S SCL	Existing
BH-423	4,758,784	422,775	263.43	9.60	E-N/S SCL	Shoulder
BH-424	4,758,788	422,805	263.38	10.36	E-N/S SCL	Existing
BH-425	4,758,791	422,804	263.34	8.08	E-N/S SCL	Shoulder
BH-426	4,758,801	422,802	260.30	7.32	E-N/S SCL	Beyond Toe
BH-427	4,758,810	422,852	260.68	8.08	E-N/S SCL	Shoulder

Borehole	Location (m)		Ground Surface Elevation (m)	Depth (m)	Foundation Element	Location
	Northing	Easting				
BH-428	4,758,812	422,851	260.48	8.08	E-N/S SCL	Beyond Toe
BH-429	4,758,817	422,940	263.07	9.60	E-N/S SCL	Existing
BH-430	4,758,821	422,940	262.84	8.08	E-N/S SCL	Shoulder
BH-431	4,758,831	422,937	260.79	7.32	E-N/S SCL	Beyond Toe

The investigation was carried out using truck- and track-mounted drilling equipment supplied and operated by a specialist drilling contractor. Samples of the overburden were obtained at generally 0.75- or 1.5-metre intervals of depth using 50-millimetre outside diameter split spoon sampling equipment in accordance with the standard penetration test procedures (ASTM D1586). The samplers limit the maximum particle size that can be sampled and tested to about 40 millimetres, therefore particles that may exist within the soils that are larger than this dimension will not be sampled or represented in the grain size distributions. Larger particle sizes, including cobbles and boulders are known to be present in the native till materials as discussed in the text of this report. The results of the standard penetration testing, as presented on the Record of Borehole sheets and in Section 4, are not factored to account for the use of an automatic hammer. In situ shear vane testing was performed in the softer cohesive and organic strata and these results are included on the Record of Borehole Sheets

The boreholes were terminated between about 1.6 to 24.8 metres below the existing pavement or ground surface. Groundwater conditions in the boreholes were observed throughout the drilling operations and a piezometer was installed in borehole 413 as indicated on the corresponding Record of Borehole sheet. The boreholes were backfilled in accordance with current MTO procedures and Ontario Regulation 903 (as amended).

The field work was monitored on a full-time basis by experienced Golder Associates staff members who also located the boreholes in the field, monitored the drilling, sampling and in situ testing operations and logged the boreholes. The samples were identified in the field, placed in labelled containers and transported to our London laboratory for further examination and testing. Index and classification tests, consisting of water content determinations, Atterberg limits determinations and grain size distribution analyses, were carried out on selected samples. The results of the laboratory testing are shown on the Record of Borehole sheets and in Appendix A.

4.0 SUBSURFACE CONDITIONS

4.1 Site Stratigraphy

The detailed subsurface soil and groundwater conditions encountered in the boreholes, together with the results of the in situ testing and the laboratory testing carried out on selected samples, are provided on the Record of Borehole sheets following the text of this report and in Appendix A. Inferred stratigraphic profiles and cross sections are shown on Drawings 2, 3 and 4. The stratigraphic boundaries shown on the Record of Borehole sheets and Drawings have been inferred from non-continuous samples and observations of drilling resistance and,

therefore, may represent transitions between soil types rather than exact planes of geological change. Further, the subsurface conditions will vary between and beyond the borehole locations. The locations and elevations of the boreholes, together with the interpreted stratigraphic profiles and cross sections, are shown on Drawings 1 to 4.

In general, the boreholes drilled in the western portion of the site encountered the existing pavement structure and fill overlying clayey silt till. The boreholes in the eastern portion of the site, generally along the existing speed change lane, encountered the existing pavement structure and significant thicknesses of fill underlain, in several areas, by varying thicknesses of organic silt and peat.

4.1.1 Pavement Structure

Thirteen boreholes were advanced through the existing speed change lanes, ramp lane and paved shoulders. Borehole 408 was drilled through the existing E-N/S ramp and encountered about 270 millimetres of asphalt and 0.6 metres of granular material. The boreholes drilled through the existing speed change lane encountered about 180 to 400 millimetres of asphalt and 0.4 to 1.8 metres of granular material. The boreholes drilled through the paved shoulders encountered about 90 to 150 millimetres of asphalt and 0.5 to 1.2 metres of granular material. Standard penetration testing carried out in the granular material indicated N values, as determined in the standard penetration testing, of 13 to greater than 100 blows per 0.3 metres.

4.1.2 Topsoil and Fill

Topsoil was encountered at the ground surface in nine boreholes. At the borehole locations, the surficial topsoil was about 0.1 to 0.4 metres thick.

Fill was encountered beneath the topsoil or pavement structure in ten boreholes. In two boreholes close to the existing structure, the fill was comprised of sand and gravel to sand and was about 0.6 to 1.2 metres thick. To the west of the existing ramp, the fill was variable and comprised of sand, silt or clayey silt. The fill was encountered between about elevation 261.4 and 262.7 metres. The fill was about 1.5 to 8.1 metres thick where fully penetrated, extending to about elevation 253.5 to 260.9 metres. Borehole 429 was terminated in the fill at about 9.6 metres depth or about elevation 253.5 metres. The very loose to dense fill had N values, ranging from the weight of the sampling hammer to 37 blows per 0.3 metres. Samples of the fill had water contents ranging from about 2 to 27 per cent. The cohesive fill materials had average plastic and liquid limits of about 16 and 28 per cent, respectively, based on seven Atterberg limits determinations. These data are shown on Figure A-11. Grain size distribution curves for samples of the fill are provided on Figure A-1.

Layers of buried topsoil about 0.8 and 0.4 metres thick were encountered beneath the fill in boreholes 422 and 425, respectively. Samples of the buried topsoil had water contents of about 27 to 31 per cent.

4.1.3 Peat and Organic Silt

Layers of very soft to firm peat were encountered in boreholes 415, 416, 424, 426, 427, 428, 430 and 431. The peat layers beneath the existing pavements were encountered between about elevation 256.4 and 258.7 metres and were about 0.2 to 0.8 metres thick. The peat beyond the highway platform was encountered between about elevation 260.3 and 261.0 metres and was about 0.9 to 4.4 metres thick. In borehole 424, the peat beneath the pavement and fill had an N value of 7 blows per 0.3 metres. Elsewhere, the peat had N values ranging from the weight of the sampling hammer to 3 blows per 0.3 metres. Samples of the peat had water contents ranging from about 6 to 469 per cent. The previous Geocres report for this area also noted a dry upper portion of the peat. Based on Geocres Report 40I14-118, the peat had an organic content ranging from about 19 to 85 per cent and undrained shear strengths of about 10 to 14 kilopascals.

Very soft to stiff organic silt was encountered in boreholes 414, 415, 416, 424, 425, 426, 427, 428 and 431. The organic silt layers beneath the highway platform were encountered between about elevation 253.5 and 258.2 metres and were about 0.4 to 0.8 metres thick. The organic silt beyond the highway platform was encountered between about elevation 256.3 and 259.4 metres. In the boreholes drilled through the platform, N values ranged from 1 to 15 blows per 0.3 metres. The organic silt beyond the platform had N values ranging from the weight of the sampling hammer to 3 blows per 0.3 metres. Samples of the organic silt had water contents ranging from about 46 to 218 per cent. In situ vane testing carried out as part of Geocres No. 40I14-118 indicated undrained shear strengths in the organic silt of about 6 to 29 kilopascals.

4.1.4 Granular Deposits

Granular materials, consisting of silt, sand and sand and gravel, were encountered in fourteen boreholes. In boreholes 405, 406, 409, 417 and 419, which were drilled west of the ramp bullnose, these layers were about 0.5 to 6.4 metres thick, where fully penetrated, and were encountered between about elevation 253.8 and 284.9 metres. Boreholes 405, 406, 417 and 419 were terminated in the granular deposits after exploring them for about 0.6 to 1.4 metres. The granular deposits in this area were very loose to very dense with N values ranging from 2 to greater than 100 blows per 0.3 metres with typical N values of over 50 blows per 0.3 metres and water contents ranging from about 8 to 27 per cent. In the ramp speed change lane area, these layers were about 0.3 to 2.5 metres thick, where fully penetrated, and were encountered between about elevation 252.6 and 258.3 metres. Seven boreholes were terminated in the granular deposits after exploring them for about 0.2 to 3.7 metres. The granular deposits adjacent to the speed change lane were very loose to compact and had N values ranging from the weight of the sampling rods to 31 blows per 0.3 metres with water contents of about 17 to 26 per cent. Grain size distribution curves for samples of the granular deposits are provided on Figures A-2 to A-6.

4.1.5 Cohesive Deposits

Very soft to very stiff cohesive deposits, consisting of silty clay and clayey silt, were encountered in fourteen boreholes between about elevation 254.0 and 278.6 metres. Where fully penetrated, the cohesive deposits were about 0.5 to 3.9 metres thick. Seven boreholes were terminated in the cohesive deposits after exploring them for about 0.6 to 2.0 metres. The cohesive deposits had N values ranging from the weight of the sampling hammer to 17 blows per 0.3 metres. Samples of the cohesive deposits had water contents ranging from about 18 to 55 per

cent. The cohesive deposits had average plastic and liquid limits of about 18 and 29 per cent, respectively, based on eleven Atterberg limits determinations. These data are provided on Figure A-12. Grain size distribution curves for samples obtained during the standard penetration testing are provided on Figures A-7 and A-8.

4.1.6 Glacial Till

Silty clay to clayey silt glacial till was encountered in nine boreholes between elevation 258.7 and 276.9 metres. Where fully penetrated, the glacial till layers were about 2.3 to 14.0 metres thick. Eight boreholes were terminated in the glacial till after exploring it for about 1.4 to 3.4 metres. The firm to hard glacial till had N values ranging from 6 to greater than 100 blows per 0.3 metres with water contents of about 14 to 23 per cent. The glacial till had average plastic and liquid limits of about 17 and 30 per cent, respectively, based on twelve Atterberg limits determinations. These data are provided on Figure A-13. Grain size distribution curves for samples of the glacial till obtained during the standard penetration testing are provided on Figure A-9 and A-10. Cobbles and boulders should be expected in the glacial till strata.

4.2 Groundwater Conditions

Groundwater conditions were observed in the boreholes during drilling and a piezometer was installed in borehole 413. The encountered and measured groundwater levels are summarized in the following table.

Borehole	Ground Surface Elevation (m)	Groundwater Elevation (m)	
		Encountered	Measured (June 19/17)
405	277.55	262.9	
406	274.41	Dry	
407	274.79	Dry	
408	270.70	Dry	
409	267.57	266.2	
410	267.25	Dry	
411	265.41	Dry	
412	264.42	Dry	
413	260.83	256.7	260.93
414	262.92	260.6	
415	260.94	260.7	
416	262.70	260.6, 256.2	
417	285.04	Dry	
418	278.34	Dry	

Borehole	Ground Surface Elevation (m)	Groundwater Elevation (m)	
		Encountered	Measured (June 19/17)
419	284.36	Dry	
420	278.73	Dry	
421	265.96	Dry	
422	263.74	Dry	
423	263.43	261.0	
424	263.38	256.8	
425	263.34	260.7	
426	260.30	Dry	
427	260.68	260.7	
428	260.48	260.5	
429	263.07	254.8	
430	262.84	261.0	
431	260.79	260.8	

The above-noted encountered water levels are not considered to be representative of the long-term, stabilized groundwater conditions. Based on the data above and our observations, the inferred groundwater level is considered to be coincident with the top of the peat deposits adjacent to the speed change lane at about elevation 261 metres. Groundwater levels should be expected to fluctuate seasonally and in response to significant precipitation events.

5.0 MISCELLANEOUS

This investigation was carried out using equipment supplied and operated by Lantech Drilling Services Inc. and Henderson Drilling Inc., both of which are Ontario Ministry of Environment and Climate Change licensed well contractors. The field operations were supervised by Mr. Matt Rhody and Mr. Lubomir Kosc, P. Eng. under the direction of Mr. Michael E. Beadle, P. Eng.

The laboratory testing was carried out at Golder Associates' London laboratory under the direction of Mr. Michael Arthur and Ms. Laura Pryla. The laboratory is an accredited participant in the MTO Soil and Aggregate Proficiency Program and is certified by the Canadian Council of Independent Laboratories for testing Types C and D aggregates. This report was prepared by Mr. Michael E. Beadle, P. Eng., an Associate with Golder Associates, and reviewed by Mr. Mark A. Swallow, P.E., P. Eng., a Principal with Golder Associates. Mr. Fintan J. Heffernan, P. Eng., the Designated MTO Contact and Quality Control Auditor for this assignment, conducted an independent quality review of the report.

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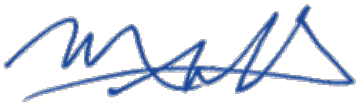
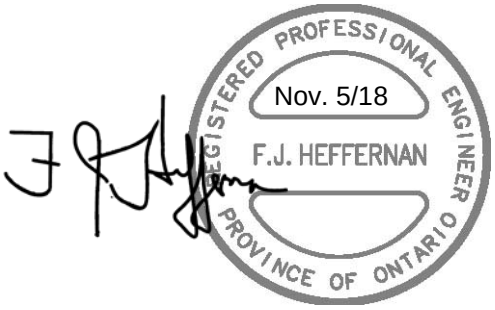
Michael E. Beadle, P. Eng.
Associate



Mark A. Swallow, P.E., P.Eng.
Principal and Senior Practice Leader



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

MEB/SJB/MAS/FJH/cr

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PART B

PRELIMINARY FOUNDATION DESIGN REPORT

MIDDLESEX ROAD 32 (DORCHESTER ROAD) E-N/S AND N/S-W RAMPS
HIGHWAY 401 INTERCHANGE IMPROVEMENTS/STRUCTURAL REPLACEMENTS
GWP 3053-11-00, ASSIGNMENT No. 2 (3011-E-0047)
MINISTRY OF TRANSPORTATION, ONTARIO - WEST REGION

6.0 ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides our recommendations on the foundation aspects of the design of the realignment of the E-N/S and N/S-W ramps at the Middlesex Road 32 (Dorchester Road) interchange on Highway 401. This Foundation Investigation and Design Report (FIDR), with the interpretation and recommendations, is intended for use of the Ministry of Transportation, Ontario (MTO) and shall not be used or relied upon for any other purposes, or by any other parties, including the construction or Design-Build Contractor. The Design-Build Contractor must make their own independent interpretation based on the factual data in Part A of the report. Where comments are made on construction, they are provided only to highlight those aspects which could affect the design of the project. Contractors must make their own independent interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

The currently proposed ramp alignments are shown in plan on Drawing 1 and in profile on Drawings 2 and 4. The new ramps will be up to about 8 metres in height above Highway 401. In addition, some minor modification of the E-N/S ramp speed change lane on Highway 401 will be required adjacent to the existing Dorchester swamp between about Station 14+100 and Station 14+600 (Highway 401 chainage). To the west, some minor cutting and slope regrading is required while, to the east, some minor filling (up to about 1.0 metres) north of the existing breakpoint is required.

6.2 New Ramp Alignments

The new ramps will be constructed in a combination of cut and fill. The general soil conditions in the areas where the new E-N/S and N/S-W ramps will be constructed generally consist of surficial topsoil or the existing pavement structure, fill materials and very stiff to hard clayey silt till. The N/S-W ramp will require cuts of up to about 4 metres and fills up to about 1.2 metres. The E-N/S ramp will require cuts up to about 2 metres and fills up to about 4 metres. The new ramp pavements will consist of a 4.75-metre wide lane with 2.5- and 1.0-metre wide paved shoulders. It is anticipated that a 1-metre wide gravel shoulder will be provided beyond the paved shoulders for a total width of about 9.3 metres. Based on the anticipated subgrade conditions, stability and settlement issues are not anticipated provided that all of the topsoil together with any organic, softened/loosened and/or deleterious materials are removed from within the embankment footprints prior to construction. Care will be required to carefully bench the new embankment fills into the existing embankment fills adjacent to Dorchester Road. For the purposes of this report, it has been assumed that the new embankments will be constructed using earth borrow that meets the requirements for select subgrade material (SSM).

Based on the MTO Embankment Settlement Criteria for Design, the total post-construction settlement of the pavement surface is to be less than 25 millimetres over a 20-year period. The settlements are expected to meet this criterion.

6.2.1 Subgrade Preparation

Following clearing and grubbing of the new alignment footprint, all unsuitable materials such as topsoil and organic materials, soft and/or loose soils and any deleterious fill materials should be subexcavated from the pavement/embankment limits. Clearing and grubbing should be carried out in accordance with Ontario Provincial Standard Specifications (OPSS) 201. The exposed subgrades should be proofrolled under the direction of qualified geotechnical personnel. Any poorly performing areas identified during proofrolling should be subexcavated and the area reinstated using SSM or Granular B Type III.

6.2.2 Embankment Construction

The embankment fill materials, where required, should consist of an approved granular material such as SSM. Depending on the prevailing weather conditions during construction, it may be necessary to place an initial 500-millimetre thick lift of Granular B Type III to create a working platform. The embankment fill materials should be placed in maximum 300-millimetre thick loose lifts and compacted. Where the new embankments meet the existing Dorchester Road approach embankments, the new embankment fill should be keyed into the existing fill in accordance with Ontario Provincial Standard Drawing (OPSD) 208.010. Following filling to subgrade level, the side slopes should be trimmed to an inclination of two horizontal to one vertical or flatter and promptly vegetated. All grading and embankment construction should be completed in accordance with OPSS 206. Compaction equipment should be used in accordance with OPSS PROV. 501. Since the embankments are expected to be less than 8 metres in height, mid-height benches are not required. Embankments constructed as indicated above are expected to have a factor of safety of greater than 1.3 against a deep seated rotational failure. Further, the total settlements under the full embankment heights are expected to be less than 25 millimetres.

