PRELIMINARY FOUNDATION INVESTIGATION
AND DESIGN REPORT
HIGHWAY 407 EAST– CENTRAL SECTION (EAST PART)
REGION OF DURHAM, ONTARIO
W.O. 07-20016

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EXECUTIVE SUMMARY

The proposed Highway 407 East extension extends from the current terminus of Highway 407 at Brock Road in the City of Pickering to Highway 35/115 in the Municipality of Clarington. For the purposes of preliminary design, the project route has been divided into three (3) sections (the Western Section, the Central Section and the Eastern Section) as shown on Drawing C-01.

The planning study and preliminary design of foundations component for the proposed Highway 407 East project were carried out in two (2) separate phases. A Phase I Desktop Study for this project was completed in 2008 for each section of the proposed highway extension for planning and feasibility study purposes by Thurber Engineering Ltd. (Thurber) and is presented in three (3) separate reports for each section titled "Foundation Desktop Study, Highway 407 East – Western Section; Central Section; Eastern Section", W.O 07-20015 to 07-20017 dated October 2008. The Phase I Desktop Study was based on an assessment of site geology using air-photo interpretation, hydrogeologic information and borehole data obtained from previous investigations including the preliminary investigation conducted by MTO in 1994 for planning purposes.

Similar to the planning study, the construction of the proposed Highway 407 East has been divided into 2 phases. Phase 1 includes construction from the current terminus of Highway 407 at Brock Road easterly to Harmony Road and Phase 2 includes construction from Harmony Road easterly to Highway 35/115. Phase 2 was further divided into the Central Section (East Part) which extends from Harmony Road in the City of Oshawa to Courtice Road in the Municipality of Clarington and the Eastern Section that extends from Courtice Road to Highway 35/115 in the Municipality of Clarington. Recommendations pertaining to the Eastern Section are provided under a separate cover.

The Central Section including West and East parts extends from Ashburn Road to Courtice Road in the Municipality of Clarington. In 2010, Thurber prepared the Preliminary Foundation Investigation and Design Report (FIDR) with the results of the Phase II foundation investigation and recommendations for the planning and preliminary design of the proposed Highway 407 East – Central Section (East part) and Central Section (West part). The purpose of Thurber's Phase II study was to provide "as near as possible" preliminary design level foundation investigation and design information given the constraints at the time of the investigation. The Thurber preliminary FIDR superseded all previous reports including the Desktop Study for the purpose of preliminary foundation design.

Peto MacCallum Ltd. (PML) prepared this report to supplement Thurber's preliminary report on the Central Section (East part) referenced above. This report is presented in three (3) parts:

Part A – Preliminary Foundation Investigation Report (FIR): presents an overall description of the project, description of the regional geology/geomorphology and general groundwater conditions within the project limits and site-specific subsurface and groundwater conditions at each of the proposed highway bridge crossings and interchanges, culverts, deep cuts and high fills based on the results of limited borehole investigation and laboratory testing carried out. Individual Preliminary FIR sheets summarizing the results of the field investigation and geotechnical laboratory testing for each structure site are presented following the text of the report.

Part B – Preliminary Foundation Design Report (FDR): provides project-wide engineering recommendations for preliminary design for each proposed structure, culvert, deep cut and high fill site.

Part C – Site Specific Preliminary Foundation Investigation and Design Report (FIDR) Sheets: provides individual site specific recommendations.

Each highway crossing site (i.e. bridge, culvert, etc.) was characterized in the Request for Proposal (RFP) as requiring low, medium or high level investigative effort. The definitions of the target effort levels are defined in the RFP and summarized in Section 3.0 of this report. The desired investigation effort was achieved at each of the 10 required sites (4 bridges, 1 culvert, 3 deep cut sections and 2 high fill sections) included in this report.

For deep cut and high fill sections (depth/height greater than 4.5 m), summary tables have been included that identify the deep cut and high fill locations, depths/heights, the anticipated subsurface conditions, and preliminary geotechnical recommendations.

The record of borehole sheets, laboratory testing, and record of borehole sheets from previous investigations are presented in Appendices A, B and C respectively.

While the information presented in this report may be used for planning and preliminary design purposes, it is not sufficient nor intended for detail design purposes. The preliminary subsurface investigation was limited to borehole drilling within accessible parts of sites. Locally, species at risk legislation limited drill rig access. Where drilling was carried out, the boreholes were not necessarily advanced at or within the footprint of the foundation elements. Accordingly, further investigation will be required at the final locations of the foundation elements, approaches, deep cut and high fill sections during detail design to establish or confirm/reassess the preliminary recommendations provided herein.

PART A

PRELIMINARY FOUNDATION INVESTIGATION REPORT
HIGHWAY 407 EAST – CENTRAL SECTION (EAST PART)
REGION OF DURHAM, ONTARIO
W.O. 07-20016

1.0 INTRODUCTION

This report presents the factual findings obtained in the preliminary foundation investigation carried out by PML in the period of October 1, 2012 to July 29, 2013 to supplement the preliminary investigation carried out by Thurber for the preliminary design of the proposed Highway 407 East – Central Section (East Part), refer to Drawing C-01. The project limits extend from Harmony Road in the City of Oshawa to Courtice Road in the Municipality of Clarington (approximately 5 km).

Delcan has been retained by MTO to undertake the 407E Phase 2 Owner's Engineer (OE) Assignment (Purchase Order No. 2011-E-0006). PML conducted the foundation investigation as a sub-consultant to Delcan under this OE assignment. The terms of reference and scope of work for the preliminary foundation investigation and design are outlined in MTO's Request for Proposal (RFP) for Work Orders No. 07-20016 and 07-20017.

All elevations in this report are expressed in metres and refer to the geodetic datum.

2.0 PROJECT DESCRIPTION

The technically recommended route for the proposed Highway 407 East starts at the current terminus at Brock Road in the City of Pickering and ends at Highway 35/115 in the Municipality of Clarington. The route includes two north-south links connecting the proposed Highway 407 extension to Highway 401 – the West Durham Link (WDL) in Whitby and the East Durham Link (EDL) in Clarington. The proposed highway extension is divided into three main sections: a Western Section which extends from Brock Road to Ashburn Road and includes the WDL, a Central Section which extends from Ashburn Road to Courtice Road, and an Eastern Section which extends from Courtice Road to Highway 35/115 in the Municipality of Clarington and includes the EDL. Drawing C-01 shows the proposed alignment for the above described overall route.

The Central Section (East Part) which is addressed in this report consists of a single roadway section referred to as the Highway 407 Central (East Part) Mainline. The Central Mainline is an approximately 5 km long highway section extending from Harmony Road in the City of Oshawa to Courtice Road in the Municipality of Clarington.

The original scope of work for this project, as described in the RFP, included a total of 10 sites (4 bridges, 1 culvert, 3 deep cut sections and 2 high fill sections). This report provides sufficient information for planning and preliminary foundation investigation and design at all 10 required sites.

Structures were originally designated as 'CM' (Central Mainline) with sequential numbers. The initial structure numbering system was retained by Thurber for the preliminary foundation report, however a new structure numbering system was subsequently provided. The new structure designation for the Mainline is 'M-' with sequential numbering. It is noted that PML has used the new structure numbering system with boreholes featuring an 'M-' numbered in accordance with their respective structure. A cross-reference of site numbers is provided in Table 1, Section 4.2.

It is also noted that subsequent to the preliminary foundation report by Thurber the stationing along the proposed Highway 407 extension was updated. This updated stationing has used by PML, unless otherwise noted.

In addition to the grade separation, bridge and culvert structures, there are deep cuts and high fill sections along the proposed alignment. The deep cuts and high fills are defined as sections where the depth of cut or height of fill exceeds 4.5 m. The deep cut and high fill sections are summarized in Table 2 in Section 4.2.

The proposed Highway 407 Central (East Part) Mainline route runs mainly through farmland, crossing a number of creek valleys, tributaries, as well as municipal and regional roads. Several wide low-lying valleys are present where the mainline crosses multiple creeks present along the alignment. The overall surface topography along the proposed routes is gently sloping downward from the east and west limits towards the centre of the mainline alignment near Regional Road 57 and to the south towards Lake Ontario. The area is incised by various creeks and associated tributaries, such as Harmony Creek and Farewell Creek.

3.0 INVESTIGATION PROCEDURES

Where no conflicts with environmentally sensitive areas (ESA), provincially significant wetlands (PSW) or species at risk (SAR) were present, subsurface investigations were carried out at or adjacent to the locations of the proposed bridge sites. The subsurface investigations presented in this report were conducted by PML in the period of October 1, 2012 to July 29, 2013 and involved a total of 19 boreholes (12 boreholes for bridge sites, 2 boreholes for culvert sites, 3 boreholes for deep cut sites and 2 boreholes for high fill sites) to depths of 6.2 to 38.4 m. Selected borehole data from Thurber's investigation and the "Foundation Investigation Report for Environmental Assessment (Hydrogeology Specialty) – Highway 407 East – Central Section" prepared by AECOM in January, 2009 has been used for preparation of this report.

The complexity of each site (i.e. target investigative effort level) was defined by Thurber based on existing geological information and available borehole information from previous investigations. The corresponding number of boreholes required to be advanced at each bridge/interchange site was determined by the site complexity designation as specified in the RFP and as summarized below:

- Low complexity sites: no borehole investigation required;
- Medium complexity sites: two (2) boreholes required; one (1) at or as close as possible to each of the proposed abutment locations; and
- High complexity sites: four (4) boreholes required; two boreholes at or near the proposed bridge abutment locations and two (2) boreholes at the locations of the approaches.

The field investigations were carried out using truck-mounted and track-mounted drill rigs supplied and operated by Fisher Environmental Ltd. and Eastern Soil Drilling. The boreholes were advanced using solid and hollow stem augers or wash boring methods to competent strata and generally penetrated 3 m beyond refusal, described as a standard penetration test N value greater than 100-blows.

Soil samples were obtained at selected intervals using a split-spoon sampler in accordance with the Standard Penetration Test (SPT) procedures (ASTM D1586 Standard Test Method for Standard Penetration Test). In-situ vane tests using an MTO 'N'-size vane (ASTM D2573 Standard Test Method for Field Vane Shear Test) were carried out at selected depths where soft to stiff cohesive soils were encountered.

The groundwater conditions in the open boreholes were observed throughout the drilling operations, and piezometers were installed at selected borehole locations. A total of eight (8) piezometers were installed by Thurber and PML as part of the subsurface investigation at or near sites mentioned in the RFP for this project. The piezometers consist of 19 mm or 50 mm outside diameter rigid PVC pipe with a 1.5 m long screen that is surrounded by a sand pack and sealed at a selected depth within the boreholes. The annulus between the borehole wall and the piezometer pipe above the filter pack was backfilled to ground surface using bentonite pellets. All other boreholes were backfilled to ground surface using bentonite pellets on completion of drilling in accordance with Ontario Regulation 903 Wells (as amended by Ontario Regulation 372).

Where artesian groundwater conditions were encountered in the boreholes, the artesian condition was sealed at the source. Details of the artesian condition and the sealing operations are included on the Record of Borehole sheets, where applicable.

The field work for the current study was supervised on a full-time basis by PML technical staff members who located the boreholes in the field, arranged for the clearance of underground service locations, directed the drilling, sampling, and in situ testing operations, and logged the boreholes. The soil samples were identified in the field, placed in labelled containers and transported to PML's laboratory in Toronto for further examination and testing. Various combinations of index and classification tests consisting of water content determinations, Atterberg limits and grain size distribution analyses were carried out on selected soil samples.

PML established borehole locations in the field and J.D. Barnes provided their co-ordinates and ground surface elevations at the boreholes. Thurber measured the borehole locations and elevations in the field using a Trimble Pathfinder ProXRT GPS unit with an accuracy of +/- 0.5 m. The northing and easting coordinates were based on MTM NAD83, with the ground surface elevations referenced to the Geodetic datum, as presented on the Record of Borehole sheets provided in Appendix A. All borehole locations were checked for the presence of underground utilities prior to drilling.

4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geology

The alignment of the proposed Highway 407 East – Central Section (East Part) is situated within the Regional Municipality of Durham which encompasses two major physiographic regions – the Oak Ridges Moraine and the South Slope, as delineated in *The Physiography of Southern Ontario*[1] and described below.

The Oak Ridges Moraine region forms the northern boundary of the alignment, and is comprised predominantly of sand and gravel deposits. The Oak Ridges Moraine is a major regional aquifer and groundwater recharge area.

In the South Slope region the majority of the Highway 407 mainline section lies within the South Slope region and is comprised of calcareous clay till with lacustrine clay and silt reworked by glaciers, with numerous scattered drumlins and deep valley cuts caused by flowing streams towards Lake Ontario.

[1] Chapman, L.J. and Putnam, D.F. *The Physiography of Southern Ontario*, Ontario Geological Survey Special Volume 2, Third Edition, 1984. Accompanied by Map P.2715, Scale 1:600,00

The bedrock within the project area is described as being comprised of blue-grey shales of the Blue Mountain Formation and limestones of the Lindsay Formation. The bedrock in the area is described as providing a deep aquifer unit, where groundwater flow occurs through the bedding plane fractures. Based on geological maps produced by the Ministry of Northern Development and Mines, bedrock is expected to around elevation 100 along the Central (East Part) Mainline, corresponding to an overburden thickness of about 80 to 140 m.

4.2 Site-Specific Descriptions and Subsurface Conditions

Table 1 summarizes the structure sites, category (i.e. underpass, overpass or culvert), location, site ranking (level of investigative effort), and boreholes advanced at or adjacent to each site as part of the current and/or past investigations. Creek and floodplain crossings are also indicated, many of which are environmentally sensitive locations that will require special consideration in this regard during preliminary design. The table includes the new structure numbers (as of October 2009), cross-referenced with the structure numbers used for Thurber's foundation report and the Watercourse IDs provided by Delcan.

For all medium or high ranking sites where boreholes were drilled during the investigations, a Preliminary FIR sheet was produced, which summarizes the results of the field investigation and geotechnical laboratory testing for each structure and includes a borehole location plan and soil strata drawing. The FIR sheets are presented following the text of the report. Following each FIR sheet is a Preliminary Foundation Design Report (FDR) sheet that includes site specific preliminary foundation recommendations for each site referenced in Part B of this report.

For the sites investigated during the current study, a summary of the soil and groundwater conditions encountered at each site, together with site-specific drawings showing the borehole locations and stratigraphic profile are presented on the individual Preliminary FIR sheets following the text of this report.

For the remaining sites, refer to the *Preliminary Foundation Investigation and Design Report – Central Section (East Part), W.O. 07-20016* prepared by Thurber in April 2010, Ref. No. 19-2805-10, Geocres No. 30M15-108.