6.2.3 Cut Slopes

Cuts of as much as 4 metres are expected in some areas. The cuts will be primarily in stiff to hard clayey silt till. Cobbles and boulders should be expected in the clayey silt till; therefore, an appropriate Non-Standard Special Provision (NSSP) should be included in the contract documents. Cut slopes should be constructed at an inclination of 2 horizontal to 1 vertical or flatter. All cut slopes should be provided with robust erosion protection until such time that vegetal cover has been established. The lands above the slope should be graded to reduce flows over the crest of the slope. Swales should be provided behind the crest of the slope that report to discreet, rock-lined channels down the slope to the roadside ditches. Since the cut slopes are expected to be less than 4 metres deep, mid-height benches are not required. Cut slopes constructed as indicated above are expected to have a factor of safety against a deep seated rotational failure of greater than 1.3.

6.3 Speed Change Lane Modifications

Some minor modification of the E-N/S ramp speed change lane on Highway 401 will be required adjacent to the existing Dorchester swamp between about Station 14+100 and Station 14+600 (Highway 401 chainage). To the west, some minor cutting and slope regrading is required while, to the east, some minor filling (up to about 1.0 metres) north of the existing breakpoint is required.

The results of the geotechnical investigation indicate that the existing lanes have been constructed on up to about 10 metres of granular and clayey fill which overlie generally thin layers of peat, organic silt and/or topsoil, all of which are underlain by loose to compact sand, loose silt or firm silty clay. Boreholes drilled beyond the existing platform encountered about 5 to 7 metres of very loose peat and organic silt overlying very loose sand, silt or silty sand and very soft clayey silt and silty clay. The modifications to the speed change lane will result in shallow cuts from about Station 0+655 to 0+690 to establish the new breakpoint and relatively shallow fills between about Station 0+690 and 0+785 for existing ditch slope flattening. This triangular wedge of fill is generally less than 1 metre thick and extends over lengths (transverse to the highway) of about 6 to 8 metres. From about Station 0+785 easterly, no significant modifications to the existing platform are proposed.

Given the modest filling that is required, it is recommended that nominally compacted Granular A be used to construct the slope flattening. Undoubtedly, some post construction movements of the Granular A will occur, but these are not expected to have any significant adverse effects on the adjacent pavements.

Should widening beyond that currently being contemplated be required, additional analyses should be completed to assess the effects of the work on the existing organic materials, highway platform fill and their behaviour during construction.

7.0 RECOMMENDATIONS FOR DETAIL DESIGN

The recommendations given in this Preliminary Foundation Design Report should be expanded upon and updated in the Foundation Design Report for detail design in accordance with MTO's standard requirements for foundation engineering assignments. Detailed recommendations should be provided for embankment construction and cut slopes. In addition, if staged construction is to be implemented, the need for additional cutting and filling or temporary detours should be addressed.

8.0 MISCELLANEOUS

This report was prepared by Mr. Michael E. Beadle, P.Eng. and reviewed by Mr. Mark A. Swallow, P.E., P.Eng.. Mr. Fintan J. Heffernan, P.Eng., the Designated MTO Contact and Quality Control Auditor for this assignment, conducted an independent quality review of the report.

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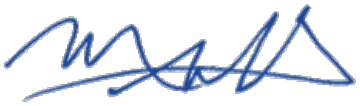

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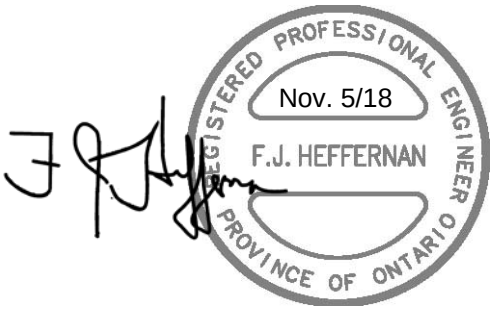

Fintan J. Heffernan, P.Eng.
MTO Designated Contact

MEB/SJB/MAS/FJH/cr

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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
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_3	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

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

* 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_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

	c_u, s_u kPa	c_u, s_u 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 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand

Golder Associates
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RECORD OF BOREHOLE No BH-405

1 OF 2

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST ____ HWY 401
DATUM GEODETIC
LOCATION N 4758658.5 , E 422243.5
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE May 30 - 31, 2017
ORIGINATED BY MR
COMPILED BY ZJB/LMK
CHECKED BY LW

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 (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
277.55	GROUND SURFACE										
0.05	TOPSOIL, sandy, Dark brown										
276.94	FILL, sand and gravel, some silt, with cobbles, Brown										
0.61	CLAYEY SILT TILL, trace to some sand, trace gravel, with cobbles between about elev. 272.0 to elev. 271.8m, and silt layers and lenses below about elev. 266.1m, Stiff to hard, Grey		1	SS	11		277				
			2	SS	14		276				
			3	SS	15		275				
			4	SS	89		274				
			5	SS	16		273				
			6	SS	14						1 9 55 35
			7	SS	62		272				
			8	SS	15		271				
			9	SS	16		270				
			10	SS	17						1 9 57 33
			11	SS	30		269				
			12	SS	15		268				
			13	SS	17		267				
			14	SS	17		266				
262.95						▽	265				
14.60							264				
							263				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-405

2 OF 2

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST HWY 401
DATUM GEODETIC
LOCATION N 4758658.5 , E 422243.5
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE May 30 - 31, 2017
ORIGINATED BY MR
COMPILED BY ZJB/LMK
CHECKED BY LM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "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 × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	SILTY FINE SAND, trace clay Compact to very dense Brown		15	SS	12		262				
			16	SS	64		261		○		0 60 38 2
			17	SS	92		260				
			18	SS	85		259				
256.55							258				
21.00	SAND AND GRAVEL, some silt Very dense Grey		19	SS	71		257		○		
256.05							256		○		
21.50	SILT, some clay Very dense Grey						255				
255.25											
22.30	SILTY SAND, trace clay Very dense Grey		20	SS	103		254		○		0 70 27 3
253.75											
23.80	SANDY SILT, trace clay, trace gravel Very dense Grey		21	SS	81		253		○		1 20 75 4
252.71											
24.84	END OF BOREHOLE Groundwater encountered at about elev. 262.9m during drilling on May 30, 2017.										

$+^3, \times^3$: Numbers refer to Sensitivity
$○^{3\%}$ STRAIN AT FAILURE

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-406

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST HWY 401
DATUM GEODETIC
LOCATION N 4758677.7 , E 422306.3
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE May 30, 2017
ORIGINATED BY MR
COMPILED BY ZJB/LMK
CHECKED BY LMK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
274.41	GROUND SURFACE										
0.00 / 274.00	TOPSOIL, sandy, Brown										
0.41	CLAYEY SILT TILL, some sand, trace gravel, Stiff to very stiff		1	SS	13		274				
			2	SS	14		273				
			3	SS	14		272				
			4	SS	20		271				2 11 56 33
			5	SS	16						
			6	SS	17		270				
269.21											
5.20	SILTY CLAY, trace sand, Stiff, Grey		7	SS	14		269				0 5 49 46
268.47											
5.94	SAND, fine to medium, trace silt, Very dense, Grey		8	SS	67		268				
267.70											
6.71	SAND AND GRAVEL, some silt, Very dense, Grey		9	SS	57						28 54 18 0
267.09											
7.32	END OF BOREHOLE Borehole dry during drilling on May 30, 2017.										

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

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

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London, Ontario

RECORD OF BOREHOLE No BH-407

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST ____ HWY 401
DATUM GEODETIC
LOCATION N 4758753.3 , E 422422.8
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE May 29, 2017
ORIGINATED BY MR
COMPILED BY ZJB/LMK
CHECKED BY LW

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
274.79	GROUND SURFACE										
0.09	TOPSOIL, silty, Dark brown										
	CLAYEY SILT TILL, some sand, trace gravel, Very stiff to hard, Brown		1	SS	16		274				
			2	SS	38		273				
			3	SS	59				○		1 19 47 33
			4	SS	51		272				
271.28											
3.51	END OF BOREHOLE Borehole dry during drilling on May 29, 2017										

$+^3, \times^3$: Numbers refer to Sensitivity
○ 3% STRAIN AT FAILURE

LDN_MTO_06 12-1132-0076-2001B.GPJ LDN_MTO.GDT 08/03/18

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RECORD OF BOREHOLE No BH-408

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST HWY 401
DATUM GEODETIC
LOCATION N 4758731.5 , E 422475.8
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE May 29, 2017
ORIGINATED BY MR
COMPILED BY ZJB/LMK
CHECKED BY LMK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
270.70	GROUND SURFACE										
0.00	ASPHALT										
0.27	FILL, sand and gravel, some silt Compact Brown										
269.79			1	SS	14		270		○		
0.91	CLAYEY SILT TILL, some sand, trace gravel Stiff to very stiff Brown turning grey at about elev. 268.3m		2	SS	24		269		○		
			3	SS	22		268		○		
			4	SS	18				⊢○⊣		1 10 51 38
266.43			5	SS	19		267				
4.27	END OF BOREHOLE Borehole dry during drilling on May 29, 2017										

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

○ 3% STRAIN AT FAILURE

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RECORD OF BOREHOLE No BH-409

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST HWY 401
DATUM GEODETIC

LOCATION N 4758746.9 , E 422532.1
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE May 29, 2017

ORIGINATED BY MR
COMPILED BY ZJB/LMK
CHECKED BY LW

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
267.57	GROUND SURFACE										
0.00	TOPSOIL, sandy, some gravel										
0.21	Dark brown FILL, silty sand, some topsoil Loose Brown		1	SS	9		267		○ at w		
266.20						▽					
1.37	SAND, fine to medium, some silt, trace clay Very loose Brown		2	SS	2		266		○ at w		0 80 15 5
265.44											
2.13	CLAYEY SILT TILL, some sand, trace gravel Hard Brown turning grey at about elev. 263.9m		3	SS	34		265				
			4	SS	37		264				
			5	SS	36						
			6	SS	32		263		⊢●⊣ at w		2 15 48 35
262.39											
5.18	END OF BOREHOLE Groundwater encountered at about elev. 266.2m during drilling on May 29, 2017										

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

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

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London, Ontario

RECORD OF BOREHOLE No BH-410

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST HWY 401
DATUM GEODETIC
LOCATION N 4758745.0 , E 422581.8
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE May 29, 2017
ORIGINATED BY MR
COMPILED BY ZJB/LMK
CHECKED BY LW

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
267.25	GROUND SURFACE										
0.00	ASPHALT										
0.24	FILL, sand and gravel, trace silt Very dense Brown		1	SS	57		267		○		
265.88							266				
1.37	CLAYEY SILT TILL, some sand, trace gravel Hard to very stiff Brown turning grey at about elev. 263.6m		2	SS	45				○		
			3	SS	51		265				
			4	SS	36		264				
			5	SS	24		263		⊢—⊣		0 11 53 36
262.83											
4.42	END OF BOREHOLE Borehole dry during drilling on May 29, 2017										

$+^3$, $\times^3$: Numbers refer to Sensitivity
$\circ^{3\%}$ STRAIN AT FAILURE

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RECORD OF BOREHOLE No BH-411

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST ____ HWY 401
DATUM GEODETIC
LOCATION N 4758764.9 , E 422629.5
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE May 29, 2017
ORIGINATED BY MR
COMPILED BY ZJB/LMK
CHECKED BY LW

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
265.41	GROUND SURFACE										
0.00	TOPSOIL, clayey										
0.15	Brown CLAYEY SILT TILL, some sand, trace gravel Hard Brown		1	SS	47		265		○ at 20		0 12 50 38
			2	SS	46		264				
			3	SS	41		263				
261.90			4	SS	32		262				
3.51	END OF BOREHOLE Borehole dry during drilling on May 29, 2017										

+ 3, × 3: Numbers refer to Sensitivity
○ 3% STRAIN AT FAILURE

LDN_MTO_06 12-1132-0076-2001B.GPJ LDN_MTO.GDT 08/03/18

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London, Ontario

RECORD OF BOREHOLE No BH-412

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST HWY 401
DATUM GEODETIC

LOCATION N 4758765.1 , E 422682.5
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE June 5, 2017

ORIGINATED BY MR
COMPILED BY ZJB/LMK
CHECKED BY LW

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
264.42	GROUND SURFACE										
0.00	ASPHALT										
0.21	FILL, sand and gravel, some silt Very dense Brown		1	SS	52		264		○		
263.05											
1.37	SILTY CLAY TILL, some sand Very stiff to hard Brown		2	SS	27		263				
			3	SS	42		262		○——42		0 14 44 42
			4	SS	36						
260.76							261				
3.66	CLAYEY SILT TILL, some sand Very stiff Brown turning grey at about elev. 259.7m		5	SS	26				○——		0 10 54 36
							260				
259.39			6	SS	25						
5.03	END OF BOREHOLE Borehole dry during drilling on June 5, 2017										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-413

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST HWY 401
DATUM GEODETIC
LOCATION N 4758790.7 , E 422729.4
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE June 6, 2017
ORIGINATED BY MR
COMPILED BY ZJB/LMK
CHECKED BY LW

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
260.83	GROUND SURFACE										
0.00	TOPSOIL, clayey										
0.18	Brown SILTY CLAY, some sand Stiff to very stiff Grey to brown, turning grey at about elev. 257.9m		1	SS	12		260				
			2	SS	18		259				
			3	SS	15				ϕ		0 11 44 45
			4	SS	16		258				
256.71			5	SS	14		257		○		
4.12	SILT, some gravel Compact Grey										
4.42	SILTY FINE SAND Loose Grey		6	SS	9						
255.80											
5.03	END OF BOREHOLE Groundwater encountered at about elev. 256.7m during drilling on June 6, 2017. Water level measured at about elev. 258.64m in standpipe on June 6, 2017. Water level measured at about elev. 260.93m in standpipe on June 19, 2017.										

Granular bentonite
Filter sand
Standpipe

+ ³, × ³: Numbers refer to Sensitivity
○ ³% STRAIN AT FAILURE

LDN_MTO_06 12-1132-0076-2001B.GPJ LDN_MTO.GDT 08/03/18

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-414

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST HWY 401
DATUM GEODETIC
LOCATION N 4758802.6 , E 422852.2
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE June 5, 2017
ORIGINATED BY MR
COMPILED BY ZJB/LMK
CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
262.92	GROUND SURFACE										
0.00	ASPHALT										
0.15	FILL, sand and gravel, some silt Compact Brown		1	SS	13		262				
261.55											
1.37	FILL, sand, some silt, trace gravel Very loose to compact Brown		2	SS	11		261				2 82 14 2
			3	SS	1	▽	260				
			4	SS	1		259				
			5	SS	WH		258				
			6	SS	2		257				
257.28			7	SS	1						
5.64	FILL, clayey silt, some sand, trace gravel Very soft to stiff Brown		8	SS	14		256				1 12 53 34
255.76			9	SS	13						
7.16	FILL, silt, some sand										
255.45	Compact										
7.47	Brown										
	FILL, clayey silt, some sand Brown Stiff		10	SS	9		255				
							254	+ >95.8			
253.47			11	SS	15					46	
9.45	SILT, organic Stiff										
252.97	Grey										
9.95	SAND, fine to medium, trace silt Compact Grey		12	SS	11		253				
							252				
							251				
250.12			13	SS	16						0 91 8 1
12.80	END OF BOREHOLE Groundwater encountered at about elev. 260.6m during drilling on June 5, 2017										

+ ³, × ³: Numbers refer to Sensitivity
○ 3% STRAIN AT FAILURE

LDN_MTO_06 12-1132-0076-2001B.GPJ LDN_MTO.GDT 08/03/18

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-415

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST HWY 401
DATUM GEODETIC
LOCATION N 4758827.0 , E 422915.3
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE June 1, 2017
ORIGINATED BY MR
COMPILED BY ZJB/LMK
CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
260.94	GROUND SURFACE										
0.00	PEAT, fibrous Very soft to soft Black		1	AS	2		260				
			2	SS	1		259	+2.3, +1.8			
			3	SS	2		258		448		
256.67							257	+1.8			
4.27	SILT, organic, some shells Very soft Grey		4	SS	1		256		145		
								+2.7			
254.39			5	SS	1		255		106		
6.55	SILTY CLAY Very soft Grey						254	+1.4			
253.47											
7.47	SAND, fine to medium, trace silt Very loose to loose		6	SS	WR		253				
			7	SS	8		252				91 7 2
							251				
249.81			8	SS	9		250				
11.13	END OF BOREHOLE Groundwater encountered at about elev. 260.7m during drilling on June 1, 2017										

+³, ×³: Numbers refer to Sensitivity
○ 3% STRAIN AT FAILURE

LDN_MTO_06 12-1132-0076-2001B.GPJ LDN_MTO.GDT 08/03/18

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-416

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST HWY 401
DATUM GEODETIC
LOCATION N 4758830.3 , E 422977.9
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE June 1, 2017
ORIGINATED BY MR
COMPILED BY ZJB/LMK
CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "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 × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
262.70	GROUND SURFACE										
0.09	ASPHALT										
262.09	FILL, sand and gravel, some silt Brown										
0.61	FILL, sand, fine to medium, some silt Compact to loose Brown		1	SS	18		262				
			2	SS	6	▽	261				
260.26											
2.44	FILL, clayey silt, some sand, trace gravel Soft to firm Grey		3	SS	3		260				
			4	SS	8		259	+ 1.7			1 17 54 28
257.67			5	SS	7		258		248		
5.03	PEAT, fibrous Firm Black							+ >95.8			
256.91							257				
5.79	SILT, organic Soft Grey		6	SS	2	▽			55		
256.14							256				
6.56	SAND, fine to medium Very loose to loose Grey		7	SS	1						
			8	SS	9		255				
254.01							254				
8.69	SILTY SAND, trace gravel, trace clay Compact Grey		9	SS	11						2 50 43 5
							253				
			10	SS	15		252				5 62 27 6
251.42											
11.28	END OF BOREHOLE Groundwater encountered at about elev. 260.6m and elev. 256.2m during drilling on June 1, 2017										

+ ³, × ³: Numbers refer to Sensitivity
○ ³% STRAIN AT FAILURE

LDN_MTO_06 12-1132-0076-2001B.GPJ LDN_MTO.GDT 08/03/18

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-417

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST HWY 401
DATUM GEODETIC
LOCATION N 4758758.4 , E 422226.1
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE May 30, 2017
ORIGINATED BY MR
COMPILED BY LMK
CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
285.04	GROUND SURFACE						285				
0.11	TOPSOIL, silty, Dark brown										
	SILT, some clay, trace sand, Brown						284				
283.49											
1.55	END OF BOREHOLE Borehole dry during drilling on May 30, 2017										

$+^3, \times^3$: Numbers refer to Sensitivity
$\circ^{3\%}$ STRAIN AT FAILURE

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-418

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST ____ HWY 401
DATUM GEODETIC

LOCATION N 4758767.8 , E 422345.7
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE May 29, 2017

ORIGINATED BY MR
COMPILED BY LMK
CHECKED BY LW

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
278.34	ROAD SURFACE										
0.00	ASPHALT										
0.14	FILL, sand and gravel, some silt, crushed, Brown and grey						278				
0.25											
277.39	FILL, sand and gravel, some silt, with cobbles, Brown										
0.95							277				
276.79	SILTY CLAY, some sand, some gravel, Brown										
1.55	END OF BOREHOLE										

Borehole dry during drilling on May 29, 2017

$+^3, \times^3$: Numbers refer to Sensitivity
$\circ^{3\%}$ STRAIN AT FAILURE

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-419

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST ____ HWY 401
DATUM GEODETIC
LOCATION N 4758793.5 , E 422223.8
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE May 29, 2017
ORIGINATED BY MR
COMPILED BY LMK
CHECKED BY LK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
284.36	GROUND SURFACE										
0.00	TOPSOIL, silty										
0.19	Dark brown						284				
	SILT, some clay, trace sand Brown										
282.81							283				
1.55	END OF BOREHOLE Borehole dry during drilling on May 29, 2017										

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-420

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST HWY 401
DATUM GEODETIC
LOCATION N 4758802.0 , E 422318.7
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE May 30, 2017
ORIGINATED BY MR
COMPILED BY LMK
CHECKED BY LW

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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
278.73	GROUND SURFACE										
0.10	TOPSOIL, clayey Dark brown										
	SILTY CLAY, some sand, some gravel Brown						278				
277.18											
1.55	END OF BOREHOLE Borehole dry during drilling on May 30, 2017										

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

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

Golder Associates
London, Ontario

PROJECT 12-1132-0076-2001A

RECORD OF BOREHOLE No BH-421

1 OF 1

METRIC

W.P. 3053-11-00 LOCATION N 4758753.5 , E 422630.4 ORIGINATED BY LK

DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK

DATUM GEODETIC DATE December 15, 2017 CHECKED BY LK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "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 × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
265.96	ROAD SURFACE										
0.00 / 265.59	ASPHALT										
0.37	FILL, sand and gravel, crushed, some silt										
0.55	Brown		1	SS	50/127mm		265		○		
	FILL, sand and gravel, some cobbles, some silt Very dense Brown		2	SS	51		264		○		
263.83											
2.13	CLAYEY SILT TILL, some sand, trace gravel Hard to very stiff Brown turning grey at about elev. 261.5m		3	SS	56		263		○		
			4	SS	61		262		○		
			5	SS	50/100mm				○		
260.93			6	SS	26		261		○		
5.03	END OF BOREHOLE Borehole dry during drilling on December 15, 2017										

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

LDN_MTO_06 12-1132-0076-2001B.GPJ LDN_MTO.GDT 08/03/18

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-422

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST ____ HWY 401
DATUM GEODETIC
LOCATION N 4758773.1 , E 422737.3
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE December 20, 2017
ORIGINATED BY LK
COMPILED BY LMK
CHECKED BY LW

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
263.74	ROAD SURFACE										
0.00 / 263.37	ASPHALT										
0.37 / 262.37	FILL, sand and gravel, some silt Compact Brown		1	SS	25		263		○		
1.37 / 260.85	FILL, clayey silt, some sand, trace gravel, trace topsoil Stiff to firm Brown		2	SS	10		262		○		
			3	SS	5		261		○		
2.89 / 260.08	TOPSOIL, clayey Firm Black		4	SS	7				○		
3.66 / 258.71	SILTY CLAY, some sand, with topsoil seams Stiff to soft Brown		5	SS	8		260		○—○		
			6	SS	4		259		○		
5.03 / 255.66	CLAYEY SILT TILL, some sand, trace gravel Firm to very stiff Grey		7	SS	6		258		○		
			8	SS	7				○—○		
			9	SS	16		257		○		
			10	SS	7		256		○		
8.08	END OF BOREHOLE Borehole dry during drilling on December 20, 2017										

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-423

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST ____ HWY 401
DATUM GEODETIC
LOCATION N 4758784.2 , E 422774.7
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE December 15, 2017
ORIGINATED BY LK
COMPILED BY LMK
CHECKED BY ____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
263.43	ROAD SURFACE										
0.00 / 263.03	ASPHALT						263				
0.40 / 262.67	FILL, sand and gravel, some silt Brown										
0.76	FILL, sand, some silt Dense becoming very loose Brown		1	SS	37		262		○		
			2	SS	8				○		
			3	SS	3	▽	261		○		
			4	SS	WH		260		○		
			5	SS	WH				○		
258.70			6	SS	4		259		○		
4.73 / 258.25	CLAYEY SILT, with sand seams, roots, and topsoil seams Soft Brown-grey								○		
5.18 / 257.79	SAND, fine to medium, trace gravel Loose Brown		7	SS	6		258		○		
5.64	CLAYEY SILT, some sand Stiff Grey		8	SS	9		257		○		
6.71 / 255.96	SANDY SILT, trace clay Loose Grey		9	SS	7				○		
7.47 / 255.20	CLAYEY SILT, some sand Very stiff Grey		10	SS	17		256		○		
8.23 / 254.44	SILT, with clayey silt seams Dense Grey		11	SS	31		255		○		
8.99 / 253.83	SANDY SILT, trace clay Compact Grey		12	SS	10		254		○		
9.60	END OF BOREHOLE Groundwater encountered at about elev. 261.0m during drilling on December 15, 2017.										

$+^3, \times^3$: Numbers refer to Sensitivity
$\circ^{3\%}$ STRAIN AT FAILURE

LDN_MTO_06 12-1132-0076-2001B.GPJ LDN_MTO.GDT 08/03/18

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-424

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST HWY 401
DATUM GEODETIC
LOCATION N 4758788.3 , E 422805.1
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE December 20, 2017
ORIGINATED BY LK
COMPILED BY LMK
CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
263.38	ROAD SURFACE										
0.00	ASPHALT										
0.18	FILL, sand and gravel, trace to some silt Compact Brown						263				
262.40			1	SS	13						
0.98	FILL, sand, some silt, trace gravel Compact to loose Brown						262				
261.25			2	SS	7						
2.13	FILL, clayey silt, some sand, trace gravel, trace topsoil Firm Mottled brown-grey		3	SS	6		261				
			4	SS	5		260				
			5	SS	6						
258.65							259				
4.73	PEAT, fibrous Firm		6	SS	7					106	
258.20	Black										
5.18	SILT, organic Soft									201	
257.83			7	SS	4		258				
5.55	Grey CLAYEY SILT, trace sand Soft Grey		8	SS	3	▽	257				
256.52											
6.86	SILT, some sand, some clay Very loose Grey		9	SS	2						
			10	SS	2		256				
							255				
254.02											
9.36	CLAYEY SILT, trace sand, with roots Soft Grey		11	SS	4		254				
			12	SS	4						
253.02											
10.36	END OF BOREHOLE Groundwater encountered at about elev. 256.8m during drilling on December 20, 2017.										

$+^3, \times^3$: Numbers refer to Sensitivity
$\circ^{3\%}$ STRAIN AT FAILURE

LDN_MTO_06 12-1132-0076-2001B.GPJ LDN_MTO.GDT 08/03/18

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-425

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST HWY 401
DATUM GEODETIC
LOCATION N 4758790.9 , E 422804.4
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE December 14, 2017
ORIGINATED BY LK
COMPILED BY LMK
CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
263.34	ROAD SURFACE										
0.00	ASPHALT										
0.15	FILL, sand and gravel, some silt Compact Brown		1	SS	21		263		○		
261.97											
1.37	FILL, silty sand, trace clay Compact to very loose Brown		2	SS	17		262		○		
			3	SS	3	▽	261		○		
			4	SS	2		260		○		
			5	SS	1		259		○		
258.46			6	SS	3				○		
4.88	FILL, clayey silt, some sand, trace topsoil Soft Grey		7	SS	7		258		○	104 ○	
257.79											
5.55	TOPSOIL, with clayey silt layers Firm Grey		8	SS	4		257		⊢○⊣		
257.24											
6.10	SILT, organic Firm Grey		9	SS	4		256		○		
	CLAYEY SILT, trace sand Soft to firm Grey		10	SS	6				○		
255.26											
8.08	END OF BOREHOLE Groundwater encountered at about elev. 260.7m during drilling on December 14, 2017.										

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

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

LDN_MTO_06 12-1132-0076-2001B.GPJ LDN_MTO.GDT 08/03/18

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-426

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST ____ HWY 401
DATUM GEODETIC
LOCATION N 4758801.4 , E 422802.0
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE December 19, 2017
ORIGINATED BY LK
COMPILED BY LMK
CHECKED BY LW

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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
260.30	GROUND SURFACE										
0.00	PEAT, fibrous Soft Black						260				
259.42			1	SS	3				91		
0.88	SILT, organic Soft Grey						259				
258.93			2	SS	WH				58		
1.37	PEAT, fibrous Very soft Black						258				
257.40			3	SS	1				89		
2.90	SILT, organic Very soft Grey		4	SS	WH		257		117		
			5	SS	WH				128		
			6	SS	WH		256		55		
254.97											
5.33	SILT, some clay Very loose Grey		7	SS	WH		255		○		
254.35											
5.95	CLAYEY SILT, trace to some sand Soft Grey		8	SS	2		254		○		
252.98			9	SS	3		253		○		
7.32	END OF BOREHOLE Borehole dry during drilling on December 19, 2017										

+ 3, × 3: Numbers refer to Sensitivity
○ 3% STRAIN AT FAILURE

LDN_MTO_06 12-1132-0076-2001B.GPJ LDN_MTO.GDT 08/03/18

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-427

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST _____ HWY 401
DATUM GEODETIC
LOCATION N 4758810.0 , E 422851.5
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE December 19, 2017
ORIGINATED BY LK
COMPILED BY LMK
CHECKED BY LM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
260.68	GROUND SURFACE					
0.00	PEAT, fibrous, with sand seams Very soft to soft Black		1	SS	2	
			2	SS	2	
			3	SS	WH	
			4	SS	3	
			5	SS	2	
256.26						
4.42	SILT, organic Very soft Grey		6	SS	1	
			7	SS	WH	
254.52						
6.16	CLAYEY SILT, trace sand Very soft Grey		8	SS	WH	
			9	SS	WH	
			10	SS	WH	
252.60						
8.08	END OF BOREHOLE Groundwater encountered at about elev. 260.7m during drilling on December 19, 2017.					

ELEVATION SCALE: 260, 259, 258, 257, 256, 255, 254, 253

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

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

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

78
62
43
124
128
117
45

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-428

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST HWY 401
DATUM GEODETIC

LOCATION N 4758812.2 , E 422850.7
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE December 19, 2017

ORIGINATED BY LK
COMPILED BY LMK
CHECKED BY LW

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "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 × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
260.48	GROUND SURFACE										
0.00	PEAT, fibrous Very soft Black										
			1	SS	WH		260		○		
			2	SS	2		259		○ 53		
			3	SS	WH		258		○ 469		
			4	SS	WH				○ 71		
256.82							257				
3.66	SILT, organic, some shells Very soft Grey		5	SS	WH				○ 139		
			6	SS	WH		256		○ 148		
254.78			7	SS	WH		255		○ 124 ○ 42		
5.70	SILTY CLAY, trace sand Very soft Grey		8	SS	WH				○ 55		
			9	SS	WH		254		○		
252.89							253				
7.59	SILT, some sand, some clay Very loose Grey		10	SS	WH				○ ○		
7.84											
8.08	SAND, fine, some silt Very loose Grey										
	END OF BOREHOLE Groundwater encountered at about elev. 260.5m during drilling on December 19, 2017.										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-429

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST ____ HWY 401
DATUM GEODETIC
LOCATION N 4758816.9 , E 422940.3
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE December 20, 2017
ORIGINATED BY LK
COMPILED BY LMK
CHECKED BY LW

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
263.07	ROAD SURFACE						263				
0.00 / 262.70	ASPHALT										
0.37	FILL, sand and gravel, some silt Compact Brown		1	SS	17		262		○		
261.42											
1.65	FILL, clayey silt, some sand, trace gravel, trace topsoil Soft to stiff Brown-grey		2	SS	2		261		○		
			3	SS	11				○		
			4	SS	9		260		○		
			5	SS	6		259		○		
			6	SS	3		258		○		
			7	SS	4				○		
			8	SS	5		257		○		
			9	SS	5		256		○		
			10	SS	4	▽			○		
254.69							255				
8.38	FILL, sandy silt, with clayey silt Very loose Grey		11	SS	WH				○		
254.08							254				
8.99	FILL, silty fine sand Very loose Grey		12	SS	1				○		
253.47											
9.60	END OF BOREHOLE Groundwater encountered at about elev. 254.8m during drilling on December 20, 2017.										

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

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

LDN_MTO_06 12-1132-0076-2001B.GPJ LDN_MTO.GDT 08/03/18

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-430

1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST HWY 401
DATUM GEODETIC
LOCATION N 4758820.7 , E 422939.5
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE December 14, 2017
ORIGINATED BY LK
COMPILED BY LMK
CHECKED BY LW

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 × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
262.84	ROAD SURFACE										
0.09	ASPHALT										
262.11	FILL, sand and gravel, trace to some silt Brown										
0.73	FILL, sand, fine, some silt Compact to very loose Brown		1	SS	22		262		○		
			2	SS	7	▽	261		○		
			3	SS	3				○		
259.94							260				
2.90	FILL, clayey silt, some sand, some topsoil Firm to very stiff Brown-grey		4	SS	11				○		
			5	SS	18		259		⊖		
			6	SS	13		258		○		
			7	SS	9				○		
256.38			8	SS	7		257		○	245	
6.46	PEAT, non-fibrous Soft Black										
6.70	CLAYEY SILT, some sand, trace gravel Very stiff to firm Grey		9	SS	17		256		⊖		
254.76			10	SS	5		255		○		
8.08	END OF BOREHOLE Groundwater encountered at about elev. 261.0m during drilling on December 14, 2017.										

$+^3, \times^3$: Numbers refer to Sensitivity
$\bigcirc^{3\%}$ STRAIN AT FAILURE

Golder Associates
London, Ontario

RECORD OF BOREHOLE No BH-431

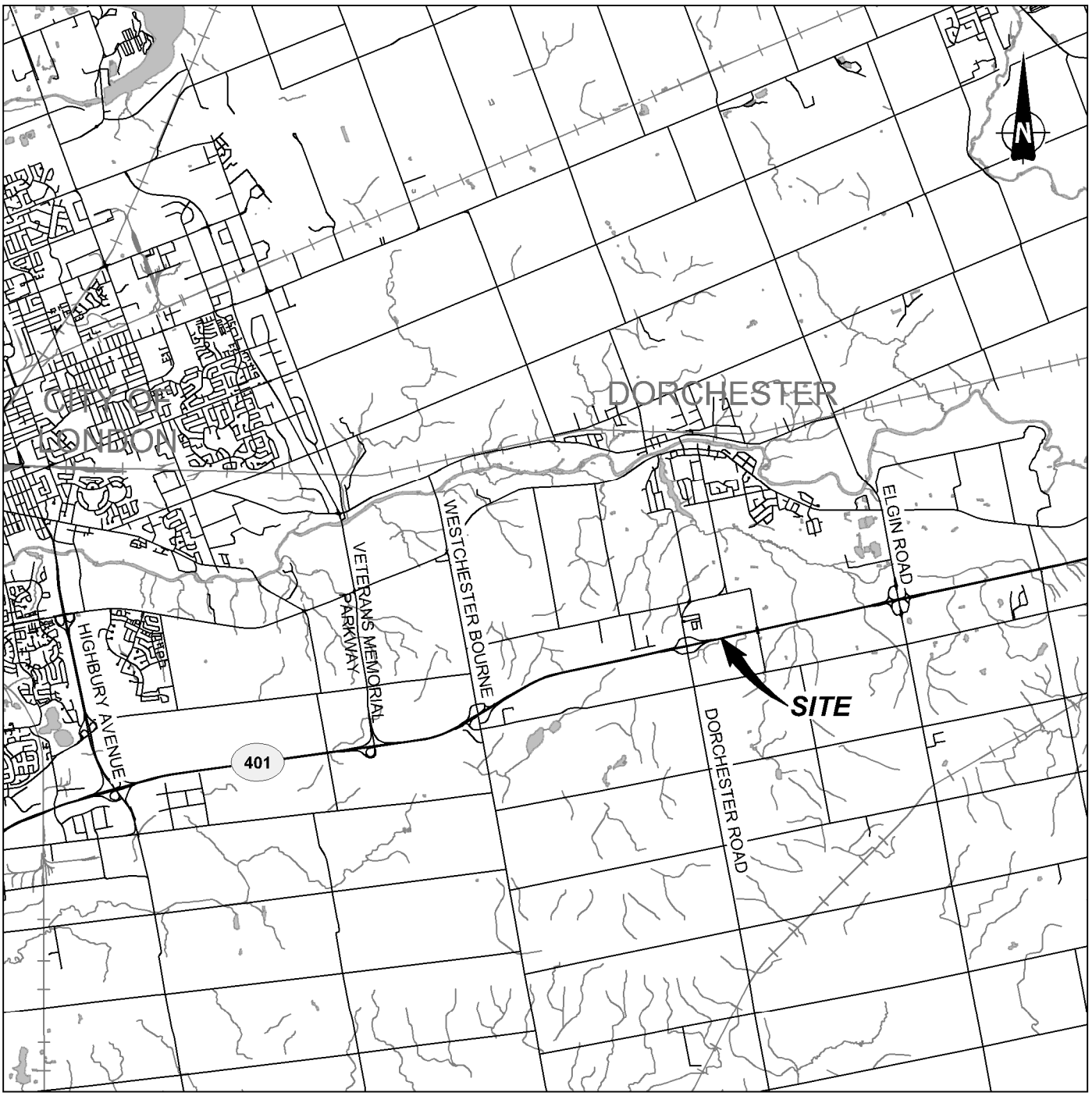
1 OF 1

METRIC

PROJECT 12-1132-0076-2001A
W.P. 3053-11-00
DIST ____ HWY 401
DATUM GEODETIC
LOCATION N 4758830.7 , E 422937.2
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE December 19, 2017
ORIGINATED BY LK
COMPILED BY LMK
CHECKED BY LV

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 × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
260.79	GROUND SURFACE										
0.00	PEAT, fibrous Very soft Black										
			1	SS	1		260		391		
			2	SS	1		259		281		
			3	SS	1				204		
257.89							258				
2.90	SILT, organic, with shells Very soft Grey		4	SS	WH				142		
			5	SS	WH		257		153		
			6	SS	WH				218		
255.61							256				
5.18	CLAYEY SILT, trace sand Very soft Grey		7	SS	WH						
			8	SS	WH		255				
253.78											
7.01	SANDY SILT, some clay Very loose Grey		9	SS	2		254				
253.47											
7.32	END OF BOREHOLE Groundwater encountered at about elev. 260.8m during drilling on December 19, 2017.										