TABLE 1 – STRUCTURE SUMMARY

New Structure No.	Original Structure No.	Watercourse No.	Category	Location	Site Ranking	Thurber Borehole Nos.	PML Borehole Nos.
CENTRAL (EAST PART) MAINLINE STRUCTURES							
M-61	CM-25/25b	CM-HC-54	Overpass	WBL and EBL over Harmony Creek	Medium	-	M61-1, M61-2
M-62	CM-26	CM-HC-56	Culvert	WBL and EBL over Harmony Creek	Medium		M62-1, M62-2
M-66	CM-29c	CM-FC-57b	Overpass	Enfield Road over Concession Road 6	High	-	M66-1, M66-2, M66-3, M66-4
M-67	CM-29d	CM-FC-57	Bridge	Enfield Road over Farewell Creek	High	CM29d-1 CM29d-2	M67-1, M67-2
M-68	CM-29e	CM-FC-57b	Overpass	Realigned Brock Road over Farewell Creek	High	-	M68-1, M68-2, M68-3, M68-4

The subsurface soil and groundwater conditions as encountered in the boreholes advanced during the current and previous investigations and the results of geotechnical laboratory tests carried out on selected soil and rock samples are given on the Record of Borehole sheets included in Appendix A and on the laboratory test result figures included in Appendix B. Where applicable, a copy of the referenced borehole logs from previous MTO investigations located along the Highway 407 alignment are provided in Appendix C.

It should be noted that the stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Subsurface conditions will vary between and beyond the borehole locations. It should also be noted that the water levels which were observed in the open boreholes or measured in the piezometers are expected to fluctuate seasonally and should be expected to rise during the spring and other wet periods of the year.

The sections where the proposed highway is to be constructed in a deep cut or as a high fill are summarized below. The summary shows the deep cut area (designated 'DC-') or high fill area (designated 'HF-') number, location (station to station), maximum depth and height of the proposed cut or fill, and existing boreholes in the area. At some deep cut and high fill areas where specific boreholes were not drilled, subsurface information from boreholes at adjacent structure sites was used to develop the preliminary subsurface conditions and recommendations provided in the Preliminary FIR sheets. The subsurface conditions at the deep cut and high fill sections are summarized in the Preliminary FIR sheets for Deep Cuts and High Fills following the FIDR sheets for the structures.

TABLE 2 - DEEP CUT / HIGH FILL SUMMARY

Deep Cut or High Fill Section[1]	Approximate Station Limits[2]		Length (m)	Approximate Maximum Depth of Cut[2]	Approximate Maximum Height of Fill[2]	Reference Data	PML Boreholes / Remarks
CENTRAL (EAST PART) MAINLINE							
DC-C4	15+450	15+700	250	5.5	-	CCM-03	DCC4-1
DC-C9	16+550	16+670	120	6.0	-	-	DCC9-1
DC-C7	11+650	12+360	710	7.0	-	CM27-1, CM27-2, CM28-1, CM28-2	DCC7-1
HF-C9	17+100 to 17+323 10+000 to 10+300	10+300	523	-	6.0	-	HFC9-1
HF-C7	11+325	11+510	185	-	9.0	CM24-3 CM24-4	HFC7-1

Notes:
1. Deep cuts / high fills are defined as areas which are deeper/higher than 4.5 m.
2. The extent and depth/height of deep cuts and high fills were estimated from base plans and profiles provided in digital format by Delcan, on August 15, 2012.

It should be noted that the subsurface conditions presented in the Preliminary Foundation Investigation Report sheets for High Fills and Deep Cuts are inferred from limited borehole information and interpreted from terrain/digital maps, as noted above. The subsurface conditions described are therefore approximate and may differ from the actual subsurface conditions that exist along the proposed deep cut and high fill sections.

4.3 General Groundwater Conditions

The water level was observed in open boreholes at the time of drilling. Standpipe piezometers were installed at eight (8) borehole locations as part of the current and previous investigations for the project. The remaining boreholes were backfilled immediately after the completion of drilling and before the local water level had stabilized.

Details of the piezometer installations and history of water levels measured in the boreholes are shown on the Record of Borehole sheets in Appendix A.

The most recent water levels measured in the piezometers are summarized below and represent the stabilized groundwater levels. The water level(s) in open boreholes at completion of drilling are presented on the Record of Borehole sheets but are not considered stabilized and are in fact affected by water introduced during drilling operations or depressed due to advancement of the boreholes.

THURBER PIEZOMETERS

Borehole Number / Piezometer	Reference Site	Ground Surface Elevation (m)	Depth to Water Level Below Ground Surface (m)	Water Level Elevation (m)	Date
CCM-03	DCC4	237.1	3.4	233.7	February 10, 2009
CM27-1	DCC7	208.9	10.8	198.3	April 30, 2009
CM28-1	DCC7	211.7	2.7	209.0	July 21, 2009
CM24-4	HFC9	224.6	10.9	213.7	July 26, 2008

PML PIEZOMETERS

Borehole Number / Piezometer	Ground Surface Elevation (m)	Depth to Water Level Below Ground Surface (m)	Water Level Elevation (m)	Date
M61-1	216.0	0.5	215.5	July 30, 2013
M62-2	199.1	2.7	196.4	July 30, 2013
M68-3	197.0	0.5	196.5	August 16, 2013
DCC7-1	213.1	3.7	209.4	July 3, 2013

The measured groundwater levels in the piezometers range from 0.1 m to 3.7 m below ground surface. Details of the site-specific groundwater conditions at each structure location are provided on the Preliminary FIR sheets, following the text of this report.

It should be noted that the groundwater levels at the site are anticipated to fluctuate as a result of seasonal variations in precipitation and runoff at the site.

5.0 CLOSURE

The Preliminary Foundation Investigation Report was prepared by Mr. Andrew DeSira, MEng, P.Eng, and Mr. Grigory Degil, PhD, P.Eng., Senior Foundation Engineer, and reviewed by Mr. Brian R. Gray, MEng, P.Eng., MTO Designated Principal Contact. Mr. Carlos M.P. Nascimento, P.Eng., Manager, MTO Foundation Services, conducted an independent review of the report.

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PART B

PRELIMINARY FOUNDATION DESIGN REPORT
HIGHWAY 407 EAST – CENTRAL SECTION (EAST PART)
REGION OF DURHAM, ONTARIO
W.O. 07-20016

6.0 ENGINEERING RECOMMENDATIONS FOR PRELIMINARY DESIGN

6.1 General

This section of the report provides foundation design recommendations for the preliminary design of the proposed bridge structures along the Highway 407 East – Central Section (East Part) Mainline. The preliminary foundation design recommendations provided herein are based on interpretation of the factual data obtained from limited current borehole investigations and previous borehole data obtained by MTO, at or near the site of the proposed structures, but not necessarily at or within the footprint of the foundation elements. The interpretation and recommendations are intended to provide the designers with adequate information to assess the feasible foundation alternatives for the preliminary design of the proposed structure foundations. Where comments are made on construction they are provided in order to highlight those aspects which could affect the current preliminary design of the project, and for which special provisions or operational constraints could potentially be required.

6.2 Structure (Bridge and Culvert) Foundation Recommendations

Preliminary foundation recommendations for four (4) bridges and one (1) culvert where the investigation was completed, including a description of the proposed bridge structure(s) configuration assumed at the time of preparation of this report, is provided in the individual Preliminary Foundation Investigation and Design Report (FIDR) sheets, following the text of this report.

It is noted that the subsurface investigation was generally limited to drilling boreholes to obtain subsurface information representative of the general site. Further investigations at the specific locations of bridge abutments, piers, approach embankments, culverts and at deep cut and high fill locations are required during detail design to obtain detail design level subsurface information and to determine the subsurface conditions and the geotechnical parameters that are appropriate for the detail design.

The foundation design for all highway structures must be carried out in accordance with the latest Canadian Highway Bridge Design Code (CHBDC) requirements. At the time of this report the latest CHBDC was published in 2006 and therefore this edition has been referenced in this report. Design of railway grade separations must also be carried out in conformance with the local railway authority requirements and American Railway Engineering and Maintenance-of-Way Association (AREMA) manual.

The following subsections provide project-wide recommendations generally applicable to all structure sites, including design assumptions and limitations associated with the recommendations provided in the Preliminary Foundation Design Report sheets.

6.2.1 Spread Footings

Preliminary foundation recommendations for spread footings on native undisturbed soil or on a structural fill Granular ‘A’ pad ‘perched’ within the bridge approaches are provided where subsoil conditions are considered to be suitable for shallow foundations, as indicated on the individual Preliminary FIDR sheets for each structure site.

For spread footings placed (or perched) within the approach embankments on a structure fill Granular ‘A’ core, the preliminary design geotechnical resistance values provided in the FDR sheets assume a minimum 2 m thick Granular ‘A’ pad placed below the base of the footing. The Granular ‘A’ pad should extend at least 1 m beyond the plan limits of the footing and be sloped no steeper than 1 Horizontal : 1 Vertical (1H:1V) in general accordance with MTO guidelines (see Figure 1). The Granular ‘A’ pad should be constructed in accordance with OPSS 501, Construction Specification for Compacting.

Preliminary design geotechnical resistance values for spread footings are provided for factored Ultimate Limit States (ULS) and at Serviceability Limit States (SLS) for 25 mm of settlement assuming a 3 m wide footing for bridges. These preliminary design values are given under the assumption that the loads are applied perpendicular to the surface of the footings. Where the load is not applied perpendicular to the surface of the footing, inclination of the load should be taken into account in accordance with Section 6.7.4 of the CHBDC (2006). The geotechnical resistance values will have to be re-evaluated and modified as necessary during detail design based on detail design level subsurface investigation at the locations of the foundation elements.

Resistance to lateral forces/sliding resistance between the concrete footings and the subgrade should be calculated in accordance with Section 6.7.5 of the CHBDC (2006).

All footings should be provided with a minimum of 1.2 m of soil cover or equivalent thickness of insulation for frost protection (OPSD 3090.101, Foundation Frost Depths for Southern Ontario).

6.2.2 Steel H-Piles

Preliminary recommendations for steel H-piles, assuming an HP 310 x 110 pile section, are provided where considered practical for foundation design of abutments and piers as indicated on the individual Preliminary FIDR sheets for each bridge site. Steel H-Pile sizes other than the HP 310x110 pile section can be considered and should be further investigated during detailed design. The factored geotechnical axial resistance at Ultimate Limit States (ULS) and the geotechnical axial resistance at Serviceability Limit States (SLS) for 25 mm of displacement for the steel H-pile foundations founded at the anticipated pile depth/pile tip elevation are provided, based on the subsurface conditions encountered in the boreholes, respective to each structure site.

The factored ULS and SLS resistance values provided will have to be re-evaluated and modified, if necessary, during detail design in consideration of the additional subsurface investigations at the locations of each bridge foundation element. The factored geotechnical axial resistance at ULS should then be verified in the field by the use of the Hiley formula (MTO Structural Standard Drawing SS103-11 Pile Driving Control) during the final stages of driving. For complex sites, such as those with artesian conditions, if determined to be warranted during the detail design stage, the ultimate load resistance and load-settlement behavior (serviceability) should be verified by full-scale pile load tests.

Pile installation should be in accordance with OPSS 903, Construction Specifications for Deep Foundations. The site specific pile termination or set criteria will be dependent on the pile driving hammer type, helmet, selected pile size and length of pile.

The structural design of the piles should consider downdrag load where applicable, unless measures to eliminate post-construction settlements are undertaken. Magnitudes of downdrag loads should be evaluated during detailed design on a site specific basis.

Resistance to lateral loading can be derived using vertical piles, with enhanced support offered by battered piles, if required. For vertical piles, the resistance to lateral loading will be derived solely from the soil in front of the piles, whereas battered piles derive lateral resistance from the soil in front of the piles as well as the horizontal component of the axial load present in the inclined pile. The resistance to lateral loading in front of the pile and pile group action for lateral loading should be accounted for and assessed during the detail design phase of the project.

All pile caps should be provided with a minimum of 1.2 m of soil cover or equivalent thickness of insulation for frost protection (OPSD 3090.101, Foundation Frost Depths for Southern Ontario).

For the installation of steel H-piles, consideration will have to be given to the possible presence of cobbles and/or boulders within the till deposits at the locations of a number of bridge sites as indicated on the FIDR sheets. Where applicable, the piles should be reinforced with driving shoes or bearing points for protection during driving. Pile driving shoe installation should be in accordance with OPSS 903, Construction Specification for Deep Foundations.

Where artesian groundwater conditions are present, specialized construction techniques will be required to mitigate the possible upward flow of water along the pile shaft. Such measures depend on the artesian head of water and may include driving the piles within a large diameter liner filled with water to counteract artesian head, and provision for an impermeable plug and or filtered granular drainage layer.

6.2.3 Caissons

Preliminary design foundation recommendations for caissons founded within “100-blow” deposits as applicable, were provided where caissons were considered to be practical for foundation design. Preliminary design values for factored geotechnical axial resistances at Ultimate Limit States (ULS) and the geotechnical axial resistance at Serviceability Limit States (SLS) for 25 mm of displacement are provided for caisson diameters of 1.2 m and 1.5 m. The geotechnical resistance values assume a caisson base elevation and/or embedment depth into the “100-blow” materials.

The factored ULS and SLS resistance values provided will have to be re-evaluated and modified during detail design in consideration of the additional subsurface investigations at the locations of each foundation element. For complex sites, if warranted during the detail design stage, the ultimate resistance and/or load-settlement behavior (serviceability) should be verified by full-scale caisson load tests.

The structural design of the caissons should consider downdrag load where applicable, unless measures to eliminate post-construction settlements are undertaken. Magnitudes of downdrag loads should be evaluated during detailed design on a site specific basis. The resistance to lateral loading developed by the soils in front of the caissons (assuming vertical caissons) and the reductions due to group effects should be accounted for and assessed during the detail design phase of the project.

It should be noted that “running” or “flowing” of water-bearing cohesionless strata, where encountered, could occur during or after drilling of caisson foundations. Therefore, where caisson foundations are considered, temporary or permanent caisson liners may be required to support these type of soils during construction and permit cleaning and inspection of the caisson base (possibly with a downhole camera). At some locations, consideration could be given to drilling caissons while maintaining a constant head of water inside the caisson liners to counterbalance high groundwater or artesian conditions followed by tremie concrete placement (see Section 6.7.3). Where the caissons are relatively long and temporary liners may be difficult to withdraw or when necking of concrete may occur upon withdrawal of temporary liners, permanent liners would be preferred for the construction of the caissons. The reduced shaft resistance (i.e. due to the smooth liner/soil interface) has been considered in the preliminary design geotechnical resistance values provided in the FDR sheets for the full length of the caissons. The use of permanent liners should be re-assessed and geotechnical resistance values revised, if necessary, when the caisson installation method has been determined during detail design.

Consideration will have to be given to the possible presence of cobbles and/or boulders within the till deposits encountered at the locations of a number of bridge sites as indicated in the FDR sheets. Caisson drilling equipment must be capable of penetrating such obstacles, where applicable (refer to Section 6.7.4).

Caissons should be installed in general accordance with OPSS 903. Caisson caps for caissons, as applicable, should be provided with a minimum of 1.2 m of soil cover or equivalent thickness of insulation for frost protection (OPSD 3090.101, Foundation Frost Depths for Southern Ontario), unless the caissons are extended above ground surface to the underside of the deck with a caisson cap.