$+^3, \times^3$: Numbers refer to Sensitivity
$\circ^{3\%}$ STRAIN AT FAILURE



SCALE IN METRES
0 2000 4000m
1:100,000

REFERENCE

PLAN BASED ON CANMAP STREETFILES V.2008.4.

NOTES

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.
ALL LOCATIONS ARE APPROXIMATE ONLY.

PROJECT
DORCHESTER ROAD RAMPS
HIGHWAY 401 INTERCHANGE IMPROVEMENTS
GWP 3053-11-00

TITLE
KEY PLAN

Golder Associates

PROJECT No. 12-1132-0076			FILE No. 1211320076-2001A-F01001	
			SCALE AS SHOWN	REV. 0
CADD	LMK	Mar. 8/18	**FIGURE 1**	
CHECK				

Drawing file: 1211320076-2001A-F01001.dwg Mar 08, 2018 - 10:06am

MINISTRY OF TRANSPORTATION, ONTARIO

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

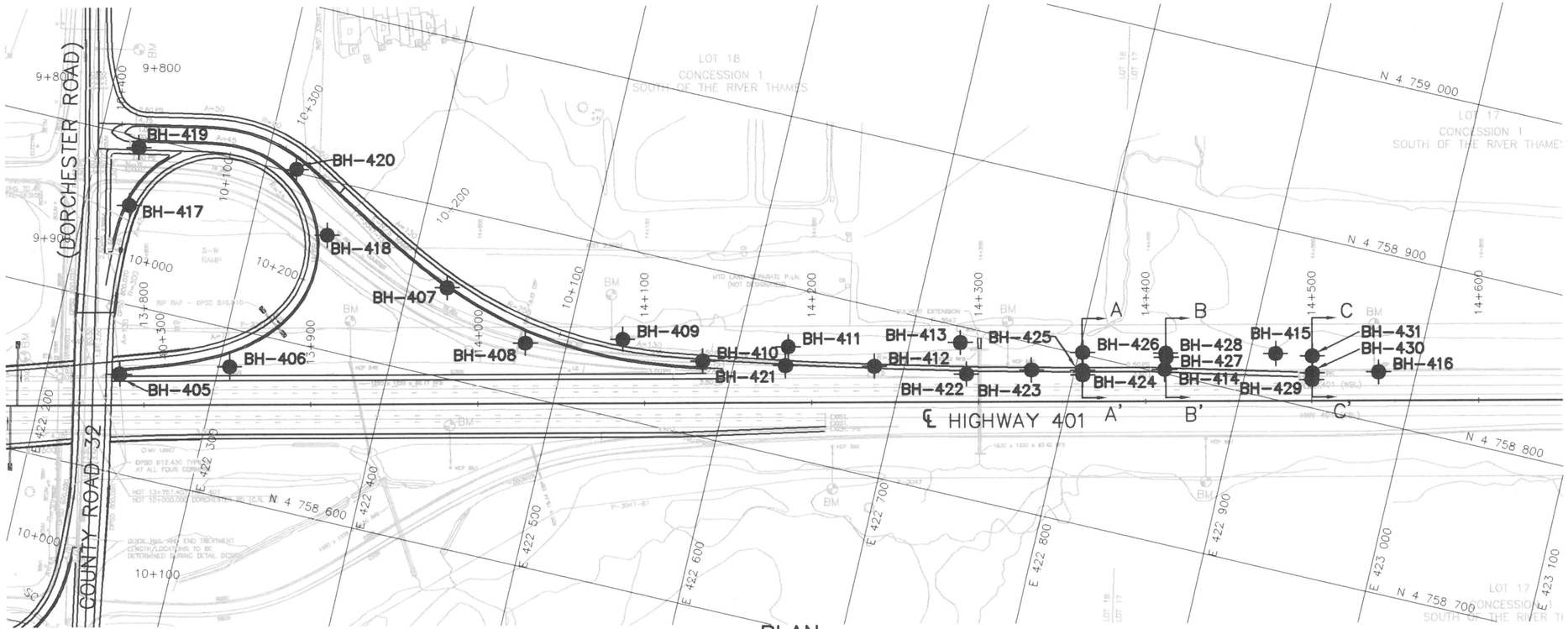
CONT No.
WP No. 3053-11-00

SHEET

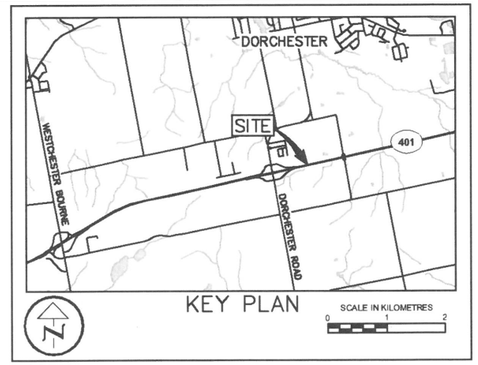
COUNTY RD. 32 (Dorchester Rd)
HIGHWAY 401 RAMPS

BOREHOLE LOCATIONS

Golder Associates Ltd.
LONDON, ONTARIO, CANADA



PLAN
SCALE
30 0 30 m



No.	ELEVATION	CO-ORDINATES (MTM ZONE 11)	
		NORTHING	EASTING
BH-405	277.55	4 758 658.5	422 243.5
BH-406	274.41	4 758 677.7	422 306.3
BH-407	274.79	4 758 753.3	422 422.8
BH-408	270.70	4 758 731.5	422 475.8
BH-409	267.57	4 758 746.9	422 532.1
BH-410	267.25	4 758 745.0	422 581.8
BH-411	265.41	4 758 764.9	422 629.5
BH-412	264.42	4 758 765.1	422 682.5
BH-413	260.83	4 758 790.7	422 729.4
BH-414	262.92	4 758 802.6	422 852.2
BH-415	260.94	4 758 827.0	422 915.3
BH-416	262.70	4 758 830.3	422 977.9
BH-417	285.04	4 758 758.4	422 226.1
BH-418	278.34	4 758 767.8	422 345.7

No.	ELEVATION	CO-ORDINATES (MTM ZONE 11)	
		NORTHING	EASTING
BH-419	284.36	4 758 793.5	422 223.8
BH-420	278.73	4 758 802.0	422 318.7
BH-421	265.96	4 758 753.5	422 630.4
BH-422	263.74	4 758 773.1	422 737.3
BH-423	263.43	4 758 784.2	422 774.7
BH-424	263.38	4 758 788.3	422 805.1
BH-425	263.34	4 758 790.9	422 804.4
BH-426	260.30	4 758 801.4	422 802.0
BH-427	260.68	4 758 810.0	422 851.5
BH-428	260.48	4 758 812.2	422 850.7
BH-429	263.07	4 758 816.9	422 940.3
BH-430	262.84	4 758 820.7	422 939.5
BH-431	260.79	4 758 830.7	422 937.2

LEGEND

Borehole – Current Investigation

NOTES

This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

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

REFERENCE

Base plans based on Dillon Consulting Limited.

NO.	DATE	BY	REVISION

Geocres No. 40I14-182

HWY. 401	PROJECT NO. 12-1132-0076			DIST.
SUBM'D. BT	CHKD.	DATE: Aug. 20/18		SITE:
DRAWN: LMK/ZJB	CHKD.	APPD.		DWG. 1

LICENSED PROFESSIONAL ENGINEER M. E. BEADLE PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER F.J. HEFFERNAN PROVINCE OF ONTARIO

PLOT DATE: November 05, 2018
FILENAME: N:\active\2012\1132 - Geo\1132-0000\12-1132-0076 DILLON-11 STRUCTURES-3011-E-0046\Drafting\AutoCAD files\12113200076-2001A-001001.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

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

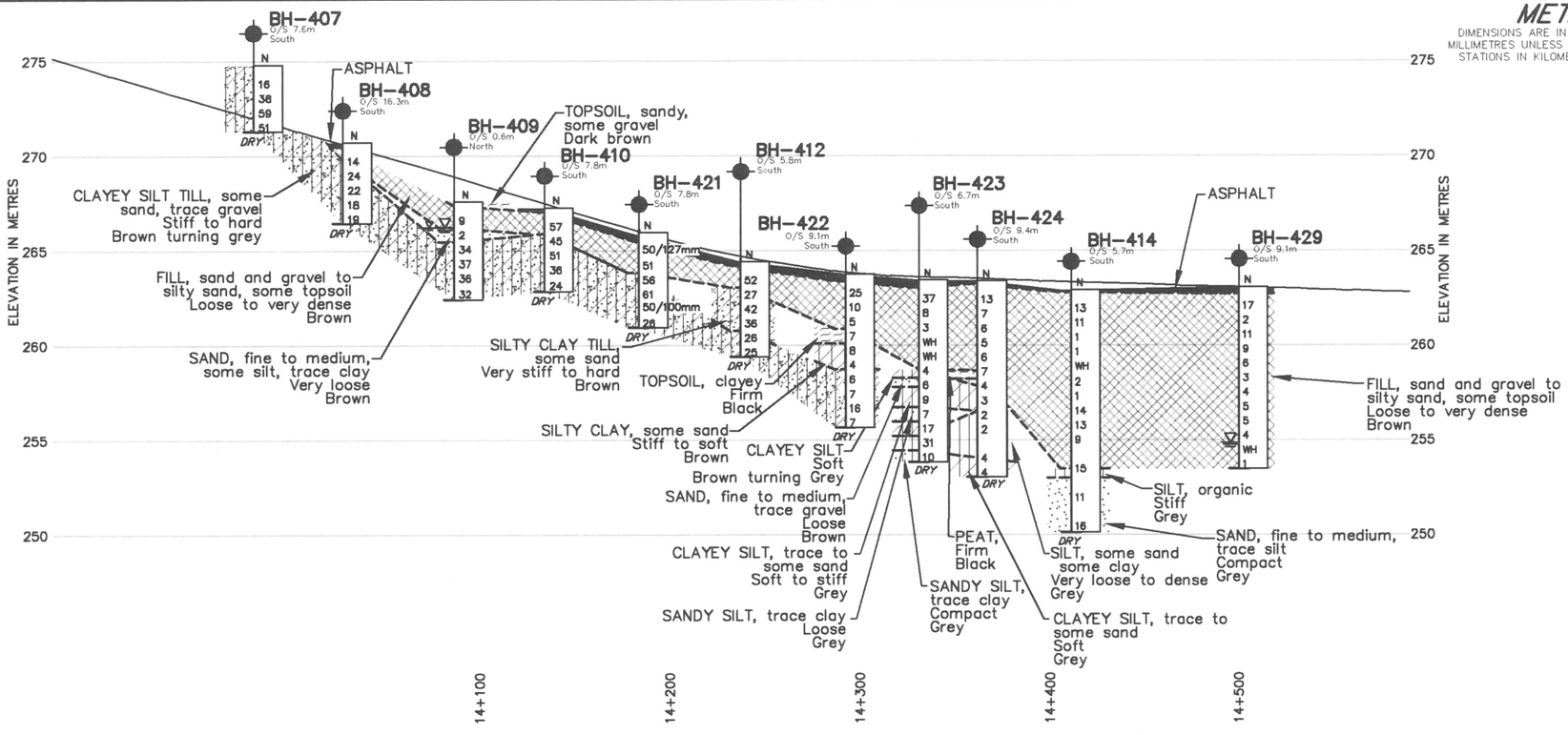
CONT No.
WP No. 3053-11-00

SHEET

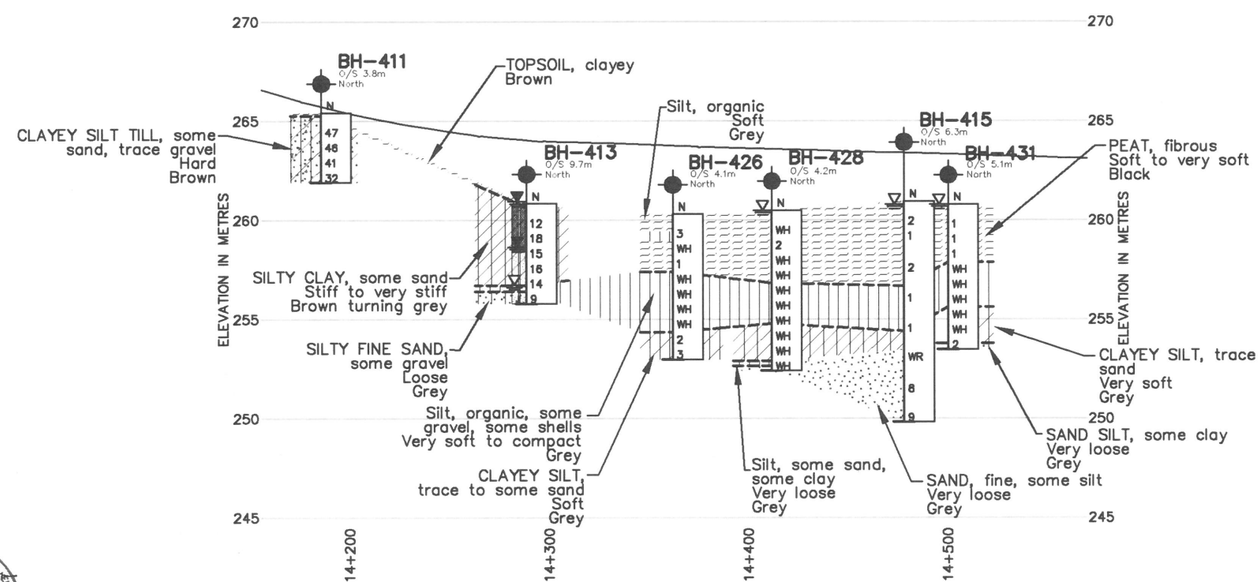
COUNTY RD. 32 (Dorchester Rd)
HIGHWAY 401 RAMPS

SOIL STRATA

Golder Associates Ltd.
LONDON, ONTARIO, CANADA



PROFILE ALONG ℄ E-NS RAMP AND SPEED CHANGE LANE



PROFILE ALONG ℄ E-NS SPEED CHANGE LANE

HORIZONTAL SCALE
30 0 30 m

VERTICAL SCALE
3 0 3 m

LEGEND

- Borehole – Current Investigation
- Seal
- Standpipe
- **N** Standard Penetration Test Value
- **16** Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL measured on June 19, 2017
- WL encountered during drilling
- ***DRY*** Water level not established

No.	ELEVATION	CO-ORDINATES (MTM ZONE 11)	
		NORTHING	EASTING
BH-407	274.79	4 758 753.3	422 422.8
BH-408	270.70	4 758 731.5	422 475.8
BH-409	267.57	4 758 746.9	422 532.1
BH-410	267.25	4 758 745.0	422 581.8
BH-411	265.41	4 758 764.9	422 629.5
BH-412	264.42	4 758 765.1	422 682.5
BH-413	260.83	4 758 790.7	422 729.4
BH-414	262.92	4 758 802.6	422 852.2
BH-415	260.94	4 758 827.0	422 915.3
BH-421	265.96	4 758 753.5	422 630.4
BH-422	263.74	4 758 773.1	422 737.3
BH-423	263.43	4 758 784.2	422 774.7
BH-424	263.38	4 758 788.3	422 805.1
BH-426	260.30	4 758 801.4	422 802.0
BH-428	260.48	4 758 812.2	422 850.7
BH-429	263.07	4 758 816.9	422 940.3
BH-430	262.84	4 758 820.7	422 937.2

NOTES

This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

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

REFERENCE

Base plans based on Dillon Consulting Limited.

LICENSED PROFESSIONAL ENGINEER M. E. BEADLE PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER F. J. HEFFERNAN PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 40I14-182

HWY. 401	PROJECT NO. 12-1132-0076		DIST.
SUBM'D. BT	CHKD.	DATE: Aug. 20/18	SITE:
DRAWN: LMK/ZJB	CHKD.	APPD.	DWG. 2

PLOT DATE: November 05, 2018
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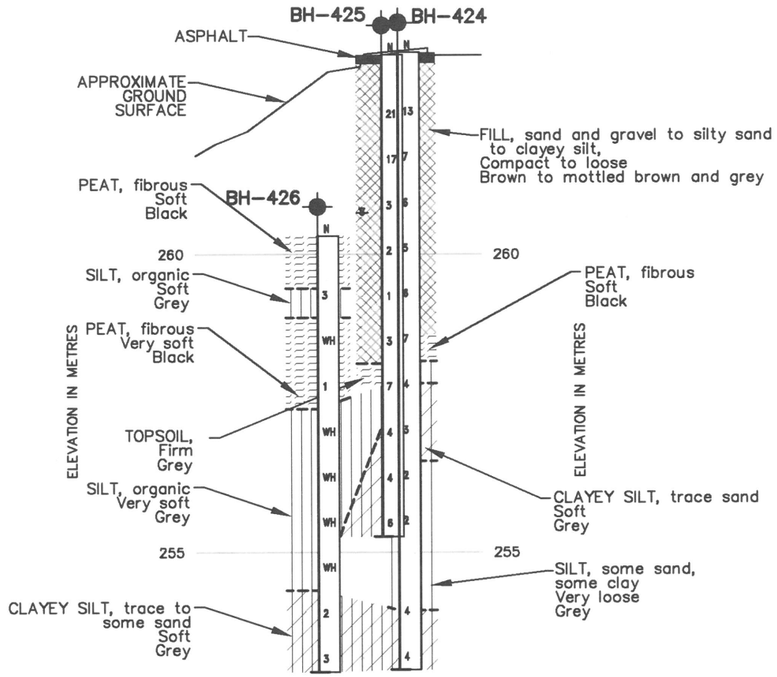
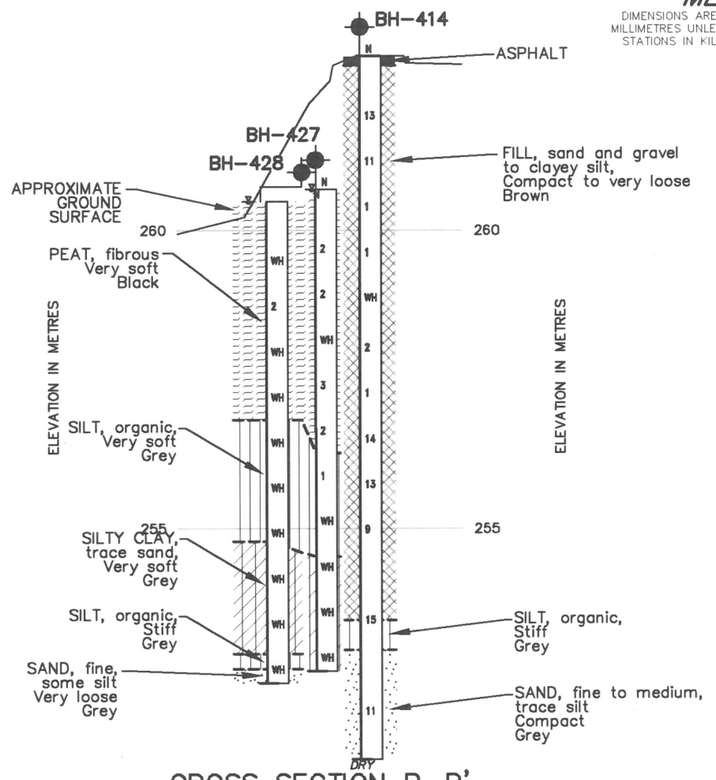
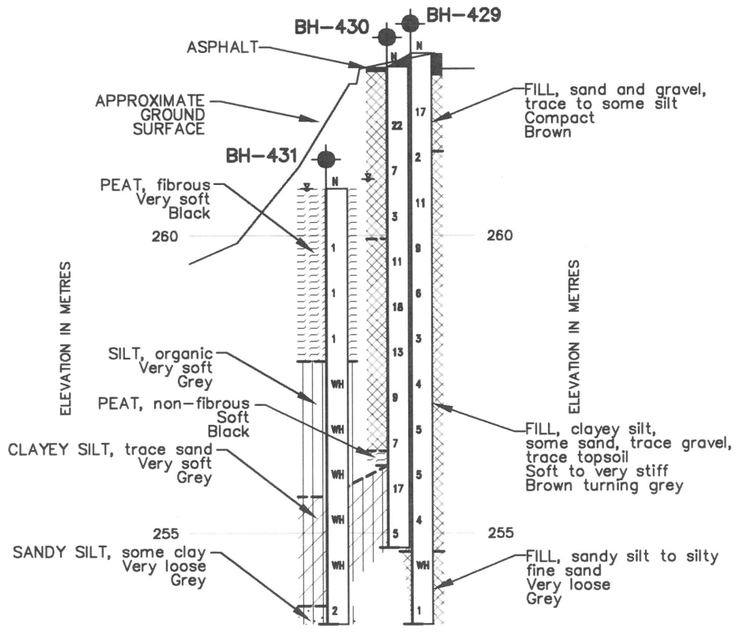
MINISTRY OF TRANSPORTATION, ONTARIO



CROSS SECTION A–A'



CROSS SECTION B–B'



CROSS SECTION C–C'

HORIZONTAL SCALE 10 0 10 m

VERTICAL SCALE 3 0 3 m

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

CONT No.
WP No. 3053-11-00

SHEET

COUNTY RD. 32 (Dorchester Rd)
HIGHWAY 401 RAMPS

SOIL STRATA

Golder Associates Ltd.
LONDON, ONTARIO, CANADA

LEGEND

- Borehole – Current Investigation
- DRY — Water level not established
- WL measured on June 19, 2017
- WL encountered during drilling

No.	ELEVATION	CO-ORDINATES (MTM ZONE 11)	
		NORTHING	EASTING
BH-414	262.92	4 758 802.6	422 852.2
BH-424	263.38	4 758 788.3	422 805.1
BH-425	263.34	4 758 790.9	422 804.4
BH-426	260.30	4 758 801.4	422 802.0
BH-427	260.68	4 758 810.0	422 851.5
BH-428	260.48	4 758 812.2	422 850.7
BH-429	263.07	4 758 816.9	422 940.3
BH-430	262.84	4 758 820.7	422 939.5
BH-431	260.79	4 758 830.7	422 937.2

NOTES

This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

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

REFERENCE

Base plans based on Dillon Consulting Limited.

M. E. BEADLE — LICENSED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO

F. J. HEFFERNAN — LICENSED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 40I14-182

HWY. 401			PROJECT NO. 12-1132-0076		DIST.
SUBM'D. BT		CHKD.	DATE: Mar. 8/18		SITE:
DRAWN: LMK/ZJB		CHKD.	APPD.		DWG. 3

PLOT DATE: November 05, 2018
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MINISTRY OF TRANSPORTATION, ONTARIO

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

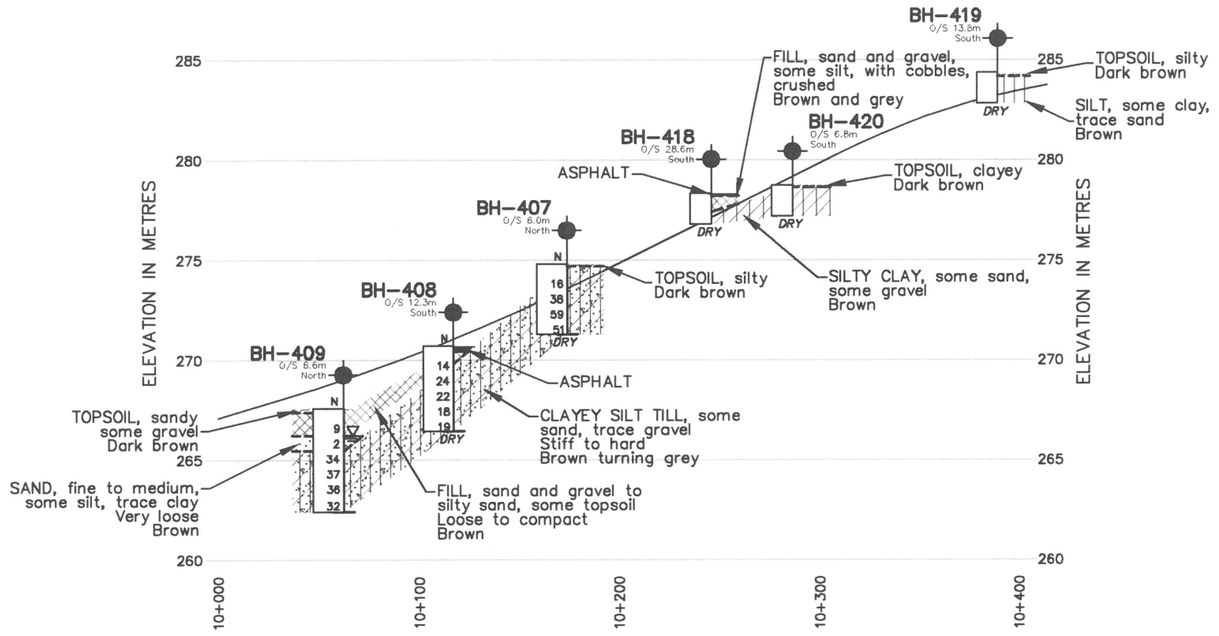
CONT No.
WP No. 3053-11-00

SHEET

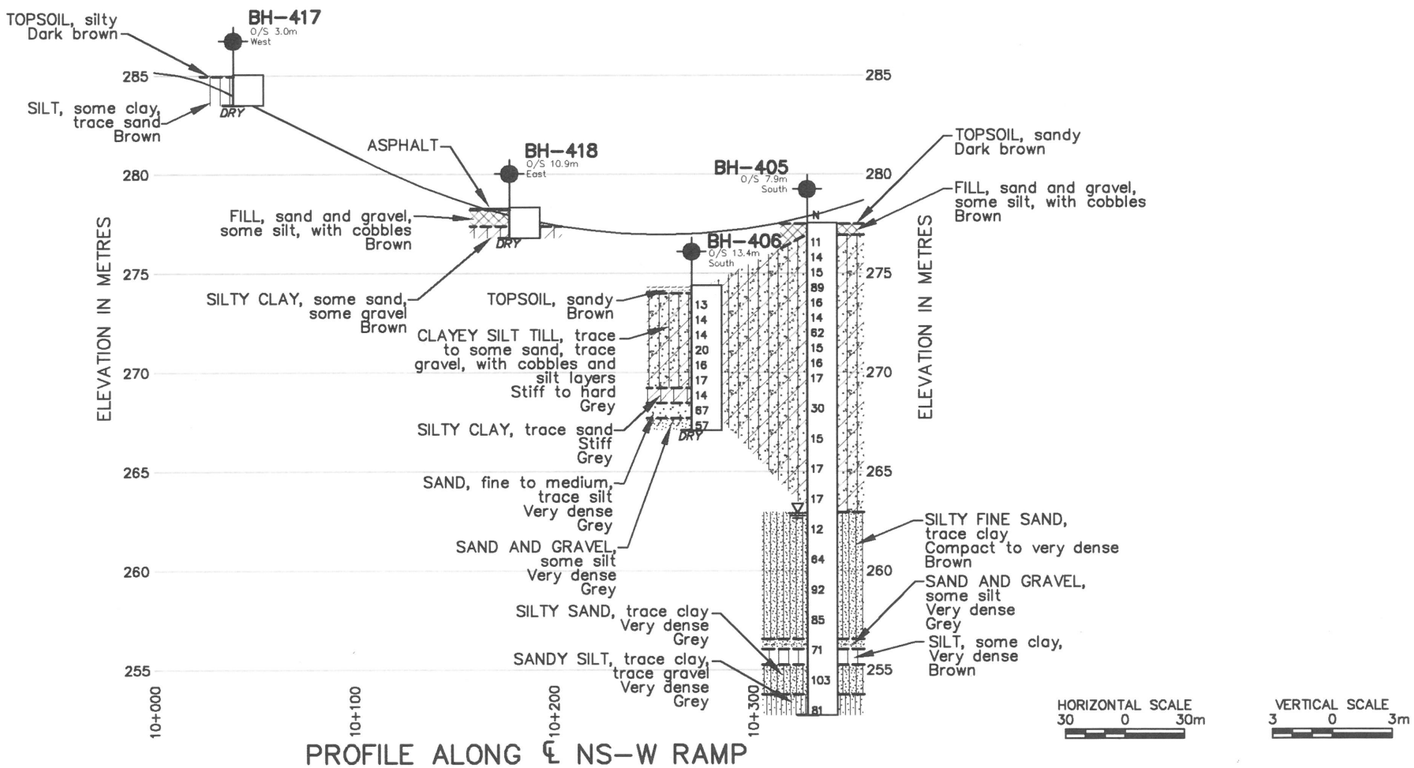
COUNTY RD. 32 (Dorchester Rd)
HIGHWAY 401 RAMPS

SOIL STRATA

Golder Associates Ltd.
LONDON, ONTARIO, CANADA



PROFILE ALONG ℄ E-NS RAMP



PROFILE ALONG ℄ NS-W RAMP

HORIZONTAL SCALE
30 0 30m

VERTICAL SCALE
3 0 3m

LEGEND

- Borehole – Current Investigation
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL encountered during drilling
- DRY — Water level not established

No.	ELEVATION	CO-ORDINATES (MTM ZONE 11)	
		NORTHING	EASTING
BH-405	277.55	4 758 658.5	422 243.5
BH-406	274.41	4 758 677.7	422 306.3
BH-407	274.79	4 758 753.3	422 422.8
BH-408	270.70	4 758 731.5	422 475.8
BH-409	267.57	4 758 746.9	422 532.1
BH-417	285.04	4 758 758.4	422 226.1
BH-418	278.34	4 758 767.8	422 345.7
BH-419	284.36	4 758 793.5	422 223.8
BH-420	278.73	4 758 802.0	422 318.7

NOTES

This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

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

REFERENCE

Base plans based on Dillon Consulting Limited.

M. E. BEADLE — LICENSED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO

F. J. HEFFERNAN — REGISTERED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

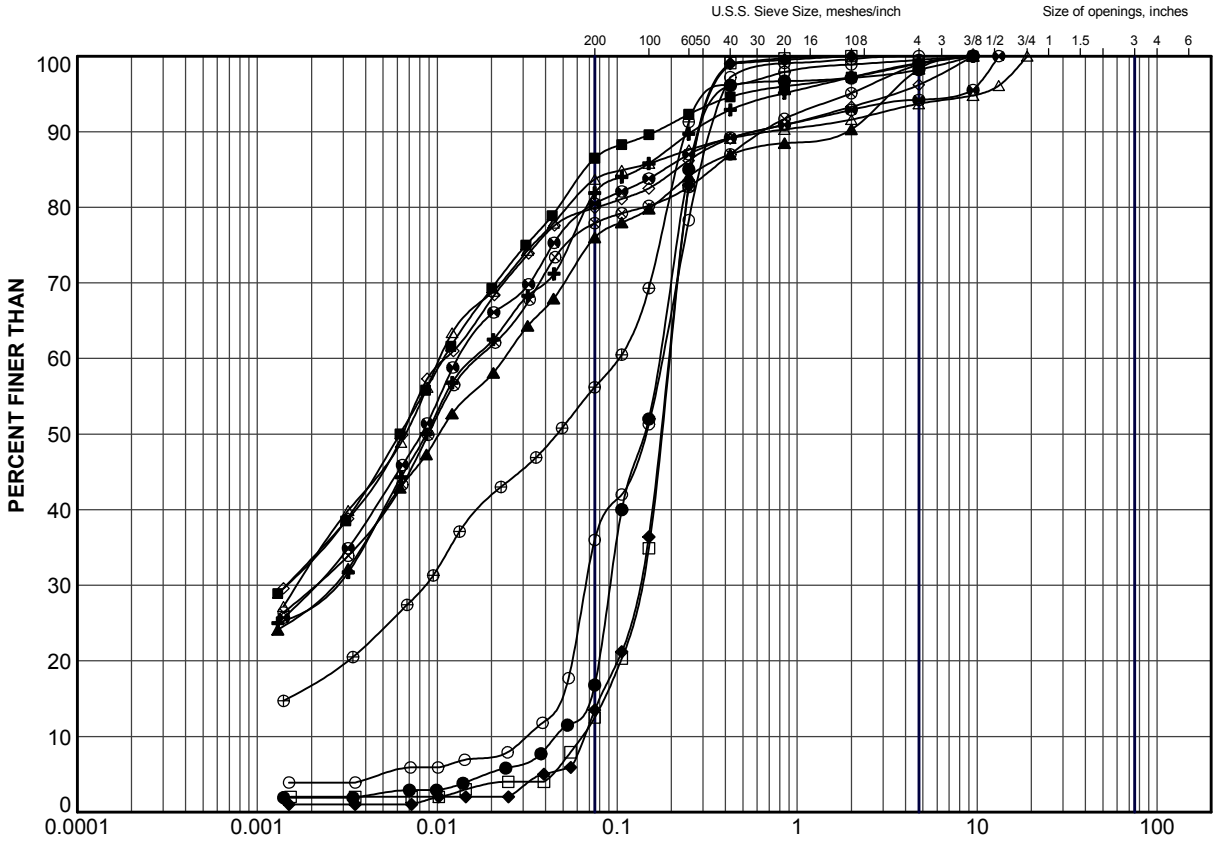
Geocres No. 40I14-182

HWY. 401		PROJECT NO. 12-1132-0076	DIST.
SUBM'D. BT	CHKD.	DATE: Aug. 23/18	SITE:
DRAWN: ZJB	CHKD.	APPD.	DWG. 4

PLOT DATE: November 05, 2018
FILENAME: N:\active\2012\1132 - Geo\1132-0000\12-1132-0076 DILLON-11 STRUCTURES-2011-E-0045\Drafting\AutoCAD Files\12113200976-2801A-001001.dwg