6.2.4 Semi-Integral, Integral and Conventional Abutments

Semi-integral, integral and conventional abutments were considered during the preliminary design and are considered feasible as indicated on the preliminary FIDR sheets. Further investigation into the selection of the preferred abutment design should be carried out during detailed design. Recommendations regarding pre-drilling, maintaining annular space around piles for integral abutments and earth pressure assumptions should also be carried out during detailed design.

6.2.5 Culvert Design

Preliminary foundation recommendations for the proposed culverts were based on the configurations provided in the general arrangement drawings, as indicated on the Site Specific Preliminary Foundation and Investigation Sheets. General preliminary culvert recommendations are provided below.

For erosion control at the culvert locations it is recommended that appropriate protective measures including those noted in the OPSD 800 series (inlet/outlet treatment, headwall, cut-off walls etc.) be adopted. Cut-offs, either by vertical walls or equivalent horizontal cut-offs, should extend sufficiently to protect the granular backfill material and to prevent flow below or around the culvert that could erode the granular base/bedding material. The design requirements concerning the length and width of horizontal aprons at the inlet/outlets of the culverts as well as the rock protection sizes, apron thickness, height of erosion protection on the embankment slope and type of material should be further investigated during detailed design.

Preparation of the culvert subgrade should be carried out and verified in accordance with OPSS 902. Compressible materials at the subgrade level should be excavated or otherwise addressed to manage settlement along the proposed culvert alignment. Excavated soils should be replaced with OPS.PROV 1010 Material Specifications for AggregatesGranular A or Granular B Type II material to raise the subgrade to design level.

For box culverts, the cover, backfill and frost treatment should be carried out in accordance with OPSD 803.010, OPSS 422 and SP 422S01.

6.3 Structure Retaining/Wing Walls

Most of the proposed bridge structures may require the construction of retaining walls and/or wing walls depending on the proposed crossing configuration, available space and surrounding ground elevations. Feasible bridge retaining wall/wing wall options may include:

- Concrete retaining walls supported on spread footings or on deep foundations (often cantilevered beyond the abutment foundation) depending on the site-specific subsoil conditions as discussed on the respective Foundation Design Report sheets following the text of this report. The preliminary design foundation recommendations for this type of retaining wall can be considered to be similar to the recommendations provided for the preliminary design of the bridge foundations elements.

- Retained Soil System (RSS) walls: RSS walls may be the most feasible wall option for most of the bridge abutment / approach locations provided differential settlements are within tolerable limits and an adequate Factor of Safety against global instability is achieved. The performance of an RSS wall during foundation settlement depends primarily on the characteristics of its front facing system. Specialized slip joints could be incorporated into the design to accommodate differential settlements. Sub-excavation of surficial soft/loose materials, where encountered, and replacing with compacted granular material, will be required to construct the reinforced soil mass. The front facing is typically supported on a strip footing placed at shallow depth below the ground surface. The footing must be founded on competent native soils or approved engineered fill, after sub-excavation and backfilling the areas where topsoil, loose/soft fill or unsuitable native soils exist. The factored geotechnical axial resistance at Ultimate Limit States (ULS) and the geotechnical axial resistance at Serviceability Limit States (SLS) for a range of tolerable settlements should be provided for the footings of the wall facing and reinforced earth mass during detail design. It should be noted that the limiting displacement value for SLS design should be re-assessed and confirmed during detail design and will be dependent on the actual facing type or possibly the serviceability limit of the supporting roadway or foundation (typically less than 25 mm), if applicable. The internal stability of a reinforced earth wall should be assessed by the proprietary product supplier/designer. Preliminary design level foundation recommendations for external stability of the RSS wall has been provided in the FDR sheets, where indicated, and should be confirmed by the geotechnical consultant at the detail design stage taking into account the final geometry and configuration.

For settlement sensitive sites (i.e. where soft cohesive deposits were encountered), retaining walls will be affected by the post-construction settlement of the wall backfill materials, depending on the height/thickness of the backfill. The selection of the wall option for such sites will thus be dependent on the predicted settlement and should be assessed during detail design. Measures to reduce settlement could be achieved by incorporating site improvement techniques such as using light weight fill materials (i.e. slag or expanded polystyrene), installing wick drains, preloading or surcharging, and staged

construction as discussed in the individual FDR sheets, where applicable. The preferred settlement mitigation option is site specific and should be confirmed when additional soil information and project scheduling are known during detail design.

6.4 Lateral Earth Pressures for Design

The lateral earth pressures acting on the bridge abutment stems and any associated retaining walls/wing walls will depend on the type and method of placement of the backfill materials, on the nature of the soils behind the backfill, on the magnitude of surcharge including construction loadings, on the freedom of lateral movement of the structure, as well as on the drainage conditions behind the walls.

The following preliminary design level general recommendations are made concerning the design of the stems/walls. It should be noted that these recommendations and parameters assume level backfill and ground surface behind the walls. Where there is sloping ground behind the walls, the coefficient of lateral earth pressure must be adjusted to account for the slope in accordance with Section C6.9.2.2 of the CHBDC (2006).

- Select free-draining Granular 'A' or Granular 'B' Type II granular material meeting OPS.PROV 1010, but with less than 5 per cent passing the 200 sieve should be used as backfill behind the walls. This material should be compacted in accordance with OPSS 501 Construction Specification for Compacting. Transverse drains and weep holes should be installed to provide positive drainage of the granular backfill. Other aspects of the granular backfill requirements with respect to sub-drains and frost taper should be in accordance with OPSD 3101.150, Walls Abutment, Backfill Minimum Granular Requirement and OPSD 3121.150, Walls Retaining, Backfill Minimum Granular Requirement.

- A minimum compaction surcharge of 12 kPa should be included in the lateral earth pressures for the structural design of the wall stem, in accordance with Section 6.9.3 and Figure 6.6 of the CHBDC (2006). Compaction equipment should be used in accordance with OPSS 501 Construction Specification for Compacting. Other surcharge loadings should be accounted for in the design, as required.

- The granular fill may be placed either in a zone with width equal to at least 1.2 m behind the back of the wall stem (Case I in Figure C6.20(a) of the Commentary to the CHBDC (2006) or within the wedge-shaped zone defined by a line drawn at 1.5 horizontal to 1 vertical (1.5H:1V) extending up and back from the rear face of the footing (Case II in Figure C6.20(b) of the Commentary to the CHBDC (2006).

- For the case where the pressures are based on granular fill behind the wall, the following parameters may be assumed.

	GRANULAR 'A'	**GRANULAR 'B' TYPE II**
Soil Unit Weight:	22 kN/m^3	21 kN/m^3
Coefficients of Static Lateral Earth Pressure:		
Active, K_a	0.27	0.27
At Rest, K_o	0.43	0.43

- For the case where the pressures are based on existing materials behind the wall, the required parameters for design should be assessed on a site-by site basis during detail design.

- Dynamic lateral earth pressures from seismic loading should be considered during detailed design as discussed in Section 6.6.

- If the wall support and superstructure allow lateral yielding of the abutment stem and retaining walls, active earth pressures may be used in the geotechnical design of the structure. If the abutment support does not allow lateral yielding, at-rest earth pressures should be assumed for geotechnical design. The movement to allow active pressures to develop within the backfill, and thereby assume an unrestrained structure, may be taken as presented in Section C6.9 and Table C6.6 of the Commentary to the CHBDC (2006).

6.5 Structure Approaches

The configuration of the structure approaches varies from site to site and includes approach embankment construction with fills and/or cuts depending on the design grades and ground elevations for each bridge crossing. Based on the available information provided at each bridge site, recommendations associated with the approaches stability and settlement are provided on the individual Preliminary FDR sheets following the text of this report. The following subsections provide additional project-wide recommendations associated with the preliminary design and construction of the bridge approaches.

6.5.1 Subgrade Preparation and Embankment Construction

For all proposed bridge sites, it is recommended that all topsoil and organic material be stripped from the proposed embankment footprint. The depth and extent of stripped material should be determined during detail design when additional subsurface information is available. Particular attention will be required in low valley areas where thicker layers of organic/alluvial soils may be present.

After stripping of organics, the exposed subgrade should be proof rolled to identify any loose/softened areas requiring sub-excavation or additional compaction prior to fill placement.

Embankment fill should be placed and compacted in accordance with SP 206S03, Earth Excavation, Grading and OPSS 501, Construction Specification for Compacting. In the case of approach cuts with a shallow water table condition, it is expected that measures will need to be undertaken to stabilize the

embankment slope face due to possible groundwater seepage (refer to Section 7.0 on Deep Cuts and High Fills).

In the case of bridge/embankment widening, in order to minimize differential settlement between the widened portions of the approach embankments due to settlement of the fill itself, the use of granular fill is preferred over the use of cohesive fill, since the majority of settlement of granular fills will occur during construction whereas some settlement of cohesive fills, if used, would occur post-construction. The new embankment fill should be benched into the existing embankment in accordance with OPSD 208.010, Benching of Earth Slopes.

To reduce erosion of the embankment side slopes due to surface water runoff, placement of topsoil and seeding or pegged sod is recommended as soon as practicable after construction of the embankments. The erosion protection must be in accordance with OPSS 804, Construction Specification for Seed and Cover.

6.5.2 Approach Embankment Stability

The design level assessments of slope stability are provided for planning purposes only and require additional investigation, evaluation and design during the detail design phase of the work. The preliminary design level assessment for the stability of the approach embankments at each bridge site was based on the geometry of the embankments, subsoil stratigraphy and groundwater conditions at each of the structures. For detail design, cut and fill embankment slopes stability shall be confirmed to deliver target slope stability on a site specific basis.

As minimum requirement,

- No cut or fill embankment slope shall be steeper than 2H:1V.
- A 2 m wide bench shall be incorporated in cut embankment slopes higher than 6 m so that no uninterrupted 2H:1V cut embankment slope shall be higher than 6 m.
- A 2 m wide berm shall be incorporated in fill embankment slopes higher than 8 m so that no uninterrupted 2H:1V fill embankment slope shall be higher than 8 m.

Where designated as safe or adequate against deep-seated slope instability, a short-term target Factor of Safety of 1.3 under static conditions is implied, assuming appropriate subgrade preparation and proper placement and compaction of embankment fill materials. Where embankments support the bridge abutments a long-term Factor of Safety of 1.5 was considered. Assessment of the overall stability of the embankment side slopes under seismic conditions is discussed in Section 6.6.

Approaches higher than 8 m should be constructed with a 2 m wide mid-height berm in order to control surficial erosion and to improve stability.

Assessment of the stability of the embankment side slopes under seismic conditions should be carried out during detail design. The design builder shall comply with the requirements of the CHBDC (2006) and its Commentary regarding appropriate safety factors for slope stability under seismic loading.

The preliminary design level assessment of stability of the approach slopes should be reviewed and confirmed based on the actual subsoil conditions encountered within the proposed approach/embankment footprint during detail design. Mitigation measures to improve slope stability for greater embankment heights can be achieved by utilizing light weight fill materials, wick drains, and staged construction, or a combination of these options, which will also help to reduce settlements.

6.5.3 Approach Embankment Settlement

Settlement of the approach embankments will occur at bridge sites due to compression of the embankment fill itself and compression and consolidation of the foundation soils. A preliminary design level assessment has been provided in this report. This assessment is intended for planning purposes only. Additional subsurface investigation, evaluation and design will be required for the Detail Design phase of the work.

As part of the preliminary design, the total settlement within the founding soils has been estimated based on the existing site-specific subsoil conditions for preliminary design using elastic analysis and Terzaghi one-dimensional consolidation theory, with the results reported on the individual Preliminary Foundation Design Report sheets for each bridge/interchange site. These preliminary design estimates do not include compression of the fill itself, which would occur during and after the construction of embankment depending on the type of materials used. The magnitude of fill compression usually ranges from 1% to 2% of the height of embankment. In the case where granular fill is used for embankment construction, settlement of the fill itself is expected to occur during or shortly after completion of embankment construction whereas non-granular earth fill or rock fill materials will exhibit additional consolidation settlement over time. Estimates of rock fill settlement should be consistent with the MTO "Post-Construction Rock Fill Settlement and Guidelines for Estimating Rock Fill Quantity", September 14, 2010.

Embankment and platform width design should allow for the anticipated settlements and future padding of the pavement structure.

The detail design level evaluation of the allowable settlements should be carried out in accordance within the MTO "Embankment Settlement Criteria Guidelines" dated March 2, 2010. Where estimated post-construction consolidation settlement within the foundation soils exceeds acceptable limits, measures to reduce such settlement to acceptable values have been proposed. The estimated settlement magnitudes and time rates indicated on the Preliminary Foundation and Investigation sheets were based

on the results of routine laboratory analysis. Comprehensive analyses, including additional laboratory testing and field investigations should be carried out during detail design to further estimate the anticipated amount and time rate of post-construction settlements and to develop the final design and construction requirements of the approach embankments in such site conditions and develop mitigation measures to reduce anticipated settlements to acceptable levels.

6.6 Seismic Considerations

The zonal acceleration ratio for the project site is 0.05 g for The City of Oshawa, (CHBDC Table A3.1.1). The Site Coefficient, S, will be based on the type of soils encountered at the founding level at each site (to be determined during detailed design) in accordance with Section 4.4.6 and Table 4.4 of the CHBDC (2006).

Abutment Stem and Retaining Wall/Wing Wall design: seismic (earthquake) loading must be considered in the design of the foundations in accordance with Sections 4 and 6 of CHBDC (2006) as significant seismic loading will result, for example, in increased lateral earth pressures acting on the abutment stem and retaining walls. The walls should be designed to withstand the combined lateral loading for the appropriate static pressure conditions plus the applicable earthquake-induced dynamic earth pressure conditions (see Section 24.9 of Canadian Foundation Engineering Manual (CFEM (2006)). The static and seismic active earth pressure coefficients can be determined in accordance with Sections 6.9 and 4.6.4 of the CHBDC (2006) and its Commentary.

Approach Embankment design: liquefaction susceptibility of the soil deposits underlying the proposed embankments (and foundations) and the consequent stability of the embankments under seismic loading conditions should be assessed during the detail design stage in accordance with Section C.4.6.2 and C.4.6.3, respectively, of the Commentary of the CHBDC (2006).

6.7 Construction Considerations

6.7.1 Excavation and Backfill

Preliminary recommendations for open-cut excavations are provided on a site-specific basis on the Preliminary Foundation Design sheets for each bridge site and include the type of soils anticipated to be within the foundation excavations according to the Occupational Health and Safety Act (OHSA), as well as the recommended maximum side slope inclination for temporary excavations. All backfill is to be placed and compacted in accordance with SP 105S10, Compaction.

6.7.2 Protection Systems

Excavation support systems may be required at the proposed bridge sites for temporary roadway protection. Where required, the temporary excavation support system should be designed and constructed in accordance with OPSS 539, Construction Specifications for Temporary Protection Systems. In general, the lateral movement of the temporary shoring system should meet Performance Level 2 as specified in OPSS 539. Performance Level 1 may be required adjacent to railways.

6.7.3 Groundwater and Surface Water Control

Groundwater levels within the foundation excavations at each proposed bridge site assumed for preliminary design purposes and possible groundwater and surface water control measures are reported on the individual Preliminary Foundation Design Report sheets. Groundwater levels were typically at ground surface down to a depth of about 5 m below ground surface. However, artesian conditions were recorded at some sites.