APPENDIX A

Laboratory Test Data



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-414	2	261.2
■	BH-414	8	256.5
▲	BH-414	10	255.0
✚	BH-416	4	259.3
◆	BH-423	3	260.9
◇	BH-424	4	260.1
○	BH-425	4	260.1
△	BH-429	5	259.0
⊗	BH-429	8	256.7
⊕	BH-429	11	254.5
□	BH-430	2	261.1
⊖	BH-430	5	258.8

PROJECT

DORCHESTER ROAD RAMPS
HIGHWAY 401 INTERCHANGE IMPROVEMENTS
GWP 3053-11-00

TITLE

GRAIN SIZE DISTRIBUTION

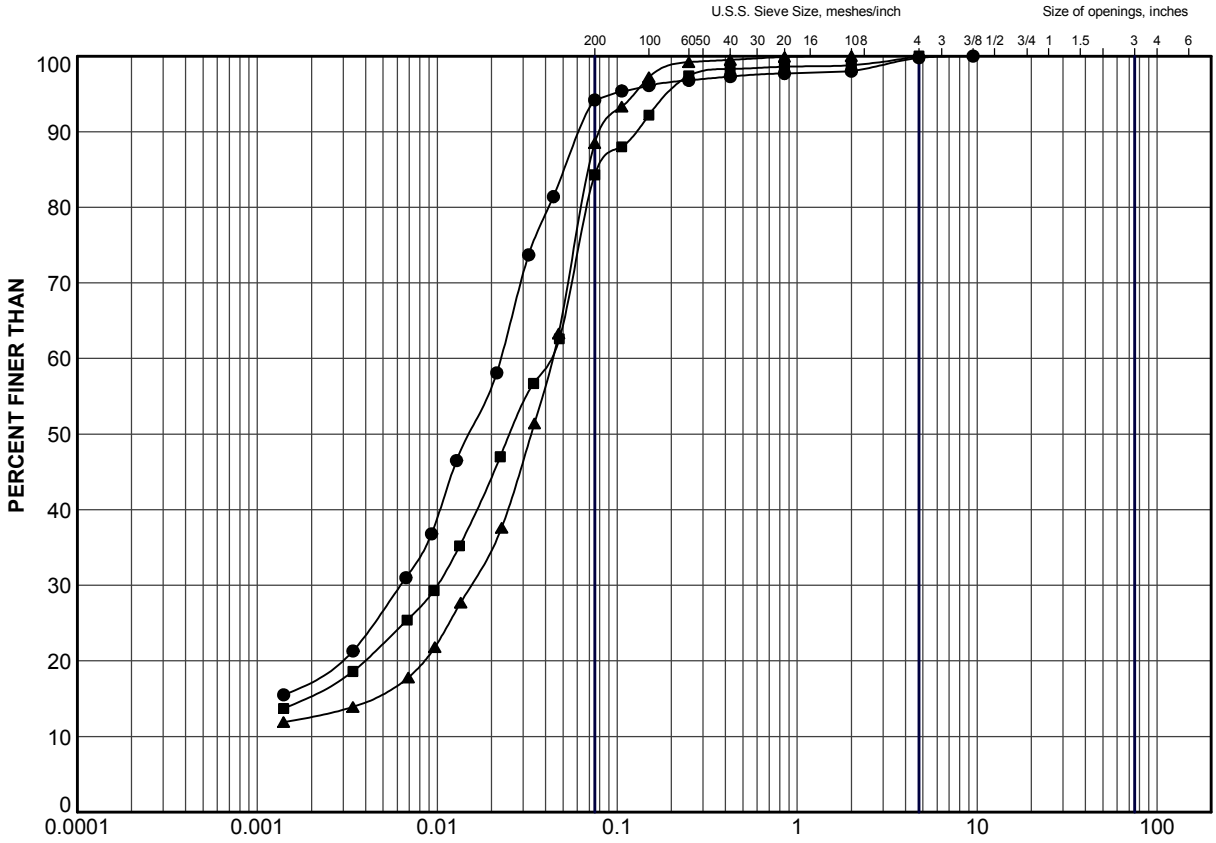
FILL

Golder Associates

PROJECT No.	12-1132-0076		FILE No.	1211320076-2001A-F010A1
			SCALE	N/A REV.
DRAWN	LMK	Mar 08/18		
CHECK				

FIGURE A-1

LDN_MTO_GSD-15 GLDR_LDN.GDT 24/01/18 14:35



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-423	11	254.8
■	BH-424	10	255.5
▲	BH-428	10A	252.8

PROJECT

DORCHESTER ROAD RAMPS
HIGHWAY 401 INTERCHANGE IMPROVEMENTS
GWP 3053-11-00

TITLE

GRAIN SIZE DISTRIBUTION

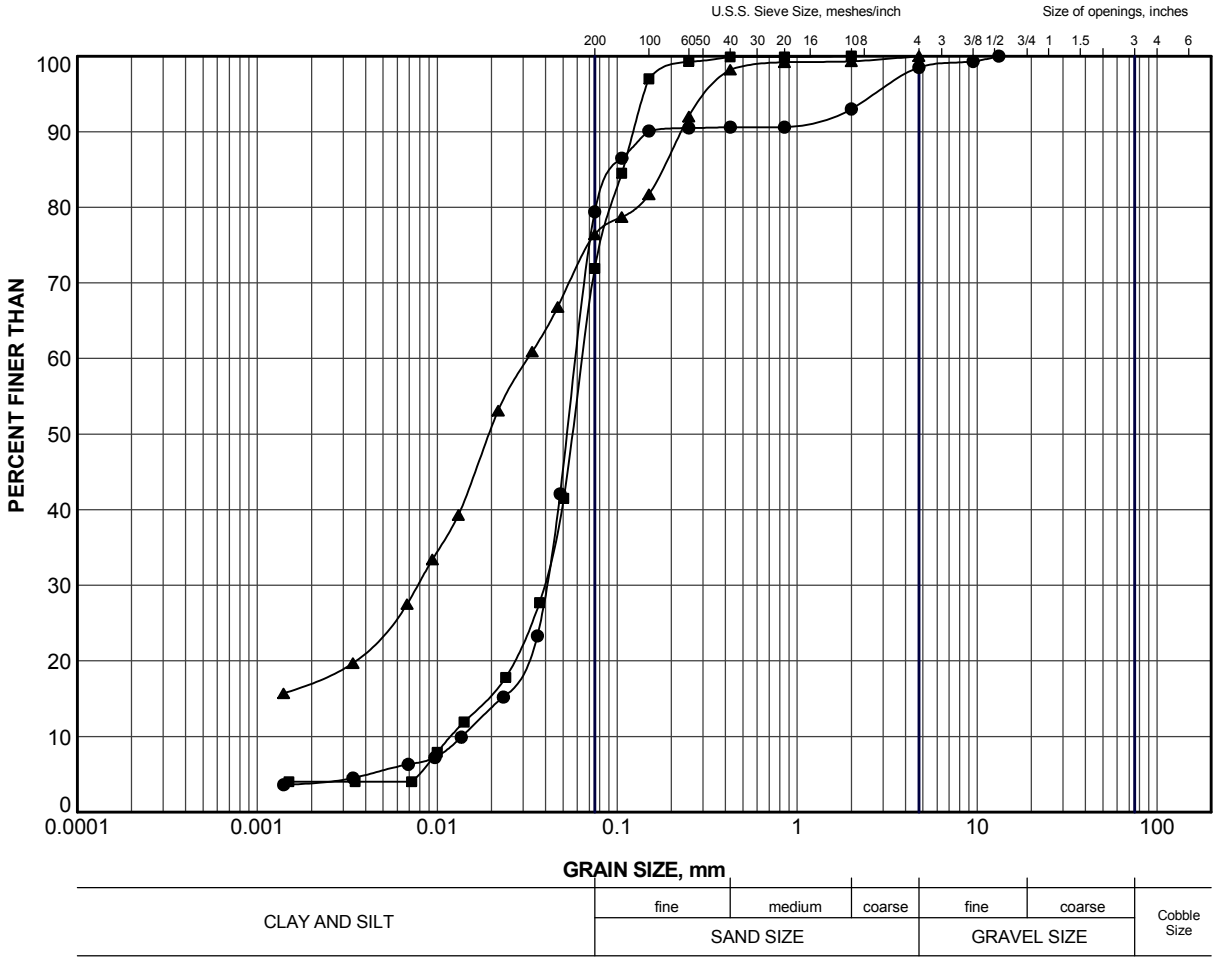
SILT

Golder Associates

PROJECT No.	12-1132-0076		FILE No.	1211320076-2001A-F010A2
			SCALE	N/A REV.
DRAWN	LMK	Mar 08/18		
CHECK				

FIGURE A-2

LDN_MTO_GSD_GLDR_LDN.GDT 24/01/18 14:47



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-405	21	252.9
■	BH-423	9	256.3
▲	BH-431	9B	253.6

PROJECT

DORCHESTER ROAD RAMPS
HIGHWAY 401 INTERCHANGE IMPROVEMENTS
GWP 3053-11-00

TITLE

GRAIN SIZE DISTRIBUTION

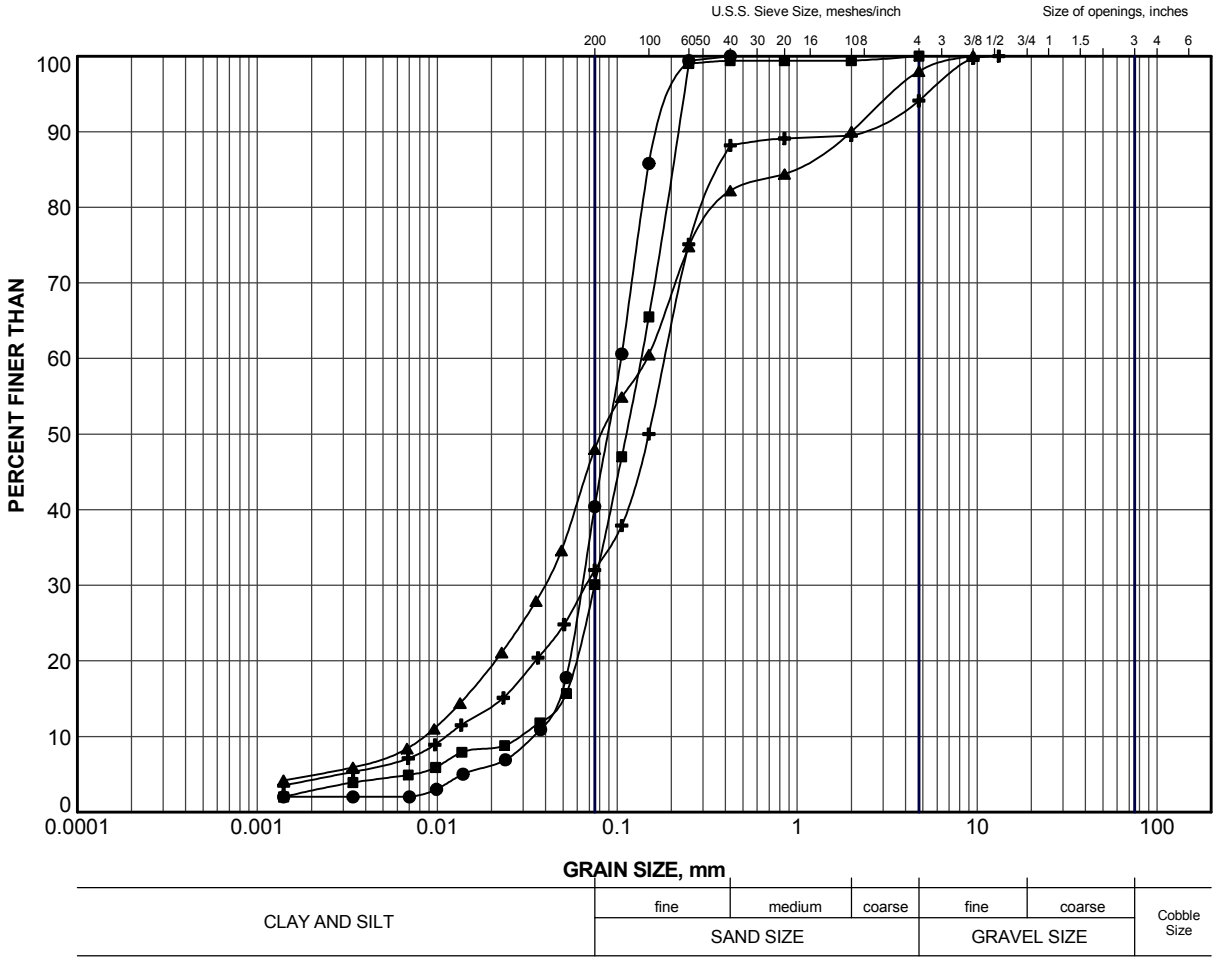
SANDY SILT

Golder Associates

PROJECT No.	12-1132-0076		FILE No.	1211320076-2001A-F010A3
			SCALE	N/A REV.
DRAWN	LMK	Mar 08/18		
CHECK				

FIGURE A-3

LDN_MTO_GSD_GLDR_LDN.GDT 24/01/18 14:42



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-405	16	260.6
■	BH-405	20	254.5
▲	BH-416	9	253.3
✚	BH-416	10	251.7

PROJECT

DORCHESTER ROAD RAMPS
HIGHWAY 401 INTERCHANGE IMPROVEMENTS
GWP 3053-11-00

TITLE

GRAIN SIZE DISTRIBUTION

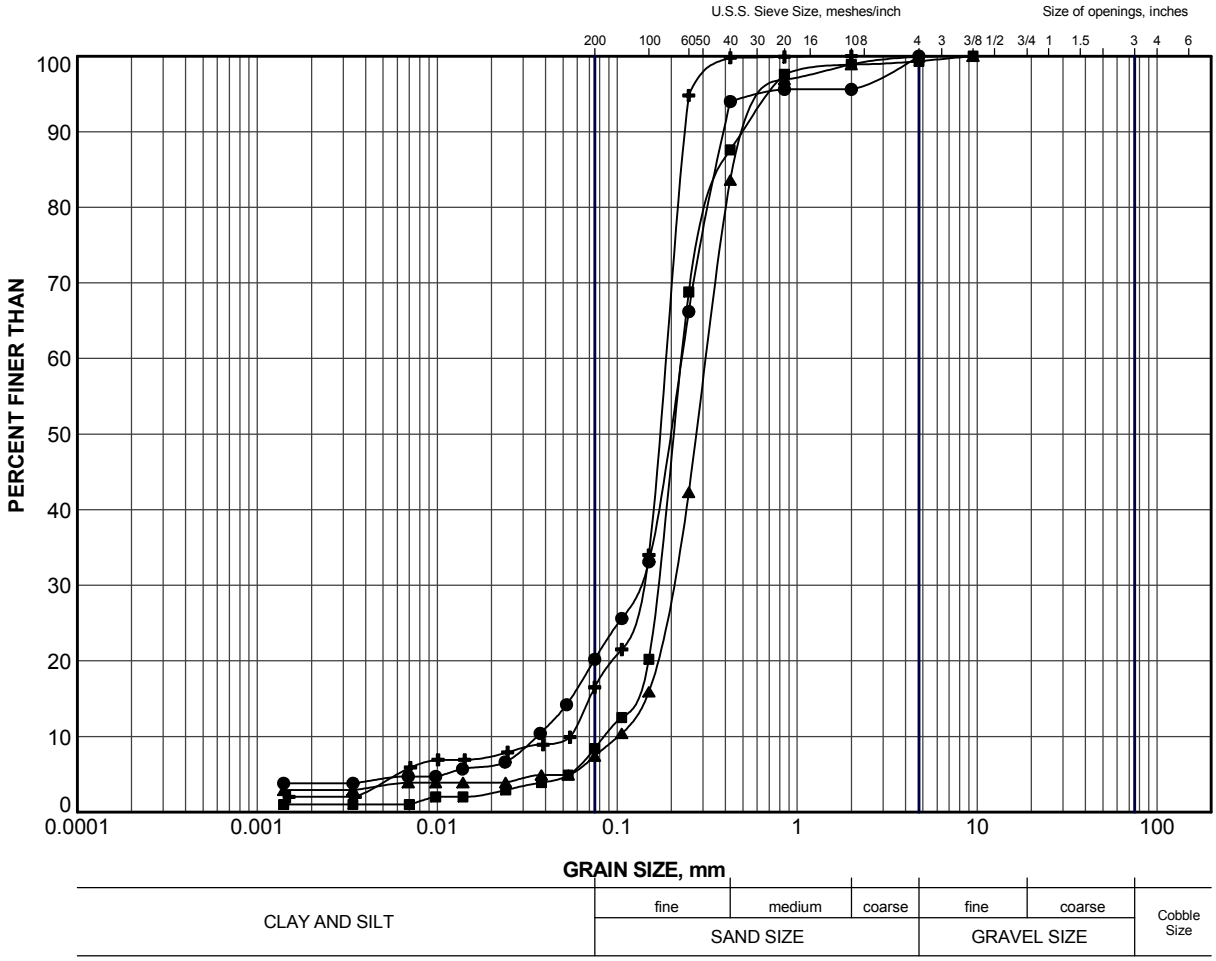
SILTY SAND

Golder Associates

PROJECT No.	12-1132-0076		FILE No.	1211320076-2001A-F010A4
			SCALE	N/A REV.
DRAWN	LMK	Mar 08/18		
CHECK				

FIGURE A-4

LDN_MTO_GSD_GLDR_LDN.GDT 24/01/18 16:10



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-409	2	265.8
■	BH-414	13	250.4
▲	BH-415	7	251.5
✚	BH-428	10B	252.5