At locations where near surface granular (cohesionless) soils are present with a high water table, groundwater infiltration should be anticipated to occur during excavation in such deposits, particularly during wet periods of the year. Dewatering at these sites will be required to allow for construction of foundation elements in a dry condition. Alternatively, excavations could be carried out within the confines of a properly designed sheet pile cofferdam. For sites where non-routine dewatering is required, a Non-Standard Special Provision (NSSP) will be required for inclusion in the Contract Documents during detail design.

Caissons constructed with temporary or permanent liners in granular subsoils subjected to unbalanced hydrostatic head will require special measures to prevent ‘boiling’ or basal heave of the base materials. These measures could include maintaining a constant head of water or drilling mud inside the caisson liners to counterbalance the unbalanced hydrostatic head. Concrete placement by tremie methods may be considered. For deep foundations at locations where artesian conditions are expected within the lower granular deposits, it is recommended that a sand filter, possibly in combination with a geotextile, be placed beneath the pile caps to prevent the migration of fines that may be transported along the piles or caisson liner during and after construction. Preliminary design level recommendations for such conditions (where considered practical) are given on the site-specific Preliminary Foundation Design report sheets and these aspects should be re-assessed during detail design.

General site drainage should be by gravity towards an outlet at a lower elevation and/or pumping.

The need for a Permit to Take Water (PTTW) should be assessed at each site during detail design.

6.7.4 Obstructions During Pile Driving / Caisson Installation

Till deposits were encountered at a number of bridge sites along the proposed Highway 407 East - Eastern Section route. It is anticipated that cobbles and/or boulders will be encountered within the till deposits, as noted in several boreholes, and may affect the installation of steel H-piles or drilled caissons. As such, an NSSP will need to be included in the Contract Documents during the detail design to identify to the contractor the possible presence of cobbles and/or boulders within the overburden soils

on a site-by-site basis. Preliminary design level recommendations regarding potential obstructions during pile driving and caisson installation have been provided on the site-specific Preliminary Foundation Design Report sheets. An estimate of the range in size and quantity of cobbles / boulders for applicable sites should be incorporated into the detail design based on additional borehole information.

6.7.5 Construction Access

Several creek valley crossings (i.e. environmentally sensitive areas) have been identified during the environmental assessment of the project. Potential environmental impacts will need to be minimized during construction access in the sensitive valleys. Specific access preparation procedures such as the use of temporary work bridges, winter construction and/or gravel roadways underlain by geosynthetics should be considered to accommodate foundation construction at these locations.

7.0 DEEP CUTS AND HIGH FILLS

Deep cut and high fill areas have been identified along the Highway 407 East – Central Section (East Part) Mainline alignment.

7.1 General

This section of the report will provide geotechnical recommendations for preliminary design of deep cuts and high fill sections where the depth/height exceeds 4.5 m. Based on the roadway profiles available at the time of the assessment, deep cuts have been identified at three (3) locations and high fills have been identified at two (2) locations. The location, extent and depth/height of the identified deep cut/high fill areas are summarized in Section 4.2. The maximum depth of cut is in the order of 7.0 m and the maximum fill height is about 9.0 m.

The preliminary design level recommendations provided herein have been based on interpretation of the factual data obtained during limited borehole investigations conducted in the cut/fill sections as well as existing information obtained from previous investigations near the sites.

The anticipated subsurface conditions at the deep cut / high fill locations and preliminary design recommendations for design are summarized on the “Preliminary Foundation Investigation Report - Deep Cuts” sheets and “Preliminary Foundation Investigation Report – High Fills” sheets will be presented following the FIDR sheets for the structures at the end of the text of this report.

The interpretation and recommendations are intended to provide the designers with preliminary design level information to assess design slope inclination, drainage requirements, and mitigation options for addressing potential stability or settlement issues. Where provided, comments regarding construction will be presented to highlight aspects which could affect the preliminary design, and for which special provisions or operational constraints could potentially be required.

Geotechnical investigations will be required during detail design to confirm the subsurface conditions that were assumed throughout the cut/fill sections and confirm/re-assess the preliminary design recommendations.

7.2 Deep Cuts

7.2.1 Stability and Drainage

Preliminary design level assessment of the stability of the cut slopes was carried out at a typical cut section based on the cut depth, subsoil stratigraphy and groundwater conditions at each of the structures. Cut slopes no steeper than the minimum recommended 2H:1V, with a minimum 2 m wide mid-slope bench for cut depths greater than 6 m were assumed for the assessment.

For preliminary design, the target factors of safety were assumed to be 1.3 for short term stability, and 1.3 and 1.5 for long term stability in cohesionless and cohesive soils, respectively.

For cut slopes deeper than 6 m, the minimum requirement is to provide a 2 m wide mid-height bench in order to control surficial erosion and improve stability. Earth cut slopes must be provided with erosion protection in accordance with OPSS 804, Construction Specification for Seed and Cover.

Permanent drainage of the cut slope is required. Roadside ditches are expected to provide an adequate level of permanent drainage in most areas. An interceptor ditch should be provided at the top of cuts as per OPSD 200.020 Earth/Shale Grading – Rural Divided.

Where cut excavation extends below the measured groundwater levels in cohesionless soils, more positive measures to provide permanent slope drainage and mitigate surficial instability may be required. Measures may include provision of subdrains positioned along the toe of slope and/or along the rear of the mid-slope bench, as well as gravel sheeting or rip-rap lined channels down the slope.

Seepage and surficial instability may also be experienced from localized permeable zones/sand layers within the less permeable soils. Determination of the frequency, extent and locations of the seepage zones from the limited borehole data is not possible. Therefore, consideration should be given to the observational approach involving examination of the cut slopes during and following construction to identify any areas of surficial instability, and provide mitigative measures such as a gravel sheeting or subdrains where required. All subdrains should be sloped on a positive grade to an outlet or pumping chamber.

Assessment of the stability of the cut side slopes under seismic conditions should be carried out during detailed design. The design builder shall comply with the requirements of the CHBDC (2006) and its Commentary regarding the appropriate safety factors for slope stability under seismic loading.

The preliminary design level assessment of stability and drainage of the cut slopes should be reviewed and confirmed during the detail design investigation based on the subsoil conditions encountered in additional boreholes drilled within the cut sections.

7.2.2 Construction Considerations

Excavation for cut slope construction should be carried out in accordance with OPSS 206 as amended by SP 206S03, Earth Excavation, Grading.

The soil deposits in many of the cut sections, and notably till deposits, will typically be very dense/hard and often contain cobbles and boulders. Excavation in these deposits may be arduous and will require use of heavy duty excavators or dozers. The contract documents should include a NSSP to emphasize these conditions to the contractor. Selection of the method of excavation must remain the responsibility of the contractor, however, and be based on their equipment, experience and interpretation of the site conditions.

Temporary drainage of the cuts should be provided to maintain a relatively dry, stable excavation. Measures may include temporary drainage ditches or gravel sheeting to maintain surficial stability before permanent drainage measures are in effect and should be implemented in accordance with OPSS 577, Temporary Erosion and Sediment Control Measures.

7.3 High Fills

7.3.1 Slope Stability

Preliminary design level assessment of the stability of the fill embankment slopes were carried out for a typical high fill embankment based on the height of the embankments, subsoil stratigraphy and groundwater conditions at each of the structures. Embankment slopes no steeper than the minimum recommended 2H:1V, with a minimum 2 m wide mid-slope berm for embankment heights greater than 8 m were assumed for the assessment.

For preliminary design, the target factors of safety were assumed to be 1.3 for short term stability, and 1.3 and 1.5 for long term stability of embankments founded on cohesionless and cohesive soils, respectively and supporting bridge abutments.

For embankment slopes higher than 8 m, the minimum requirement is to provide a 2 m wide mid-height bench in order to control surficial erosion and improve stability. Earth fill slopes must be provided with erosion protection in accordance with OPSS 804, Construction Specification for Seed and Cover.

Assessment of the stability of the embankment side slopes under seismic conditions should be carried out during detail design. The design builder shall comply with the requirements of the CHBDC (2006) and its Commentary regarding appropriate safety factors for slope stability under seismic loading.

The preliminary design level assessment of stability of the embankment slopes should be reviewed and confirmed based on the actual subsoil conditions encountered within the proposed embankment footprint during the detail design investigation. Mitigation measures to improve slope stability if required may include slope flattening, utilizing light weight fill materials, staged construction, or a combination of these options.

7.3.2 Settlement

Settlement of the fill embankments will occur due to compression and consolidation of the foundation soils under the weight of the overlying fill material as well as from compression of the embankment fill itself. The total settlement within the founding soils has been estimated using elastic analysis and Terzaghi one-dimensional consolidation theory, based on the subsoil conditions deduced from the existing borehole data and the maximum embankment heights indicated by profile and general arrangement drawings available at the time of the analysis.

Where the estimated embankment settlement exceeds 25 mm, the computed value is indicated on the Preliminary Foundation Investigation Report sheet for the particular section. The evaluation of the allowable settlements should be carried out in accordance within the MTO “Embankment Settlement Criteria Guidelines” dated March 2, 2010. The settlement tolerance for embankments may range from up to 25 mm to 100 mm depending on the distance from a structure constructed on a Freeway. The highway design criteria should be site specific and based on maintenance considerations at the detail design stage.

The preliminary design level estimates do not include compression of the embankment fill itself, which would occur during and after the construction of embankment depending on the type of materials used. The magnitude of fill compression usually ranges from 1% to 2% of the height of embankment. Where granular fill is used for embankment construction, settlement of the fill itself is expected to occur during or shortly after completion of embankment construction. Non-granular earth fill or rock fill materials may exhibit additional consolidation settlement over time. Rock fill settlement should be consistent with the MTO’s Post-Construction Rock Fill Settlement and Guidelines for Estimating Rock Fill Quantity, 2010.

Embankment and platform width design should allow for the anticipated settlements and future padding of the pavement structure.

The estimated settlement magnitudes and time rates indicated on the Preliminary Foundation and Investigation sheets were based on the results of routine laboratory analysis. Further analyses, including additional laboratory and field work should be carried out during detail design to confirm the anticipated magnitude of settlement, assess the time rate of post-construction settlement, and where required develop mitigation measures such as preloading, surcharging, wick drains or light weight fill to reduce anticipated settlements to acceptable levels.

7.3.3 Construction Considerations

It is recommended that topsoil and organic material be stripped from the proposed embankment footprint. The depth and extent of stripped material should be determined during detail design when additional subsurface information is available. Particular attention will be required in low valley areas where thicker layers of organic/alluvial soils may be present.

After stripping of organics, the exposed subgrade should be proof rolled to identify any loose/softened areas requiring sub-excavation or additional compaction prior to fill placement.

Embankment fill should be placed and compacted in accordance with SP 206S03, Earth Excavation, Grading and OPSS 501, Construction Specification Compacting. New embankment fill placed against existing embankment slopes or on a sloping ground surface should be benched into the existing slope in accordance with OPSD 208.010, Benching of Earth Slopes.

Trafficability of construction equipment may be problematic in low floodplain areas where soft/loose and organic alluvial material may be encountered and where environmental constraints may be imposed on site access. Further, drainage in these areas is likely to be poor, with groundwater levels varying subject to seasonal fluctuations. The contractor must be prepared to supply equipment capable of working on this terrain and/or provide alternative measures to improve trafficability such as placement of granular pads in working areas.

Potential environmental impacts will need to be minimized during construction access into sensitive floodplain or valley areas. Specific access preparation procedures such as the use of temporary work bridges, winter construction and/or gravel roadways underlain by geosynthetics should be considered. Further, sediment control measures such as silt fences, straw bales and/or granular check-dams will need to be installed downgradient of the works to reduce sediments impacts to surface water bodies, consistent with OPSS 577, Temporary Erosion and Sediment Control Measures.

8.0 CLOSURE

The Preliminary Foundation Design Report was prepared by Mr. Andrew DeSira, M.Eng, P.Eng, and Mr. Grigory Degil, PhD, P.Eng., Senior Foundation Engineer, and reviewed by Mr. Brian R. Gray, MEng, P.Eng., MTO Designated Principal Contact. Mr. Carlos M.P. Nascimento, P.Eng., Manager, MTO Foundation Services, conducted an independent review of the report.

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REFERENCES:

AECOM. 2009 “Foundation Investigation Report for Environmental Assessment (Hydrogeology Specialty) – Highway 407 East Extension - Central Section”.

Canadian Geotechnical Society. 2006. “Canadian Foundation Engineering Manual (CFEM), 4th Edition”, The Canadian Geotechnical Society c/o BiTech Publishers Ltd., Richmond, British Columbia.

Canadian Standards Association CAN/CSA-S6-06, 2006. “Canadian Highway Bridge Design Code (CHBDC) and Commentary”, CSA Special Publication, S6.1-06.

Chapman, L.J. and Putnam, D.F. 1984. “The Physiography of Southern Ontario, 3rd Edition”, Ontario Geological Survey, Special Volume 2, Ontario Ministry of Natural Resources.

Holden, K.M., Mitchell, D and Karrow, P.F. 1993. “Bedrock topography, Oshawa area; Ontario Geological Survey, Preliminary Map P.3192, scale 1:50 000.”

Ministry of Transportation, Ontario. 1988. “Feasibility Study of Highway 401 Widening Brock Road to Courtice Road, WP 242-86-00”, Geocres No. 30M15-80.

Ministry of Transportation, Ontario. 1994. “Preliminary Design Study for Proposed Hwy 407 from Hwy 48 to Whitby / Oshawa Boundary”, WP 282-86-01”, Geocres No. 30M14-227, August.

Ministry of Transportation, Ontario. 1994. “Feasibility Study of Freeway Link from Hwy 401 to Hwy 407, Pickering / Ajax / Whitby Freeway Link”, WP 662-89-00, Geocres No. 30M15-84.

Ministry of Transportation Ontario. 2003. “Standard Drawing SS103-11 – Pile Driving Control”, Structural Manual, Policy, Planning and Standards Branch, Bridge Office.

Ministry of Transportation Ontario. 2010. “Post-Construction Rock Fill Settlement and Guidelines for Estimating Rock Fill Quantity”.

Ministry of Transportation Ontario. 2010. “Embankment Settlement Criteria for Design”.

Reinforced Earth Company (RECo). 2000. “ Design Manual for Reinforced Earth Walls”.

Rocscience Inc. 2008. Settle3D v 1.010 (Software Program and Technical Manual).

Rocscience Inc. 2005. Slide v 5.018 (Software Program and Technical Manual).

Thurber Engineering Ltd. 2008. “Foundation Desktop Study, Hwy 407 East Extension – Central Section”, W.O. 07–20016.

Thurber Engineering Ltd. 2009 “Preliminary Foundation and Design Report, Highway 407 East Extension – Central Section (East Part)” W.O. 07-20016.