PROJECT

DORCHESTER ROAD RAMPS
HIGHWAY 401 INTERCHANGE IMPROVEMENTS
GWP 3053-11-00

TITLE

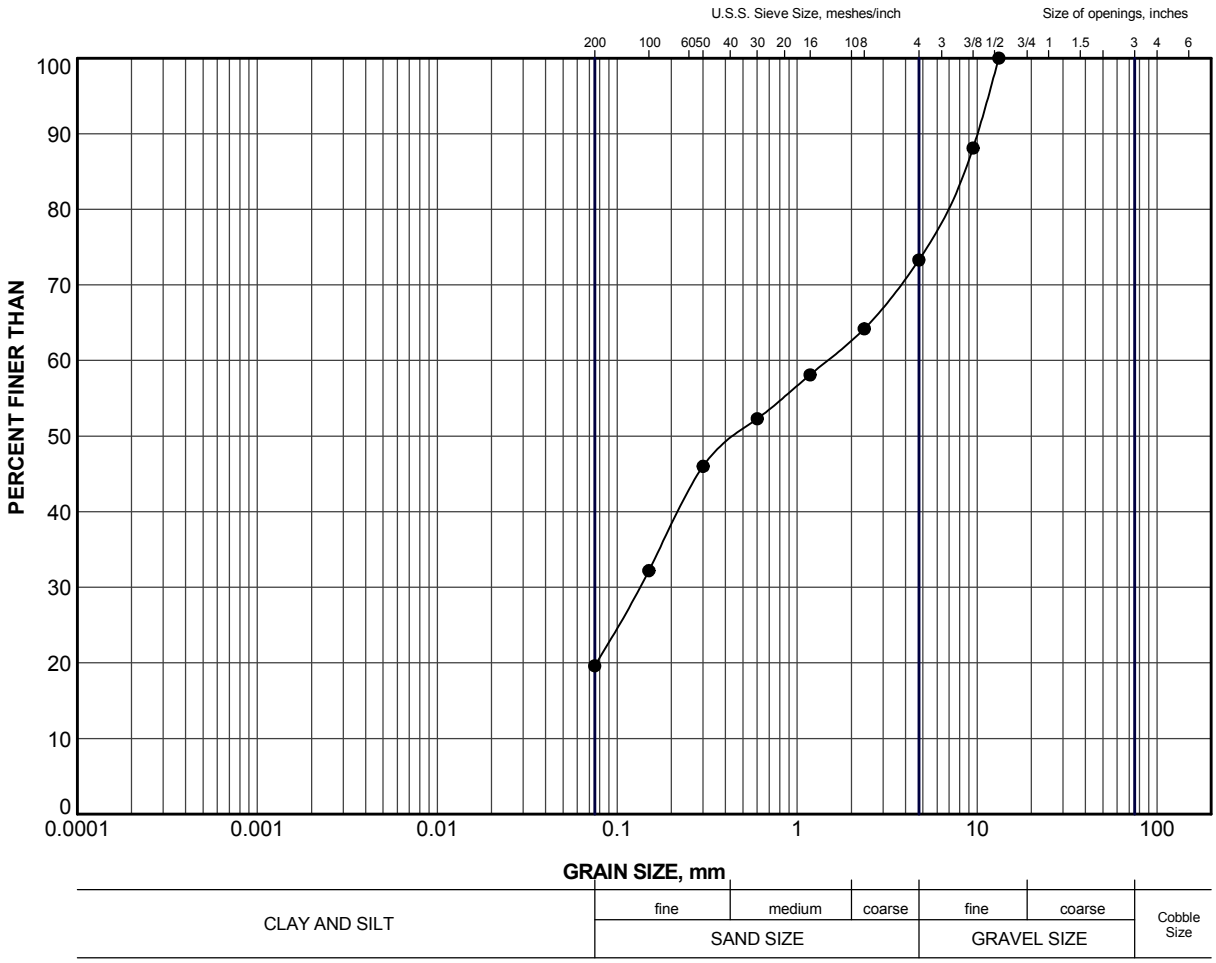
GRAIN SIZE DISTRIBUTION

SAND

Golder Associates

PROJECT No. 12-1132-0076			FILE No. 1211320076-2001A-F010A5
			SCALE N/A REV.
DRAWN	LMK	Mar 08/18	
CHECK			FIGURE A-5

LDN_MTO_GSD_GLDR_LDN.GDT 24/01/18 16:09



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-406	9	267.3

PROJECT

DORCHESTER ROAD RAMPS
HIGHWAY 401 INTERCHANGE IMPROVEMENTS
GWP 3053-11-00

TITLE

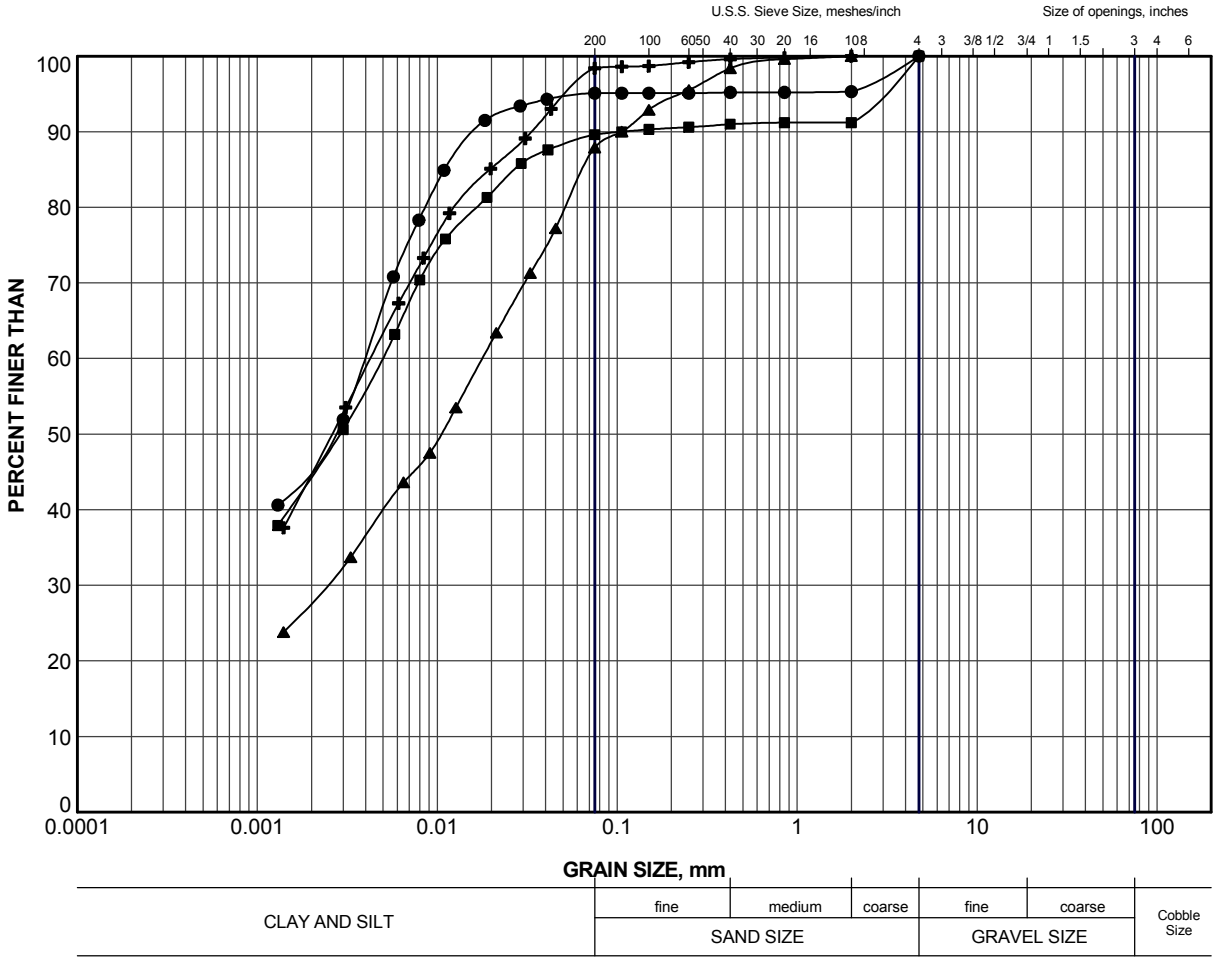
GRAIN SIZE DISTRIBUTION

SAND AND GRAVEL

Golder Associates

PROJECT No. 12-1132-0076			FILE No. 1211320076-2001A-F010A6	
			SCALE N/A	REV.
DRAWN	LMK	Mar 08/18	FIGURE A-6	
CHECK				

LDN_MTO_GSD_GLDR_LDN.GDT 24/01/18 16:12



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-406	7	268.8
■	BH-413	3	258.3
▲	BH-422	5	259.7
✚	BH-428	8	254.2

PROJECT

DORCHESTER ROAD RAMPS
HIGHWAY 401 INTERCHANGE IMPROVEMENTS
GWP 3053-11-00

TITLE

GRAIN SIZE DISTRIBUTION

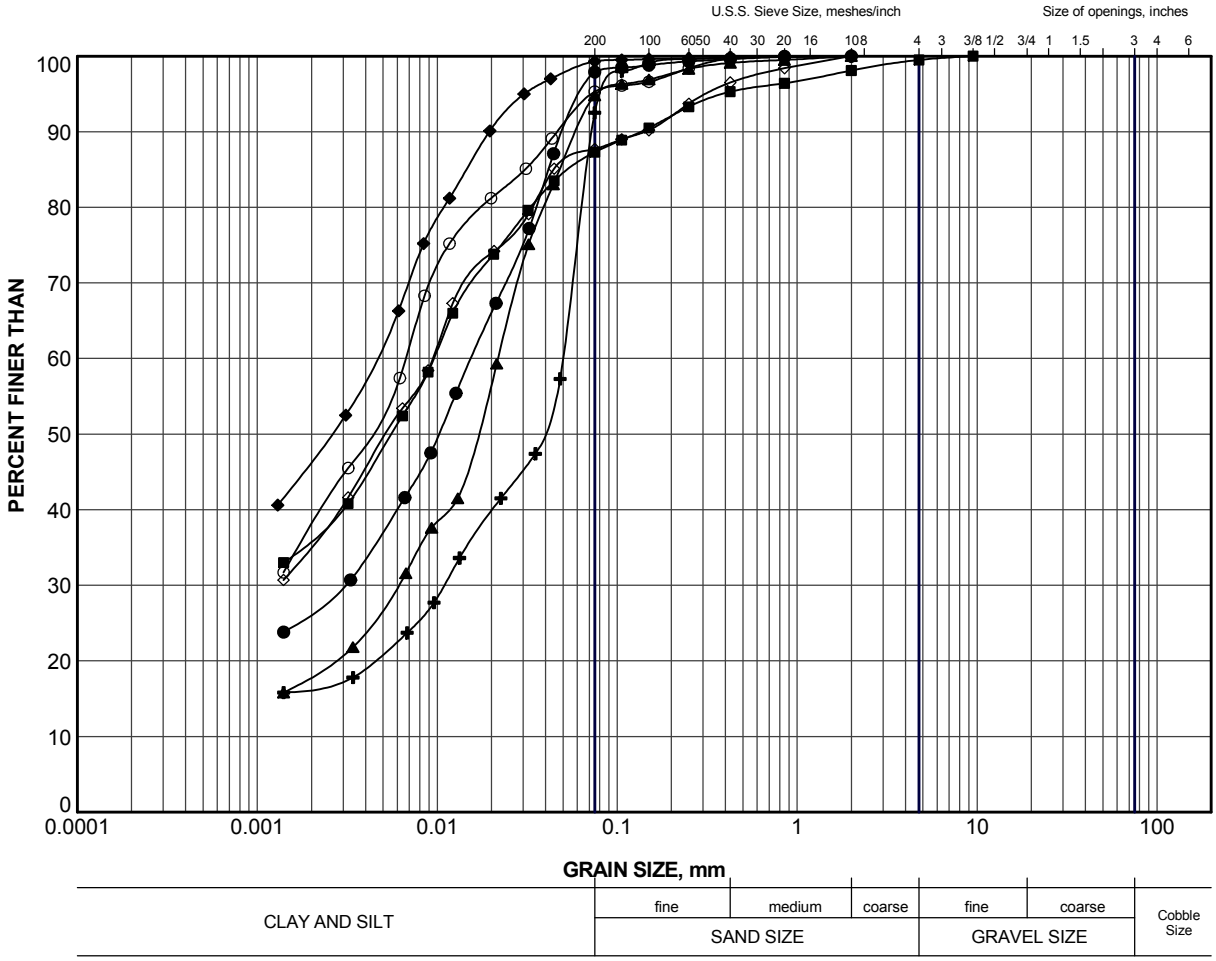
SILTY CLAY

Golder Associates

PROJECT No.	12-1132-0076		FILE No.	1211320076-2001A-F010A7
			SCALE	N/A REV.
DRAWN	LMK	Mar 08/18		
CHECK				

FIGURE A-7

LDN_MTO_GSD_GLDR_LDN.GDT 24/01/18 14:33



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-424	7B	257.7
■	BH-424	12	253.2
▲	BH-425	8	257.0
✚	BH-426	8	254.0
◆	BH-427	9	253.6
◇	BH-430	9	255.8
○	BH-431	8	254.5