STANDARDS:

ASTM International:

ASTM D1586	Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils.
ASTM D1587	Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes.
ASTM D2573	Standard Test Method for Field Vane Shear Test in Cohesive Soil

Contract Design Estimating and Documentation (CDED):

Special Provision 105S10	Amendment to OPSS 501 – Construction Specification for Compaction.
Special Provision 206S03	Amendment to OPSS 206 – Earth Excavation, Grading.
Special Provision 422S01	Amendment to OPSS 422 – Precast Concrete Box Culverts.

Ontario Occupational Health and Safety Act:

Ontario Regulation 213/91	Construction Projects.
Ontario Regulation 443/09	Amendment to Ontario Regulation 213.

Ontario Provincial Standard Drawing:

OPSD 200.020	Earth/Shale Grading – Divided Rural.
OPSD 208.010	Benching of Earth Slopes.
OPSD 803.010	Backfill and Cover for Culverts with Spans Less than or Equal to 3.0 m.
OPSD 3090.101	Foundation Frost Depths for Southern Ontario.
OPSD 3101.150	Walls – Abutment, Backfill Minimum Granular Requirement.
OPSD 3121.150	Walls – Retaining, Backfill Minimum Granular Requirement.

Ontario Provincial Standard Specification:

OPSS 206	Construction Specification for Grading.
OPSS 422	Construction Specifications for Precast Reinforced Concrete Box Culverts and Box Sewers in Open Cut.
OPSS 501	Construction Specification for Compacting.
OPSS 539	Construction Specification for Temporary Protection Systems.
OPSS 577	Construction Specification for Temporary Erosion And Sediment Control Measures.
OPSS 804	Construction Specification for Seed and Cover.
OPSS 902	Construction Specifications for Excavating and Backfilling.
OPSS 903	Construction Specification for Deep Foundations.
OPS.Prov	

Ontario Water Resources Act:

Ontario Regulation 372/07	Amendment to Ontario Regulation 903
Ontario Regulation 903/90	Wells

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE
F V	FIELD VANE		

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

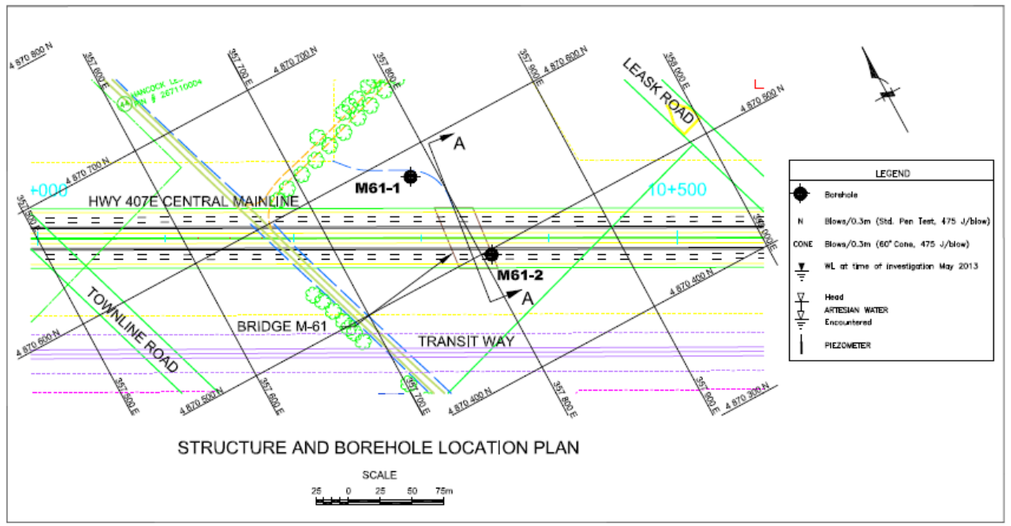
ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL
e	1, %	VOID RATIO
n	1, %	POROSITY
w	1, %	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
DTPL		DRIER THAN PLASTIC LIMIT
APL		ABOUT PLASTIC LIMIT
WTPL		WETTER THAN PLASTIC LIMIT
e_{max}	1, %	VOID RATIO IN LOOSEST STATE
e_{min}	1, %	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

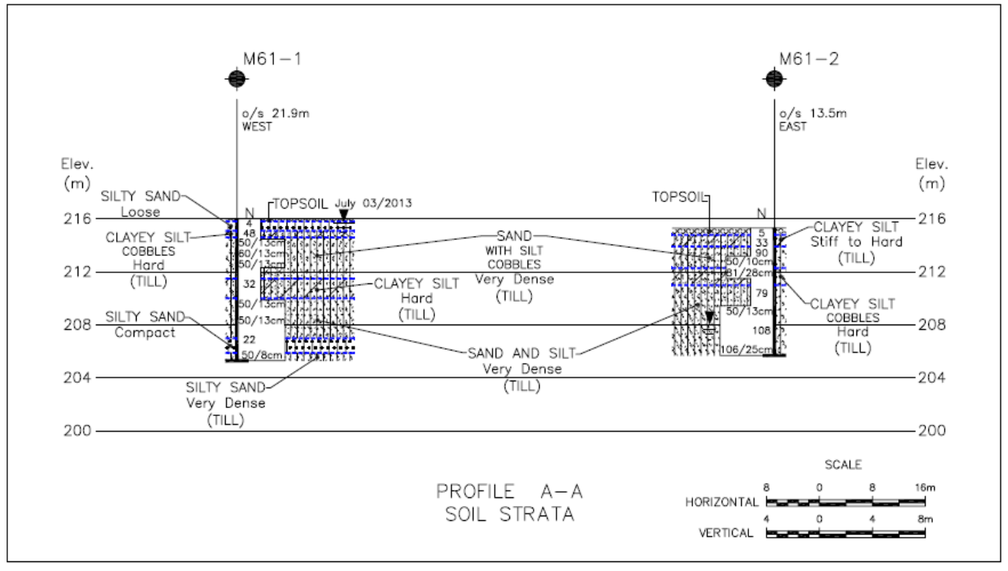
PART C

PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT (FIDR) SHEETS

PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST– CENTRAL SECTION (EAST PART)
W.O. 07 – 20016

Structure Description: Bridge over Harmony Creek
Location No: M-61 (CM-HC-54)
Highway 407 Proposed Grade: 220.5 – 221.0 m
Existing Ground Elevation: 215.3 – 216.0 m
Site Ranking: Medium
Station: 10+335





FOUNDATION INVESTIGATIONS

Site Description:

The proposed bridge is located over Harmony Creek some 200 m west of Leask Road between Concession Road 6 and Concession Road 7 in the Municipality of Clarington, Ontario. The site topography is generally flat and surrounded by farmland, with Harmony Creek flowing to the south.

Borehole Information:

Borehole No	Borehole Location	MTM NAD 83 – Northing	MTM NAD 83 – Easting	Borehole Elevation (m)	Borehole Depth (m)
M61-1	West Abutment, WBL	4 870 579.9	357 779.9	216.0	10.7
M61-2	East Abutment, EBL	4 870 495.6	357 807.1	215.3	9.6

Subsurface Conditions:

- **Topsoil:** Surficial topsoil was present in both boreholes. With a moisture content of 37%, the silty topsoil was 200 and 500 mm in thickness and penetrated at elevation 215.8 and 214.8 in boreholes M61-1 and M61-2 respectively.
- **Silty Sand:** Directly beneath the topsoil at 0.2 m depth (elevation 215.8) in borehole M61-1 was silty sand. This unit contained organics and was loose in relative density (SPT-`N` value of 4). The silty sand was 700 mm thick and penetrated at a depth of 0.9 m (elevation 215.1).
- **Clayey Silt Till:** Overlain by the topsoil / silty sand at 0.9 m depth (elevation 215.1) in borehole M61-1 and a depth of 0.5 m (elevation 214.8) in borehole M61-2 was a cohesive deposit of clayey silt till. This deposit was also revealed below sand till at 4.5 m depth (elevation 211.5) in the former borehole and a depth of 3.0 m (elevation 212.3) in the latter. The clayey silt till was 0.5 to 1.5 m in thickness and stiff to hard in consistency, its moisture content varying between 7 and 15%. The upper deposit was penetrated at 1.4 m depth (elevation 214.6 and 213.9) and the lower one at depths of 6.0 and 4.3 m (elevation 210.0 and 211.0) in boreholes M61-1 and M61-2 respectively. The results of Atterberg limits testing and grain size distribution analysis conducted on a sample of the clayey silt till are presented in respective Figures M61-PC-1 and M61-GS-1 (Appendix B). It is noteworthy that cobbles were encountered in the deposit in both boreholes.
- **Cohesionless Till:** Underlying the upper cohesive deposit at 1.4 m depth (elevation 214.6 and 213.9) in boreholes M61-1 and M61-2 was sand till. Containing cobbles, this stratum was penetrated at respective depths of 4.5 and 3.0 m (elevation 211.5 and 212.3). Sand and silt till was revealed below the lower cohesive deposit at 6.0 m depth (elevation 210.0) in borehole M61-1 and a depth of 4.3 m (elevation 211.0) in borehole M61-2. A 1.1 m thick layer of compact silty sand (SPT-'N' value of 22) was identified below the sand and silt till at 9.0 m depth (elevation 207.0) in borehole M61-1, overlying silty sand till at a depth of 10.1 m (elevation 205.9). The cohesionless till strata were very dense and had a moisture content ranging from 6 to 16%. Boreholes M61-1 and M61-2 were terminated in the silty sand till / sand and silt till at respective depths of 10.7 and 9.6 m (elevation 205.3 and 205.7). The results of grain size distribution analyses performed on 2 samples of the sand till / sand and silt till are presented in Figures M61-GS-2 and M61-GS-3 (Appendix B).

Groundwater Conditions:

- **Borehole M61-1:** In the process of augering, water was detected at 6.1 m depth (elevation 209.9). Groundwater was at a depth of 5.5 m (elevation 210.5) upon completion of drilling. The piezometric water level was at 0.3 m depth (elevation 215.7) on July 3 and a depth of 0.5 m (elevation 215.5) on July 30, 2013.
- **Borehole M61-2:** In the process of augering, water was detected at 4.3 m depth (elevation 211.0). Groundwater was at a depth of 7.3 m (elevation 208.0) upon completion of drilling.

PART B - PRELIMINARY FOUNDATION DESIGN REPORT
HWY 407 EAST – CENTRAL SECTION (EAST PART)
W.O. 07 – 20016

LOCATION No: M-61 (CM-HC-54)

FOUNDATION RECOMMENDATIONS

Note: The site-specific foundation recommendations are for planning purposes only. Refer to Section 6.0 of the Foundation Design Report for the project-wide foundation recommendations, design assumptions and limitations.

General: Based on a General Arrangement drawing prepared by AECOM in March 2009, Bridge M-61 will carry the Highway 407 traffic over Harmony Creek. The proposed bridge consists of two single 30.0 m span structures (for EBL and WBL) with approach embankments approximately 2 m high at both abutments. Based on the existing subsurface information, the feasible foundation options for the proposed bridge abutments are listed below with advantages and disadvantages associated with each option.

Foundation Option	*Advantages*	*Disadvantages*
Spread footings founded on hard clayey silt till / very dense sand till Spread footings founded on a compacted Granular 'A' pad	• Lower cost than deep foundations • Conventional construction	• Some post-construction settlement due to consolidation of underlying soils • Dewatering measures may be required during construction
Steel H-Piles driven into "100-blow" sand and silt till	• Allows for integral abutment design • Not affected by surficial soil variability	• Requires flange plate reinforcement to facilitate driving through the very dense / hard till containing cobbles and possible boulders • Dewatering may be required during construction (i.e. pile caps)
Caissons bored to found within "100-blow" sand and silt till	• Higher bearing resistance than steel H-Piles • Not affected by surficial soil variability	• Drilling must be advanced through the very dense / hard till containing cobbles and possible boulders • Requires temporary or permanent liner to prevent seepage inflow and softening of the caisson base • Dewatering may be required during construction (i.e. caisson caps), special techniques may be required when artesian conditions are encountered

A – Spread Footings: Spread footings may be founded on hard clayey silt till / very dense sand till at or below elevation 214.0 to 214.5 at both abutments. All footings should be placed at a minimum depth of 1.2 m below the lowest surrounding grade for frost protection. Alternatively, spread footings can be founded within the approach embankment on a minimum 2 m thick compacted Granular 'A' pad.

Founding Stratum	*Geotechnical Resistance*	
	Factored ULS	**SLS**
Hard Clayey Silt Till / Very Dense Sand Till	600 kPa	400 kPa
Compacted Granular 'A' Pad	900 kPa	350 kPa

B – Steel H-Piles: Steel HP 310x110 piles driven to found within the "100-blow" sand and silt till at or below elevation 208.0 are feasible for support of the west and east abutments. Pile lengths will be about 9 m at both abutments. Pre-augering may be required to provide the minimum 5 m pile length necessary for integral abutment design.

Location	*Pile*	*Geotechnical Axial Resistance*	
		Factored ULS	**SLS**
Abutments	HP 310x110	1,600 kN	1,400 kN

C – Caissons: Caissons should be founded a minimum 2 m within the "100-blow" sand and silt till at or below elevation 207.0. Caissons would be approximately 10 m long at the abutments.

Location	*Caisson Diameter*	*Geotechnical Axial Resistance*	
		Factored ULS	**SLS**
Abutments	1.2 m	4,500 kN	3,500 kN
	1.5 m	6,500 kN	5,500 kN

Recommended Foundation Alternative: Spread footings founded on hard clayey silt till / very dense sand till or on a compacted Granular 'A' pad are recommended from a foundation engineering perspective.

• ABUTMENT TYPE

The site soils are suitable for construction of conventional, integral or semi-integral abutments.

• APPROACHES

Height: Based on the GA drawing, the west and east approach embankments will be approximately 2 m high. Based on the subsoil conditions encountered at the site, approach embankments consisting of up to 2 m high earth fill can be constructed. However, sub-excavation of about 0.5 m of topsoil and loose silty sand with organics would be required.

Stability: Approach embankments up to 2 m high, constructed of select subgrade materials or granular fill, with side slopes no steeper than 2 horizontal to 1 vertical (2H:1V) will have an adequate factor of safety against deep-seated slope instability. Measures to stabilize the embankment slope face due to potential surface water flow / seepage at the slope surface may have to be implemented.

Settlement: Assuming the use of conventional earth or granular embankment fills, where applicable, the total settlement at the west and east approach embankments is assessed to be in the order of 50 and 40 mm respectively. About 80 per cent of the total settlement is expected to take place during and immediately after completion of construction (i.e. elastic settlement); the remaining consolidation settlement is anticipated to occur over a period of 3 to 4 months. Further geotechnical analyses need to be carried out during detail design to assess the construction requirements of the new embankment fills.

• CONSTRUCTION CONSIDERATIONS

Excavation: The surficial loose silty sand and stiff clayey silt till above the water table are classified as Type 3 soils according to OHSA. Temporary excavations (i.e. open for a relatively short time period) should be made with side slopes no steeper than 1H:1V in Type 3 soils assuming dewatering is provided. For saturated granular soils below the water table, temporary shoring may be required.