PROJECT

DORCHESTER ROAD RAMPS
HIGHWAY 401 INTERCHANGE IMPROVEMENTS
GWP 3053-11-00

TITLE

GRAIN SIZE DISTRIBUTION

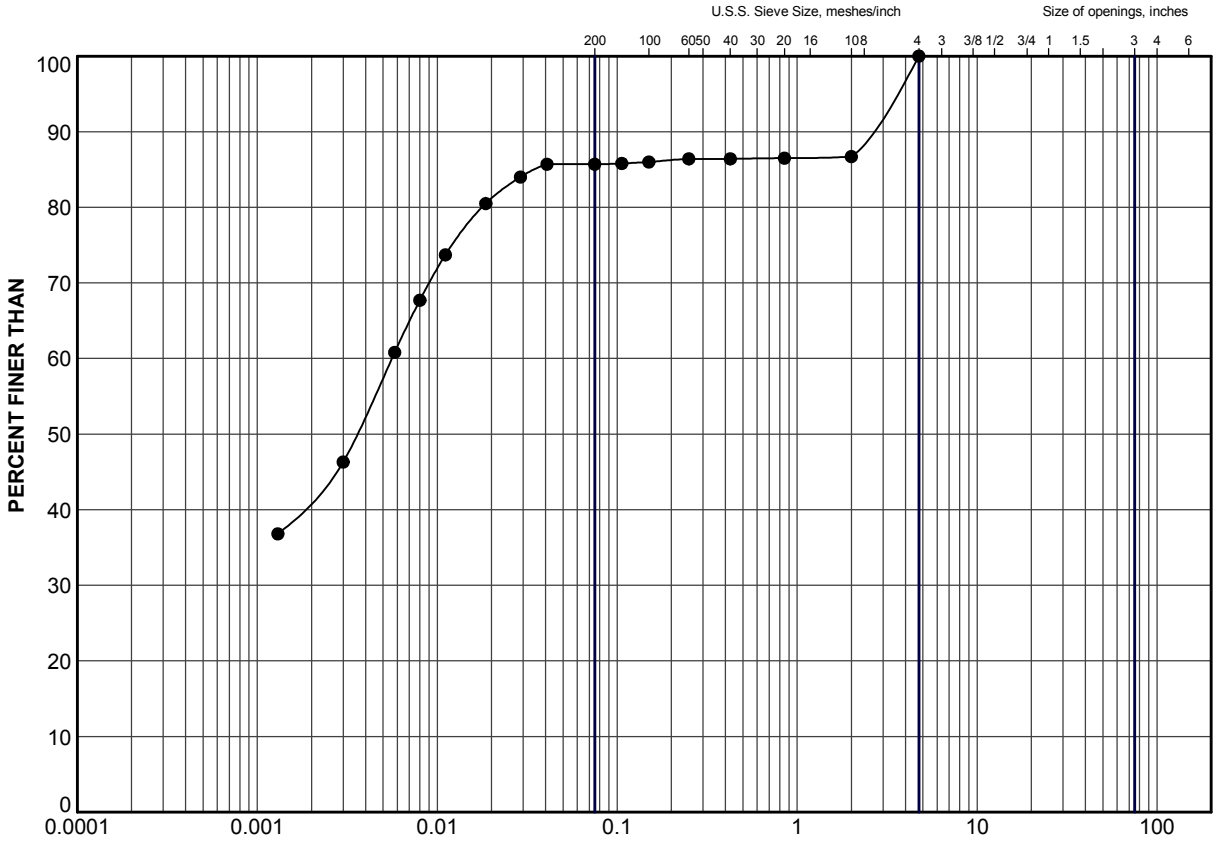
CLAYEY SILT

Golder Associates

PROJECT No.	12-1132-0076	FILE No.	1211320076-2001A-F010A8
		SCALE	N/A
DRAWN	LMK	Mar 08/18	REV.
CHECK			

FIGURE A-8

LDN_MTO_GSD_GLDR_LDN.GDT 24/01/18 16:07



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-412	3	261.9

PROJECT

DORCHESTER ROAD RAMPS
HIGHWAY 401 INTERCHANGE IMPROVEMENTS
GWP 3053-11-00

TITLE

GRAIN SIZE DISTRIBUTION

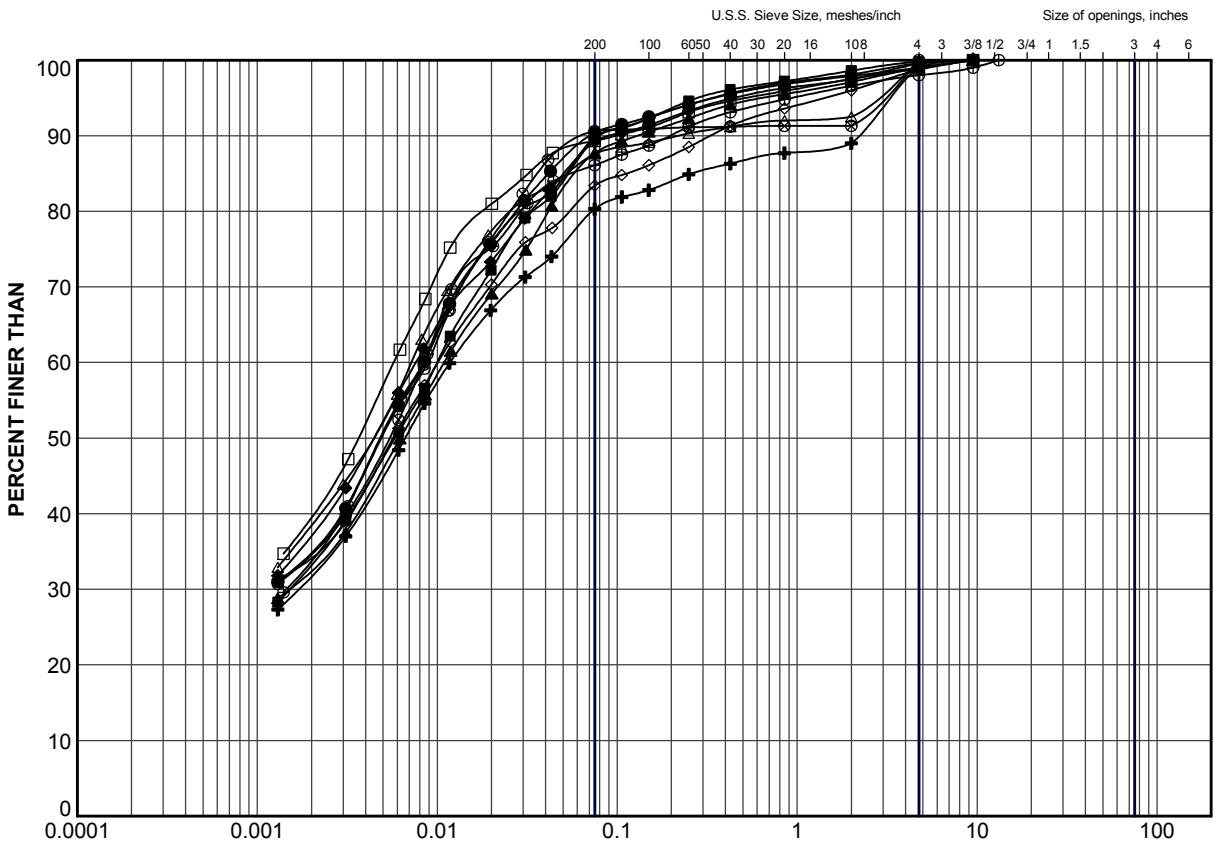
SILTY CLAY TILL

Golder Associates

PROJECT No.	12-1132-0076		FILE No.	1211320076-2001A-F010A9
			SCALE	N/A
DRAWN	LMK	Mar 08/18	REV.	
CHECK				

FIGURE A-9

LDN_MTO_GSD_GLDR_LDN.GDT 24/01/18 16:13



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-405	6	272.8
■	BH-405	10	269.7
▲	BH-406	4	271.1
✚	BH-407	3	272.3
◆	BH-408	4	267.4
◇	BH-409	6	262.7
○	BH-410	5	263.1
△	BH-411	1	264.4
⊗	BH-412	5	260.4
⊕	BH-421	3	263.4
□	BH-422	8	257.4

PROJECT

DORCHESTER ROAD RAMPS
HIGHWAY 401 INTERCHANGE IMPROVEMENTS
GWP 3053-11-00

TITLE

GRAIN SIZE DISTRIBUTION

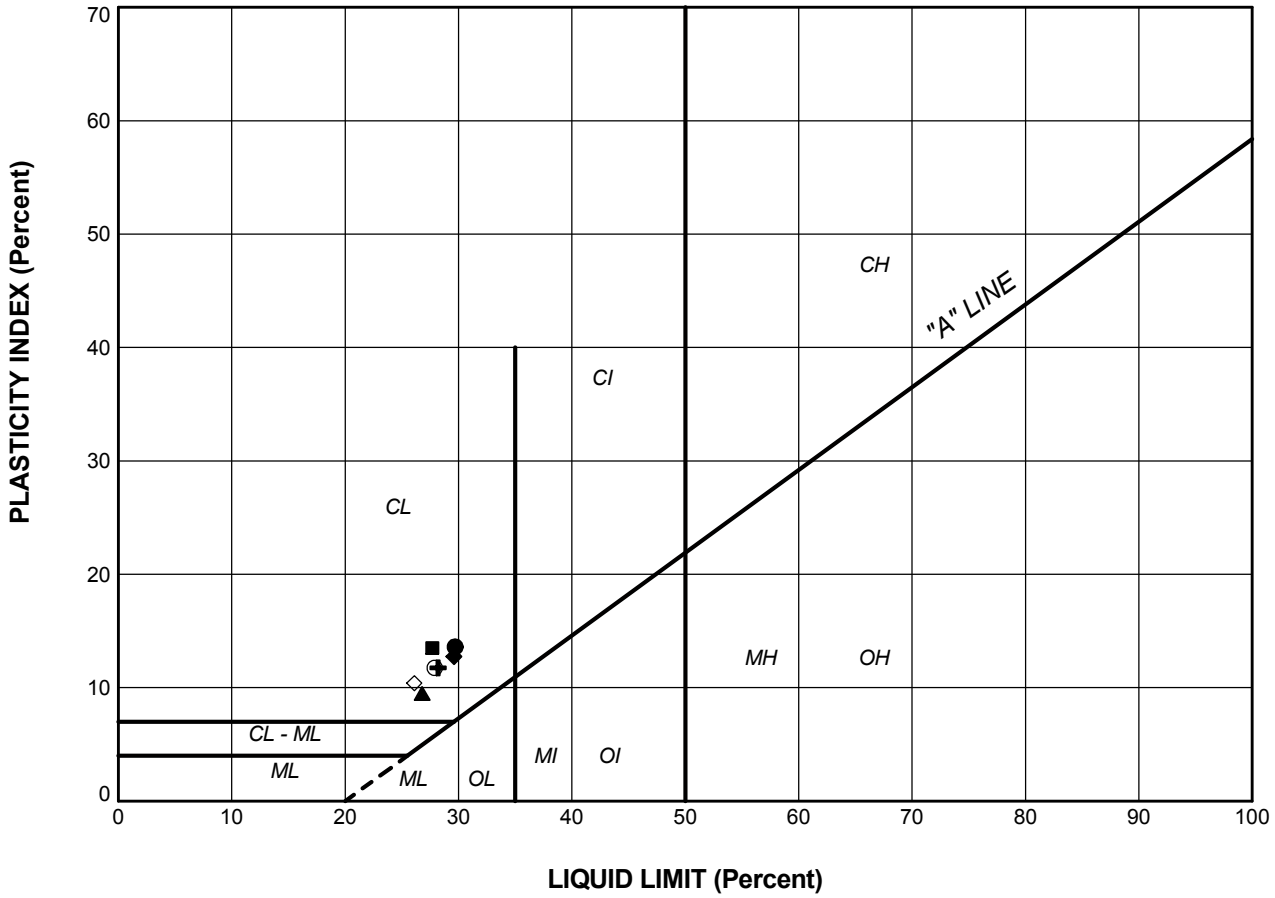
CLAYEY SILT TILL

Golder Associates

PROJECT No.	12-1132-0076	FILE No.	1211320076-2001A-F010A10
		SCALE	N/A REV.
DRAWN	LMK	Mar 08/18	
CHECK			

FIGURE A-10

LDN_MTO_GSD-15 GLDR_LDN.GDT 24/01/18 14:30



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	BH-414	8	29.7	16.1	13.6
■	BH-414	10	27.7	14.2	13.5
▲	BH-416	4	26.8	17.3	9.5
✚	BH-424	4	28.2	16.5	11.8
◆	BH-429	5	29.6	16.9	12.8
◇	BH-429	8	26.1	15.7	10.4
○	BH-430	5	27.9	16.2	11.8

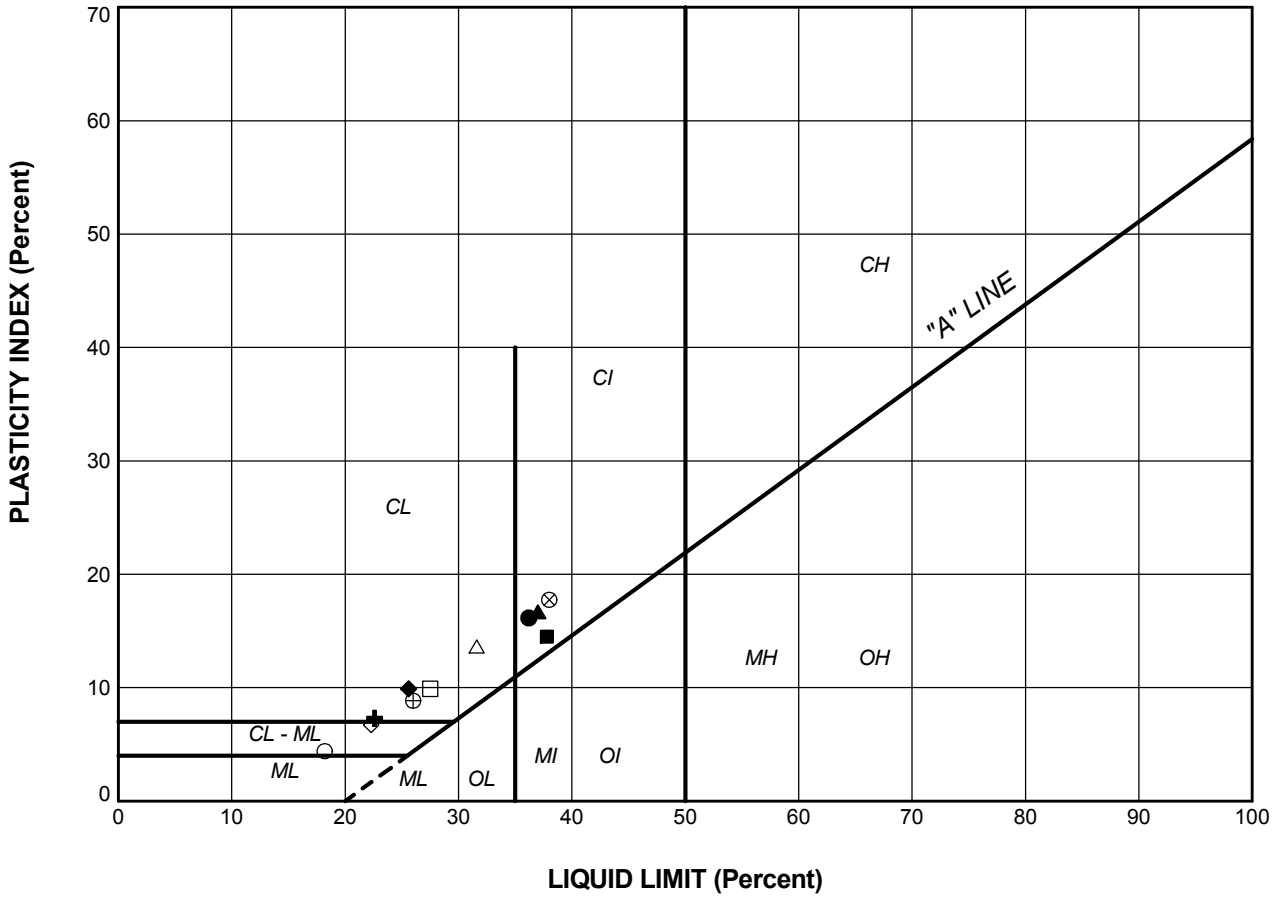
PROJECT
DORCHESTER ROAD RAMPS
HIGHWAY 401 INTERCHANGE IMPROVEMENTS
GWP 3053-11-00

TITLE
PLASTICITY CHART (FILL)

Golder Associates

PROJECT No.	12-1132-0076	FILE No.12-1132-0076-2001A-F010A11
		SCALE N/A REV.
DRAWN	ZJB Mar 08/18	
CHECK		**FIGURE A-11**

LDN_MTO_PI GLDR_LDN.GDT 26/02/18 11:56



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	BH-406	7	36.2	20.1	16.2
■	BH-413	3	37.8	23.3	14.5
▲	BH-422	5	37.0	20.3	16.7
✚	BH-424	7B	22.6	15.3	7.3
◆	BH-424	12	25.6	15.7	9.9
◇	BH-425	8	22.3	15.6	6.7
○	BH-426	8	18.2	13.8	4.4
△	BH-427	9	31.6	18.0	13.7
⊗	BH-428	8	38.0	20.3	17.8
⊕	BH-430	9	26.0	17.2	8.9
□	BH-431	8	27.5	17.6	9.9

PROJECT

DORCHESTER ROAD RAMPS
HIGHWAY 401 INTERCHANGE IMPROVEMENTS
GWP 3053-11-00

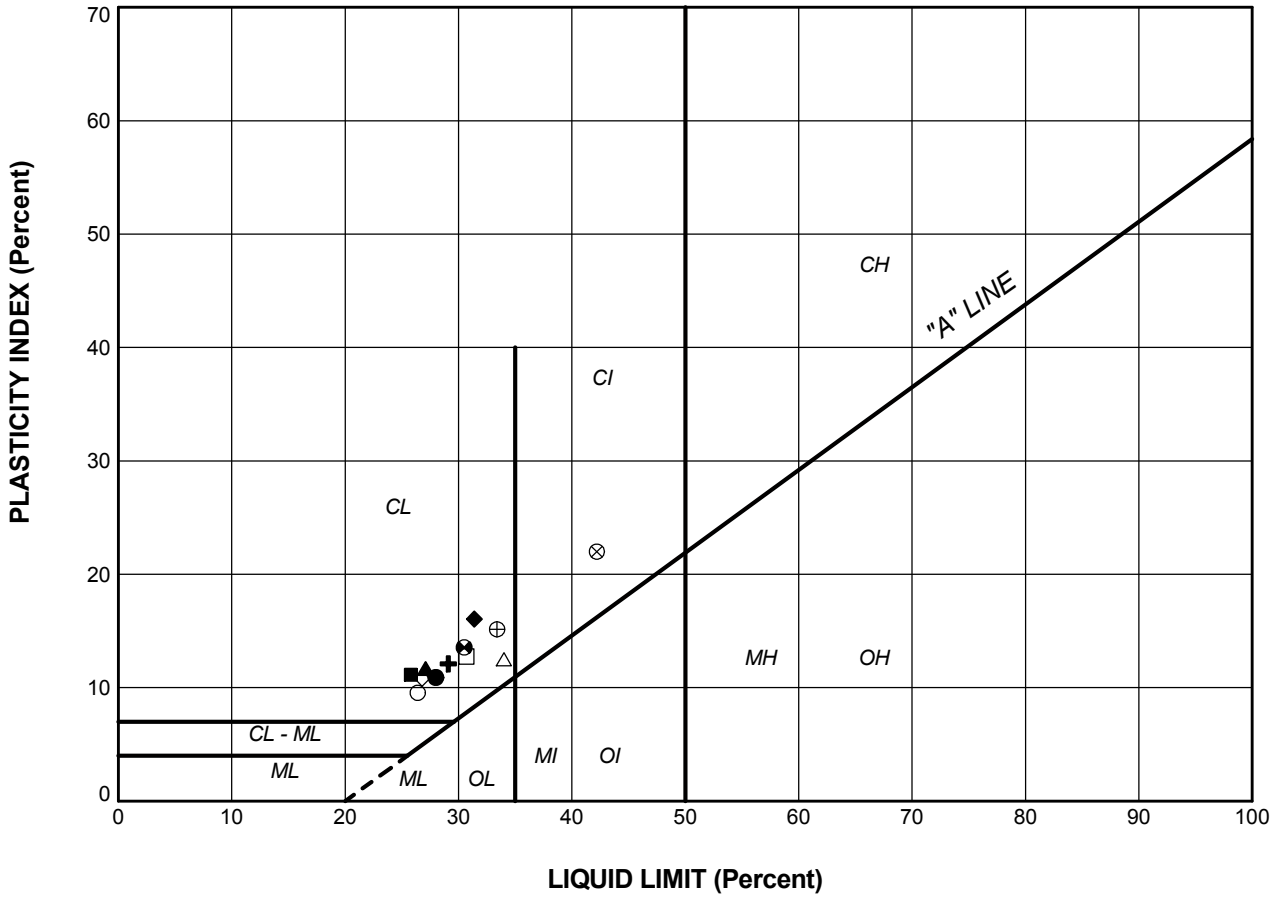
TITLE

PLASTICITY CHART
(COHESIVE DEPOSITS)

Golder Associates

PROJECT No.	12-1132-0076		FILE No.12-1132-0076-2001A-F010A12
			SCALE N/A REV.
DRAWN	ZJB	Mar 08/18	
CHECK			**FIGURE A-12**

LDN_MTO_PI GLDR_LDN.GDT 26/02/18 12:00



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	BH-405	6	28.0	17.1	10.9
■	BH-405	10	25.8	14.7	11.2
▲	BH-406	4	27.1	15.4	11.7
✚	BH-407	3	29.1	17.0	12.1
◆	BH-408	4	31.4	15.4	16.1
◇	BH-409	6	26.8	16.0	10.8
○	BH-410	5	26.4	16.9	9.6
△	BH-411	4	34.0	21.5	12.5
⊗	BH-412	3	42.2	20.2	22.0
⊕	BH-412	5	33.4	18.3	15.2
□	BH-421	3	30.7	18.0	12.8
◓	BH-422	8	30.5	17.0	13.6

PROJECT
DORCHESTER ROAD RAMPS
HIGHWAY 401 INTERCHANGE IMPROVEMENTS
GWP 3053-11-00

TITLE
PLASTICITY CHART
(GLACIAL TILL)

Golder Associates

PROJECT No.	12-1132-0076	FILE No. 12-1132-0076-2001A-F010A13
		SCALE N/A REV.
DRAWN	ZJR Mar 08/18	
CHECK		FIGURE A-13

LDN_MTO_PI_GLDR_LDN.GDT 26/02/18 12:06

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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