Groundwater / Surface Water Control: It is anticipated that conventional sump pumping techniques may not be sufficient to control groundwater within the foundation excavations and more elaborate dewatering measures may be required. Basal heave will need to be assessed if artesian conditions are encountered. Artesian groundwater conditions should be expected when advancing deep foundations such as piles through the silty/sandy deposits. Refer to Section 6.7.3 for options to control groundwater and migration of fines when driving piles at sites with artesian groundwater conditions.

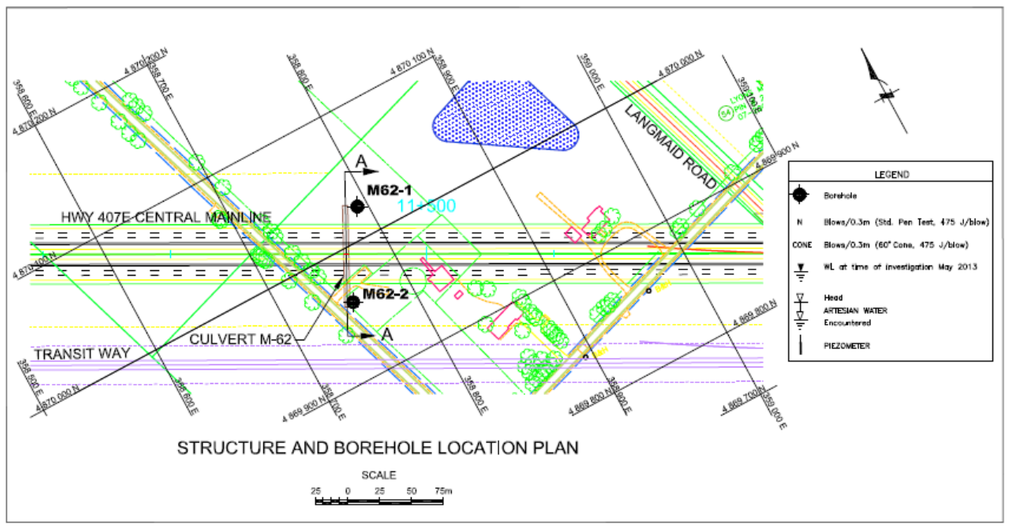
Obstructions During Pile Driving: Flange plate reinforcement for steel H-Piles should be used to facilitate driving into or through the very dense till containing cobbles and possible boulders. Caisson drilling equipment must be capable of penetrating obstructions when cobbles / boulders are present in the till deposits.

• RECOMMENDATIONS FOR ADDITIONAL WORK

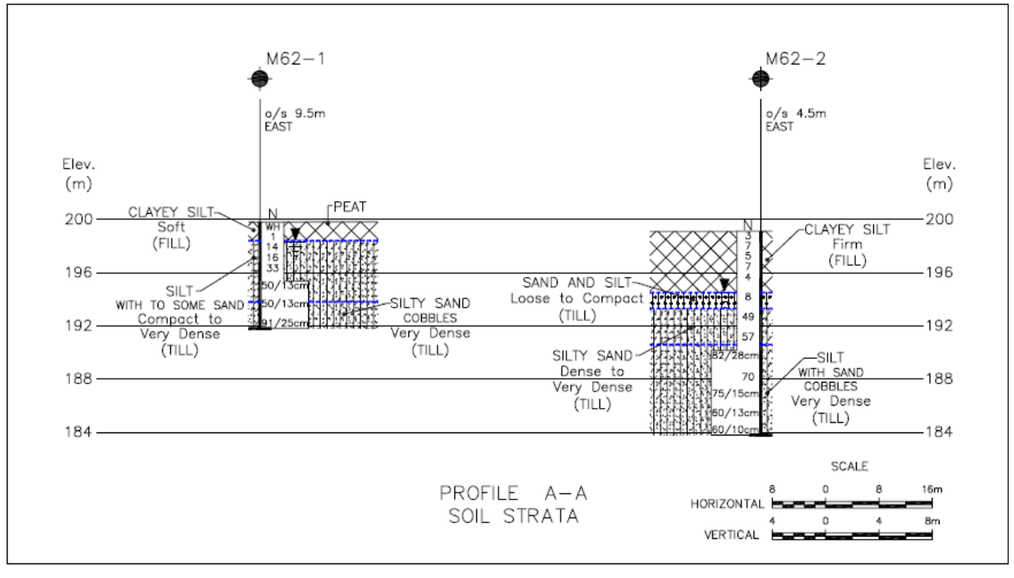
Further subsurface investigation should be carried out during detail design to confirm the subsoil and groundwater conditions at the location of the bridge foundation elements.

PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST– CENTRAL SECTION (EAST PART)
W.O. 07 – 20016

Structure Description: Culvert at Highway 407 over Harmony Creek
Location No: M-62 (CM-HC-56)
Highway 407 Proposed Grade: 204.0 – 204.5 m
Existing Ground Elevation: 199.1 – 199.8 m
Site Ranking: Medium
Station: 11+437



STRUCTURE AND BOREHOLE LOCATION PLAN



PROFILE A–A
SOIL STRATA

FOUNDATION INVESTIGATIONS

Site Description:

The site of the proposed culvert M-62 at Highway 407 is located over Harmony Creek some 400 m north of Concession Road 6 between Leask Road and Langmaid Road in the Municipality of Clarington, Ontario. The site topography is generally flat and surrounded by farmland, with Harmony Creek flowing to the south.

Borehole Information:

Borehole No	Borehole Location	MTM NAD 83 – Northing	MTM NAD 83 – Easting	Borehole Elevation (m)	Borehole Depth (m)
M62-1	North End (Inlet)	4 870 024.3	358 792.1	199.8	8.0
M62-2	South End (Outlet)	4 869 959.9	358 753.6	199.1	15.3

Subsurface Conditions:

- **Fill:** Surficial fill was present in both boreholes. It appeared that the fill consisting of clayey silt with organics had been randomly dumped at the site. Soft to firm in consistency and 14 to 22% in moisture content, the fill was 1.5 and 4.6 m thick and penetrated at elevation 198.3 and 194.5 in boreholes M62-1 and M62-2 respectively.
- **Silt Till / Sand and Silt Till:** Directly beneath the fill at depths of 1.5 and 4.6 m (elevation 198.3 and 194.5) in boreholes M62-1 and M62-2 was a layer of silt till / sand and silt till. This layer was loose to very dense (SPT-'N' values of 8 to over 50) and about 11% in moisture content. The silt till / sand and silt till had a thickness of 4.5 m in borehole M62-1 and 1.2 m in borehole M62-2 and was penetrated at respective depths of 6.0 and 5.8 m (elevation 193.8 and 193.3). The results of grain size distribution analysis conducted on a sample of the layer are presented in Figure M62-GS-1 (Appendix B).
- **Silty Sand Till:** Overlain by the silt till / sand and silt till at 6.0 m depth (elevation 193.8) in borehole M62-1 and a depth of 5.8 m (elevation 193.3) in borehole M62-2 was silty sand till. This unit contained cobbles and extended to the termination depth of 8.0 m (elevation 191.8) in the former borehole. In the latter, the silty sand till was 2.7 m in thickness and penetrated at a depth of 8.5 m (elevation 190.6). The unit was dense to very dense (SPT-'N' values of 49 to 91 blows per 25 cm) and had a moisture content of 9 to 11%. The results of grain size distribution analysis performed on a sample of the unit are presented in Figure M62-GS-2 (Appendix B).
- **Silt Till:** Underlying the silty sand till at 8.5 m depth (elevation 190.6) in borehole M62-2 was silt till. This stratum was very dense (SPT-'N' values of 60 blows per 13 cm to 82 blows per 28 cm) and extended to the termination depth of 15.3 m (elevation 183.8). The moisture content of the silt till varied between 6 and 11%. It is noted that cobbles were encountered in the stratum. The results of Atterberg limits testing and grain size distribution analysis conducted on a sample of the silt till are presented in respective Figures M62-PC-1 and M105-GS-3 (Appendix B).

Groundwater Conditions:

- **Boreholes M62-1:** Water was detected at 1.5 m depth (elevation 198.3) during drilling. Groundwater was at a depth of 7.0 m (elevation 192.8) upon completion of drilling.
- **Boreholes M62-2:** Groundwater was at 4.6 m depth (elevation 194.5) during and upon completion of drilling. The piezometric water level was at 2.9 m depth (elevation 196.2) on May 29 and a depth of 2.7 m (elevation 196.4) on July 30, 2013.

Record of Borehole Sheets – Appendix A **Laboratory Test Results – Appendix B** **Key Location Plan – Drawing C-04**

PART B - PRELIMINARY FOUNDATION DESIGN REPORT
HWY 407 EAST– CENTRAL SECTION (EAST PART)
W.O. 07 – 20016

LOCATION No: M-62 (CM-HC-56)

FOUNDATION RECOMMENDATIONS

Note: The site-specific foundation recommendations are for planning purposes only. Refer to Section 6.0 of the Foundation Design Report for the project-wide foundation recommendations, design assumptions and limitations.

General: Based on a General Arrangement drawing of Culvert M-62 prepared by AECOM in March 2009, the culvert will carry Highway 407 over Harmony Creek. The proposed open footing arch culvert will have a span of 9.1 m and length of 71.0 m. The stream bed levels of the culvert are specified to be at elevation 196.4 at the north end (inlet) and elevation 195.5 at the south end (outlet). Based on the existing subsurface information, the feasible foundation options for the proposed arch culvert foundations are listed below with advantages and disadvantages associated with each option.

Foundation Option	*Advantages*	*Disadvantages*
Spread footings founded on compact to dense silty/sandy soils	• Lower cost than deep foundations • Conventional construction	• Requires excavation of surficial soils to construct footings • Dewatering is required for footing construction • Variability of surficial soils • Scour protection is required for footings
Steel H-Piles driven into “100-blow” silty/sandy soils	• Higher bearing resistance than for footings • Not affected by surficial soil variability	• Requires flange plate reinforcement to facilitate driving into very dense silt till / silty sand till containing cobbles and possible boulders • Sub-excavation and dewatering is required for pile cap construction
Caissons bored to found within “100-blow” silty/sandy soils	• Higher bearing resistance than for footings • Not affected by surficial soil variability	• Requires temporary or permanent liner • Drilling equipment must be capable of penetrating very dense till deposits with cobbles and boulders • Sub-excavation and dewatering is required for caisson cap construction

A – Spread Footings: Spread footings founded on the compact silt till at elevation 198.3 at the north end or dense to very dense silty/sandy tills at or below elevation 195.5 at the north (inlet) end and elevation 193.3 at the south (outlet) end of the culvert. All footings should be placed at a minimum depth of 1.2 m below the lowest surrounding grade for frost protection.

Founding Stratum	*Geotechnical Resistance*	
	Factored ULS	**SLS**
Compact Silt Till	300 kPa	200 kPa
Dense Silt Till / Silty Sand Till	600 kPa	400 kPa

B – Steel H-Piles: Steel HP 310x110 piles driven into the “100-blow” silty sand till / silt till at or below elevation 193.0 at the north (inlet) end and elevation 185.5 at the south (outlet) end of the culvert are feasible for support of the foundation loads. Pile lengths would be approximately 3 and 10 m at the north and south ends, respectively.

Pile	*Geotechnical Axial Resistance*	
	Factored ULS	**SLS**
HP 310x110	1,600 kN	1,400 kN

C – Caissons: Caissons drilled to found within the “100-blow” silty sand till / silt till at or below elevation 192.0 at the north (inlet) end and elevation 184.5 at the south (outlet) end of the culvert. Caissons should be socketed a minimum 2 m into the “100-blow” material. Caissons would be about 4 m long at the north end and 11 m long at the south.

Caisson Diameter	*Geotechnical Axial Resistance*	
	Factored ULS	**SLS**
1.2 m	4,500 kN	3,500 kN
1.5 m	6,500 kN	5,500 kN

Recommended Foundation Alternatives: Spread footings founded on compact to dense silty/sandy soils or steel H-Piles driven into “100-blow” cohesionless till deposit.

• APPROACHES

Height: Based on the GA drawing, an embankment height of about 7 m is anticipated. It is noted that sub-excavation of 1.5 to 4.6 m thick fill would be required.

Stability: An embankment up to 7 m in height, constructed with select subgrade materials or granular fill, with side slopes no steeper than 2 horizontal to 1 vertical (2H:1V) will have an adequate factor of safety against deep-seated instability.

Settlement: Assuming the use of conventional earth or granular embankment fill materials and based on consolidation parameters and elastic deformation moduli of the foundation soils, the maximum predicted total settlement of the embankment is in the order of 60 mm. About 80 percent of the total settlement is expected to take place during and immediately after completion of construction (i.e. elastic settlement). The remaining settlement is anticipated to occur over a period of 3 to 4 months. Further geotechnical analyses need to be carried out during the detail design.

• CONSTRUCTION CONSIDERATIONS

Excavation: The fill and loose to compact silty/sandy soils are classified as a Type 3 soil according to OHSA. Temporary excavations (i.e. open for a relatively short time period) should be stable with side slopes no steeper than 1H:1V in Type 3 soils.

Groundwater / Surface Water Control: It is anticipated that sump pumping techniques will not be sufficient to control groundwater within the foundation excavations for footing construction and more elaborate dewatering measures will be necessary. Depending on construction season, diversion of surface water from the excavation may need to be implemented.

Protection Systems: Refer to Section 6.7.2 of the Report.

Obstructions During Pile Driving: Flange plate reinforcement for steel H-Piles if employed should be used to facilitate driving into the very dense silty sand till / silt till containing cobbles and possible boulders. Caisson drilling equipment must be capable of penetrating obstructions such as cobbles and boulders.

• RECOMMENDATIONS FOR ADDITIONAL WORK

Further subsurface investigation should be carried out during detail design to confirm the subsoil and groundwater conditions at the location of the arch culvert foundations.

PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST – CENTRAL SECTION (EAST PART)
W.O. 07 – 20016

Structure Description: Enfield Road / Concession Road 6 Overpass

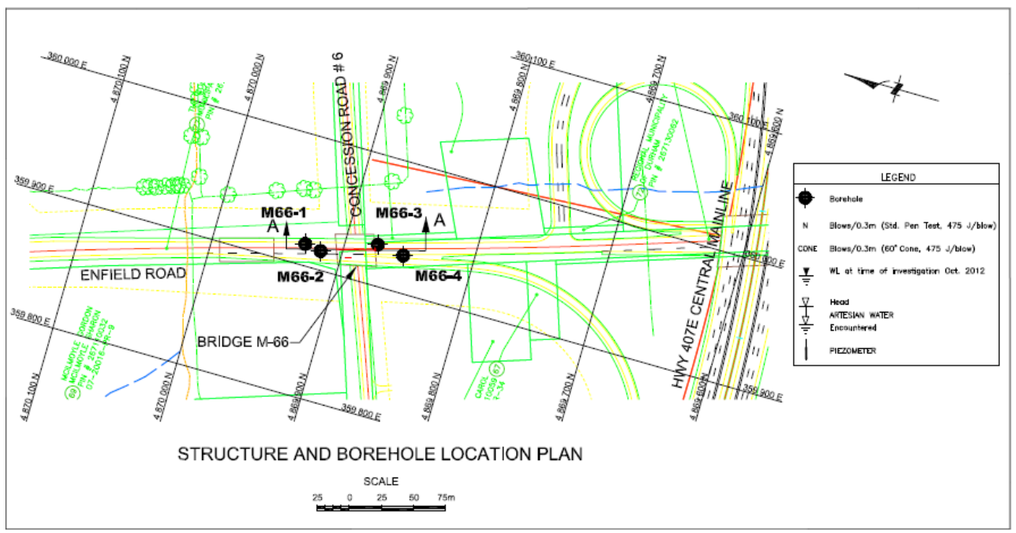
Location No: M-66 (CM-29c)

Enfield Road Proposed Grade: 206.5 m – 207.0 m

Existing Ground Elevation: 198.5 m – 199.2 m

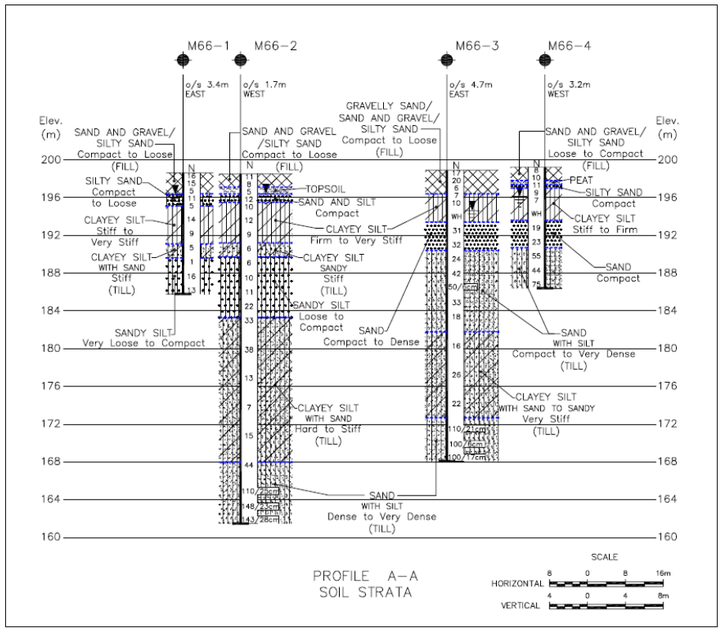
Site Ranking: High

Station: ~9+714



STRUCTURE AND BOREHOLE LOCATION PLAN

SCALE 25 0 25 50 75m



PROFILE A–A
SOIL STRATA

SCALE HORIZONTAL 8 0 8 16m VERTICAL 4 0 4 8m

FOUNDATION INVESTIGATIONS

Site Description:

- The site of the proposed overpass M-66 is located some 300 m north of Highway 407 in the Municipality of Clarington, Ontario. The site topography is generally flat and surrounded by farmland, with Farewell Creek flowing less than 100 m to the north.

Borehole Information:

Borehole No	Borehole Location	MTM NAD 83 – Northing	MTM NAD 83 – Easting	Borehole Elevation (m)	Borehole Depth (m)
M66-1	North Approach	4 869 929.5	359 916.5	198.6	12.8
M66-2	North Abutment	4 869 916.5	359 914.5	198.5	37.0
M66-3	South Abutment	4 869 875.1	359 931.5	198.9	30.8
M66-4	South Approach	4 869 853.8	359 928.7	199.2	12.8

Subsurface Conditions:

- **Fill:** Fill typically composed of sand and gravel over silty sand with organic inclusions was present surficially in all the boreholes. The fill was loose to compact in relative density (SPT-'N' values of 5 to 20) and 5 to 15% in moisture content. The fill was 1.4 to 2.5 m in thickness and penetrated at elevation 196.4 to 197.8.
- **Topsoil / Peat:** Buried under the silty sand fill at 1.4 m depth (elevation 197.1 and 197.8) was silty topsoil in borehole M66-2 and fine fibrous peat in borehole M66-4. Having a moisture content of 60 and 307%, these deposits were 700 and 400 mm thick and penetrated at respective depths of 2.1 and 1.8 m (elevation 196.4 and 197.4).
- **Silty Sand / Sand and Silt:** Directly beneath the fill, topsoil or peat at depths of 1.8 to 2.2 m (elevation 196.4 to 197.4) in boreholes M66-1, M66-2 and M66-4 was silty sand / sand and silt. This unit was 0.4 to 1.3 m in thickness and loose to compact in relative density (SPT-'N' values of 5 to 12), its moisture content ranging from 16 to 18%. The silty sand / sand and silt was penetrated at depths of 2.2 to 3.5 m (elevation 195.1 to 197.0). The results of grain size distribution analysis performed on the sand and silt are presented in Figure M66-GS-1 (Appendix B).
- **Clayey Silt:** Overlain by the fill or silty sand / sand and silt at depths of 2.2 to 3.5 m (elevation 195.1 to 197.0) in all the boreholes was a cohesive deposit of clayey silt. This deposit was 3.0 to 4.3 m thick and firm to very stiff in consistency. The results of in situ vane testing within the clayey silt yielded an undrained shear strength of 100 kPa, with penetrometer tests indicating shear strength values in a range of 75 to 125 kPa. The deposit was penetrated at depths of 5.5 to 7.5 m (elevation 191.1 to 193.6). The results of Atterberg limits testing and grain size distribution analyses conducted on two samples of the clayey silt are presented in respective Figures M66-PC-1 and M66-GS-2 (Appendix B). The moisture content of the deposit varied between 19 and 24%.
- **Clayey Silt Till:** A cohesive deposit of clayey silt till was identified below the clayey silt in boreholes M66-1 and M66-2 at respective depths of 7.5 and 7.3 m (elevation 191.1 and 191.2). This deposit was 1.5 m in thickness and stiff in consistency. The results of in situ vane testing within the clayey silt till yielded an undrained shear strength of 100 kPa. The deposit was penetrated at 9.0 m depth (elevation 189.6) in borehole M66-1 and a depth of 8.8 m (elevation 189.7) in borehole M66-2. The results of Atterberg limits testing and grain size distribution analysis conducted on the clayey silt till are presented in respective Figures M66-PC-2 and M66-GS-3 (Appendix B). The moisture content of the deposit varied between 8 and 14%.

- **Sandy Soils:** Underlying the clayey deposits at depths of 5.5 to 9.0 m (elevation 189.6 to 193.6) in all the boreholes were sandy soils (sandy silt, sand). The sandy silt extended to the termination depth of 12.8 m (elevation 185.8) in borehole M66-1 and was penetrated at 15.0 m depth (elevation 183.5) in borehole M66-2. The sand had a thickness of 3.0 and 2.9 m in boreholes M66-3 and M66-4 and was penetrated at a depth of 8.5 m (elevation 190.4 and 190.7). The sandy soils were loose to dense (typical SPT-'N' values of 6 to 32), their moisture content ranging from 12 to 19%. The results of grain size distribution analyses performed on four samples of the sand and sandy silt are presented in respective Figures M66-GS-4 and M66-GS-5 (Appendix B).
- **Sand Till:** A layer of sand till was revealed below the sand at 8.5 m depth (elevation 190.4 and 190.7) in boreholes M66-3 and M66-4 respectively. This layer was 8.6 m thick and penetrated at a depth of 17.1 m (elevation 181.8) in the former borehole and extended to the termination depth of 12.8 m (elevation 186.4) in the latter. The sand till was compact to very dense (SPT-'N' values of 18 to 75) and had a moisture content of 9 to 15%. It is noteworthy that cobbles were present within the layer in borehole M66-3. The results of grain size distribution analyses performed on two samples of the sand till are presented in Figure M66-GS-6 (Appendix B).
- **Clayey Silt Till:** Overlain by the sandy silt at 15.0 m depth (elevation 183.5) in borehole M66-2 or by the sand till at a depth of 17.1 m (elevation 181.8) in borehole M66-3 was a cohesive deposit of clayey silt till. Stiff to hard in consistency, this deposit had a thickness of 15.0 and 9.1 m and was penetrated at depths of 30.0 and 26.2 m (elevation 168.5 and 172.7) in boreholes M66-2 and M66-3 respectively. The results of Atterberg limits testing and grain size distribution analyses conducted on four samples of the clayey silt till are presented in respective Figures M66-PC-3 and M66-GS-7. The moisture content of the deposit varied between 8 and 22%.
- **Sand Till:** Underlying the clayey silt till in boreholes M66-2 and M66-3 at respective depths of 30.0 and 26.2 m (elevation 168.5 and 172.7) was sand till. This stratum was dense to very dense (SPT-'N' values of 44 to over 148) and had a moisture content of 10 to 12%. The sand till was not penetrated upon termination of drilling at depths of 37.0 and 30.8 m (elevation 161.5 and 168.1) in boreholes M66-2 and M66-3 respectively. It is worth noting that the stratum contained cobbles in borehole M66-2. The results of grain size distribution analysis performed on the sand till are presented in Figure M66-GS-8 (Appendix B).

Groundwater Conditions:

- **Boreholes M66-1 to M66-4:** In the process of augering, water was detected at depths of 2.1 to 4.3 m (elevation 194.6 to 196.4) in all the boreholes. Groundwater was measured in borehole M66-1 to be at 6.4 m depth (elevation 192.2).

PART B - PRELIMINARY FOUNDATION DESIGN REPORT
HWY 407 EAST – CENTRAL SECTION (EAST PART)
W.O. 07 – 20016

LOCATION No: M-66 (CM-29c)

FOUNDATION RECOMMENDATIONS

Note: The site-specific foundation recommendations are for planning purposes only. Refer to Section 6.0 of the Foundation Design Report for the project-wide foundation recommendations, design assumptions and limitations.

General: Based on a General Arrangement drawing prepared by AECOM in March 2009, Overpass M-66 will carry the Enfield Road traffic over Concession Road 6. The proposed overpass is a single span structure 30 m long and about 24 m wide and with approach embankments 8.5 and 7.5 m high at the north and south abutments, respectively. Based on the existing subsurface information, the feasible foundation options for the proposed overpass abutments are listed below with advantages and disadvantages associated with each option. It is noted that spread footings are not considered to be a practical option given the limited bearing resistance available in the upper soils present at the site.

Foundation Option	*Advantages*	*Disadvantages*
Steel H-Piles driven into "100-blow" sand till for abutment foundations	• Allows for integral abutment design	• Requires flange plate reinforcement to facilitate driving through the very dense sand till containing cobbles
Caissons bored to found within "100-blow" sand till for abutment foundations	• Higher bearing resistance than steel H-Piles	• Drilling must be advanced through the very dense sand till containing cobbles • Requires temporary or permanent liner extending above the prevailing groundwater level to prevent seepage inflow and softening of the caisson base

A – Steel H-Piles: Steel HP 310x110 piles driven to refusal into the "100-blow" sand till at or below elevation 164.0 at the north abutment and elevation 170.5 at the south abutment are feasible for support of the abutments with "perched" pile caps. Piles would be about 39 and 32 m long at the north and south abutments, respectively.

Location	*Pile*	*Geotechnical Axial Resistance*	
		Factored ULS	**SLS**
Abutments	HP 310x110	1,600 kN	1,400 kN

C – Caissons: Abutments on caissons should be founded a minimum 2 m within the "100-blow" sand till at or below elevation 163.0 at the north abutment and elevation 169.5 at the south abutment. Caissons would be about 40 and 33 m long at the north and south abutments, respectively.

Location	*Caisson Diameter*	*Geotechnical Axial Resistance*	
		Factored ULS	**SLS**
Abutments	1.2 m	4,500 kN	3,500 kN
	1.5 m	6,500 kN	5,500 kN

Recommended Foundation Alternative: Steel H-Piles.

• ABUTMENT TYPE

The site soils are suitable for construction of conventional, semi-integral or integral abutments.

• APPROACHES

Height: Based on the GA drawing, the north and south approach embankments will be up to 8.5 m high. Based on the subsoil conditions encountered at the site, approach embankments consisting of 8.5 m high earth fill can be constructed. However, sub-excavation of approximately 2.5 m of existing fill and topsoil / peat at both abutments would be required.

Stability: Approach embankments up to 8.5 m high, constructed of select subgrade materials or granular fill and with side slopes no steeper than 2 horizontal to 1 vertical (2H:1V) will be safe against deep-seated slope instability. In addition, construction of a 2 m wide mid-height berm may be required for embankments exceeding 8 m in height to control surficial erosion and improve stability. Measures to stabilize the embankment slope face due to potential surface water flow / seepage at the slope surface will have to be implemented. From a stability perspective, embankments higher than 9 m earth fill are not recommended.

Settlement: Assuming the use of conventional earth or granular embankment fills, where applicable, it is expected that the total settlement at the north and south approach embankments is expected to be in the order of 200 and 150 mm respectively. About 20 per cent of the total settlement is expected to take place during and immediately after completion of construction (i.e. elastic settlement); the remaining consolidation settlement is anticipated to occur over a period of 6 to 9 months. Measures to reduce post-construction settlement to acceptable values may be undertaken (preloading with a surcharge, construction staging). Further geotechnical analyses need to be carried out during detail design to assess the construction requirements of the new embankment fills, including appropriate settlement monitoring instrumentation.

• CONSTRUCTION CONSIDERATIONS

Excavation: Surficial fill, loose to compact sandy soils, firm to stiff clayey silt and topsoil / peat are classified as Type 3 and Type 4 soils, respectively, according to OHSA. Temporary excavations (i.e. open for a relatively short time period) should be made with side slopes no steeper than 1H:1V in Type 3 soils and at 3H:1V in Type 4 soils.

Groundwater / Surface Water Control: It is anticipated that groundwater within the foundation excavations may be adequately controlled using conventional sump pumping techniques.

Obstructions During Pile Driving: Flange plate reinforcement for steel H-Piles should be used to facilitate driving into or through the sand till containing cobbles and possible boulders. Caisson drilling equipment must be capable of penetrating obstructions when cobbles / boulders are present in the till deposits.

• RECOMMENDATIONS FOR ADDITIONAL WORK

Further subsurface investigation should be carried out during detail design to confirm the subsoil conditions at the location of the foundation elements of this structure.

PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST – CENTRAL SECTION (EAST PART)
W.O. 07 – 20016

Structure Description: Enfield Road Bridge over Farewell Creek

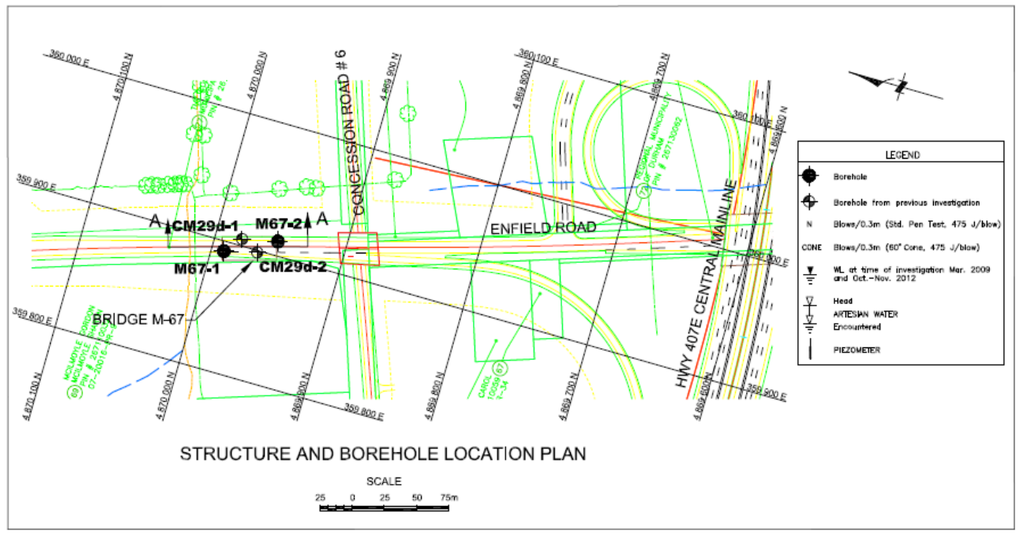
Location No: M-67 (CM-29d)

Enfield Road Proposed Grade: ~ El. 207 m

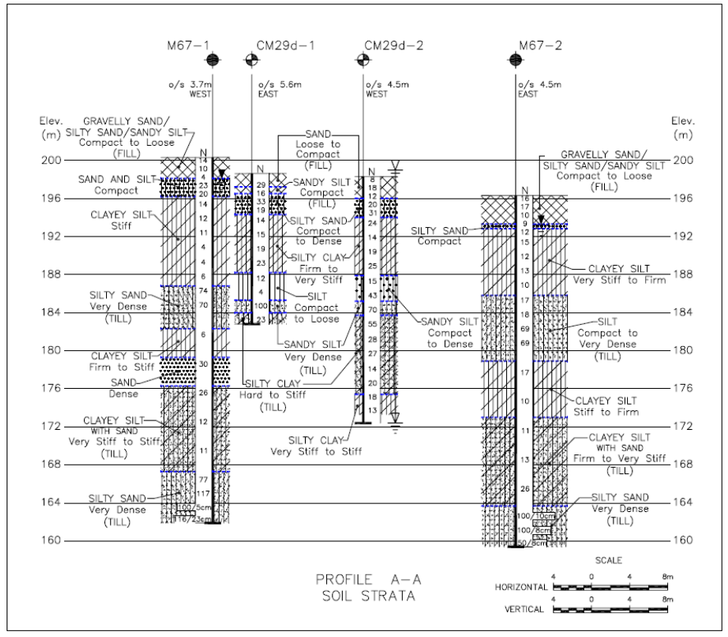
Existing Ground Elevation: ~ El. 197 to 200 m

Site Ranking: High

Station: ~9+629



STRUCTURE AND BOREHOLE LOCATION PLAN



PROFILE A–A
SOIL STRATA

FOUNDATION INVESTIGATION

Site Description:

At this site, Enfield Road is an existing two-lane, rural undivided paved roadway. Farewell Creek flows in a west to east direction through an existing culvert under Enfield Road. Terrain mapping shows the creek area is characterized by organics and sand, silt and gravel alluvial plain over glacial till. The local relief is low with poor drainage.

Borehole Information:

Borehole No.	Borehole Location	MTM NAD 83 – Northing	MTM NAD 83 - Easting	Borehole Elevation (m)	Borehole Depth (m)
M67-1	North Abutment (SBL)	4 869 990.3	359 892.3	200.3	38.4
M67-2	South Abutment (NBL)	4 869 952.2	359 911.4	196.3	36.9
CM29d-1	South of North Abutment (NBL)	4 869 979.3	359 905.2	198.6	15.8
CM29d-2	North of South Abutment (SBL)	4 869 965.2	359 898.5	198.3	25.9

Subsurface Conditions:

• **Fill:** Surficial fill composed of gravelly sand, sand, silty sand and sandy silt was present in all the boreholes and extended to depths of 2.1 to 3.0 m (elevation 193.3 to 198.1). The fill was loose to compact with SPT-'N' values ranging from 4 to 29. The moisture content of the fill varied between 4 and 20%.

• **Silty Sand:** A layer of silty sand (sand and silt in borehole M67-2) was revealed below the fill at depths of 2.1 to 3.0 m (elevation 193.3 to 198.1). The thickness of this layer ranged from 0.5 to 2.2 m, with underside elevations of 192.8 to 196.2. The sandy soils were compact to dense (SPT-'N' values of 12 to 33) and had a moisture content of 11 to 19%. The results of grain size distribution analyses performed on samples of the layer are presented in Figures M67-GS-1 and CM29d-B1 (Appendices B and C).

• **Clayey Silt / Silty Clay:** A deposit of clayey silt / silty clay was encountered below the silty sand / sand and silt at depths of 3.5 to 4.3 m (elevation 192.8 to 196.2) in all the boreholes. This deposit was 6.1 to 9.4 m thick and penetrated at depths of 10.4 to 13.5 m (elevation 185.8 to 188.2). The clayey silt / silty clay was firm to very stiff with SPT-'N' values ranging from 11 to 25 and an undrained shear strength of 32 to 120 kPa indicated in field vane and penetrometer tests. The measured moisture content varied between 12 and 24%. The results of Atterberg limits testing and grain size distribution analyses conducted on samples of the deposit are presented in respective Figures M67-PC-1, CM29d-B5 and M67-GS-2, CM29d-B2 (Appendices B and C).

• **Silt:** Directly beneath the silty clay at 10.4 m depth (elevation 188.2 and 187.9) in boreholes CM29d-1 and CM29d-2 was a 2.7 to 2.9 m thick layer of silt. This layer extended to respective depths of 13.3 and 13.1 m (elevation 185.3 and 185.2). The silt was loose to dense (SPT-'N' values of 4 to 43) and had a moisture content of 10 to 18%. Grain size distribution analyses for samples of this soil are presented in Figure CM29d-B3 (Appendix C).

• **Silty Sand Till / Sandy Silt Till / Silt Till**: Silty sand / sandy silt / silt till was revealed below the clayey silt or silt / sandy silt at depths of 10.5 to 13.5 m (elevation 185.2 to 186.8). This layer was 1.3 to 6.9 m in thickness, extending to elevation 178.9 to 183.7. The till was compact to very dense with SPT-'N' values of 17 to 100. The moisture content ranged from 8 to 16%. The results of grain size distribution analyses performed on the silty sand till and silt till are presented in respective Figures M67-GS-3 and M67-GS-4 (Appendix B). Glacial tills typically contain cobbles and boulders.

• **Clayey Silt:** Underlying the silty sand till in borehole M67-1 and the silt till in borehole M67-2 at respective depths of 18.0 and 17.4 m (elevation 182.3 and 178.9) was clayey silt. This deposit was 3.0 and 5.9 m in thickness and firm to stiff in consistency, its moisture content varying between 9 and 20%. The undrained shear strength was 40 to 88 kPa (soil sensitivity of 2 to 3) as determined in vane testing and 25 kPa in a penetrometer test. The clayey silt was penetrated at depths of 21.0 and 23.3 m (elevation 179.3 and 173.0) in boreholes M67-1 and M67-2 respectively.

PART B - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST– CENTRAL SECTION (EAST PART)
W.O. 07 – 20016

LOCATION No: M-67 (CM-29d)

- **Sand:** Overlain by the clayey silt at 21.0 m depth (elevation 179.3) in borehole M67-1 was a layer of sand. This unit was 3.0 m thick and dense (SPT-'N' value of 30) with a moisture content of about 7%. The sand was penetrated at 24.0 depth (elevation 176.3). The results of grain size distribution analysis are presented in Figure M67-GS-5 (Appendix B).

- **Clayey Silt Till / Silty Clay Till:** A deposit of clayey silt / silty clay till was encountered below the sand, clayey silt or sandy silt till in all the boreholes. Borehole CM29d-1 was terminated in this till layer at 15.8 m depth (elevation 182.8). This 8.3 to 9.3 m thick deposit was firm to hard with SPT-'N' values ranging from 11 to 55 and extended to depths of 22.9 to 33.0 m (elevation 163.7 to 175.4). The measured moisture content ranged from 8 to 22%. The results of Atterberg limits testing and grain size distribution analyses conducted on samples of the deposit are presented in respective Figures M67-PC-2, CM29d-B6 and M67-GS-6, CM29d-B4 (Appendices B and C).

- **Silty Clay:** A deposit of silty clay was revealed below the silty clay till at a depth of 22.9 m (elevation 175.4) in borehole CM29d-2. This silty clay is very stiff to stiff with SPT-'N' values of 18 and 13. The moisture content ranged from 7 to 18%. After sampling to 25.0 m depth (elevation 173.3) and extending to 25.9 m depth (elevation 172.4), an artesian condition was encountered and borehole CM29d-2 terminated. Based on this observation, the lower boundary of the clay layer is believed to be between 25.0 and 25.9 m depth.

- **Silty Sand Till:** Underlying the clayey silt till at 33.0 m depth (elevation 167.3) in borehole M67-1 and at a depth of 32.6 m (elevation 163.7) in borehole M67-2 was silty sand till. This stratum of at least 4.3 m thickness was not penetrated upon termination of drilling at respective depths of 38.4 and 36.9 m (elevation 161.9 and 159.4). The silty sand till was very dense (SPT-"N" values in excess of 50) and had a moisture content of 8 to 12%. The results of grain size distribution analysis performed on a sample of the stratum are presented in Figure M67-GS-3 (Appendix B).

Groundwater Conditions:

- **Borehole CM29d-2:** The groundwater level was at 0.74 m above the ground surface (elevation 199.04) 45 minutes after the artesian condition was encountered at 25.9 m depth (elevation 172.4).

- **Boreholes 67-1 and M67-2:** In the process of augering, water was observed at depths of 2.3 and 3.1 m (elevation 198.0 and 193.2) in boreholes M67-1 and M67-2 respectively.

PART A - PRELIMINARY FOUNDATION DESIGN REPORT
HWY 407 EAST– CENTRAL SECTION (EAST PART)
W.O. 07 – 20016

Structure Description: Enfield Road Bridge over Farewell Creek

Location No: M-67 (CM-29d)

Enfield Road Proposed Grade: ~ El. 207 m

Existing Ground Elevation: ~ El. 197 to 200 m

Site Ranking: High

Station: ~9+629

FOUNDATION RECOMMENDATIONS

Note: The site specific foundation recommendations are for planning purposes only. Refer to Section 6 of the Foundation Design Report for the project-wide foundation recommendations, design assumptions and limitations.

General: A two span structure with two abutments and a central pier is proposed.

Foundation Option	*Advantages*	*Disadvantages*
Spread Footings founded on compact to dense silty sand / sand and silt	- Conventional construction - Low cost alternative	- Does not permit integral abutment design - Potential variability of surficial soils; footings must be extended below these soils - Temporary shoring may be required - Dewatering will be required - Scour protection will be required for the footings - Sub-excavation of existing fill, soft and organic soils is required
Spread Footings perched on Granular A pads for abutments	- Lower cost than deep foundations - Minimize excavation requirements - Higher bearing resistance than footings on native soil	- Higher cost than spread footings on native soils - Sub-excavation of existing fill, soft and organic soils is required - Dewatering may be required - Scour protection is required
Steel H-Piles driven to very stiff clayey soils or very dense silty sand till	- Permits use of integral abutments - Not affected by surficial soil variability	- Higher cost than spread footings - Piles may have to be driven after constructing approach fill
Caissons founded in very stiff clayey soils or very dense silty sand till	- Higher bearing resistance - Not so affected by surficial soil variability	- Higher cost than spread footings - Does not permit integral abutment design - Caisson embedment length and bearing resistance limited to keep caisson bases above the artesian layer

A - Spread Footings

Spread footings founded on compact to dense silty sand / sand and silt may be used for the abutments. Footings for perched abutments may be founded on compacted Granular A cores in accordance with current MTO practices. The preliminary geotechnical design resistances and founding levels for spread footings on native soils or compacted Granular A cores are as follows:

Founding Stratum	Geotechnical Resistance		Foundation Level
	Factored ULS	SLS	
Silt Sand/Sand and Silt	300 kPa	200 kPa	At or below elevation 193.0 to 197.5
Compacted Granular A	900 kPa	350 kPa	Fill base at or below elevation 193.0 to 198.0

B – Steel H-Piles

Steel H-piles driven within the very stiff clayey soils may be used to provide foundation support. In case pile tips were kept well above the artesian layer encountered at elevation 172.4 in borehole CM29d-2, the preliminary pile design would be based largely on skin friction. Higher geotechnical resistances may be achieved by driving the piles deeper to refusal. If the deeper pile penetration reaches the artesian layer, then specialized pile construction techniques will be required to mitigate the upward slow of artesian water. This may involve measures such as constructing the approach embankment first, then driving piles from a higher elevation through approach embankments. The preliminary design geotechnical resistances and tip elevations are as follows:

Pile	Axial Geotechnical Resistance		Anticipated Pile Tip Elevation
	Factored ULS	SLS	
HP 310 x 110 founded in very stiff clayey soils	600 kN	500 kN	At or below elevation 178.0
HP 310 x 110 founded in very dense silty sand till	1,600 kN	1,400 kN	At or below elevation 162.0 to 164.0

C - Caissons

Based on the potential difficulties with installing caissons under artesian pressure conditions, uncertainties associated with cleaning and inspecting the base, the limited bearing resistance available in the soils above the artesian zone, and the potential presence of cobbles and boulders in the till soils, the use of caisson foundations is not recommended at this site and the option has not been developed.

Recommended Foundation Alternative

The recommended foundation alternative at this site is steel H-piles driven into the very dense silty sand till. In view of the risks associated with driving piles into a layer under artesian groundwater condition, extensive additional investigation during detail design is recommended for designing pile foundation at this site.

- **ABUTMENT TYPE**

The soil conditions at this site are suitable for conventional, integral or semi-integral abutment design.

- **APPROACHES**

Approach embankments 8 to 10 m high are anticipated.

Stability

Approach embankments up to 10 m in height are anticipated to be stable at side slope inclinations of 2H:1V using SSM or granular material. A 2 m wide mid-height bench is required for embankment slopes higher than 8 m.

Settlement

Settlements in the order of 150 mm are expected to occur over a period of 9 to 12 months following construction of the 10 m high approach fills. During detail design phase, additional settlement calculations should be undertaken to determine if the approach fills should be placed ahead of foundation construction.

PART B - PRELIMINARY FOUNDATION DESIGN REPORT
HWY 407 EAST– CENTRAL SECTION (EAST PART)
W.O. 07 – 20016

LOCATION No: M-67 (CM-29d)

- **CONSTRUCTION CONSIDERATIONS**

Pile Installation

Driving shoes should be fitted to the pile tips for reinforcement and enhanced seating of the piles.

Excavation

Temporary unsupported side slopes should not be steeper than 1H:1V where groundwater control measures are implemented as outlined below. In accordance with OHSA, the fill and compact sandy soils are classified as Type 3 material.

Groundwater/Surface Water Control

Diversion of stream flow and surface runoff from the temporary excavations for foundation construction and pumping from carefully constructed, filtered sumps should be adequate to control groundwater. The required groundwater control system should be further assessed during detail design.

Protection Systems

Protection systems would be required for any vertically sided excavations for foundation construction or where space restrictions prohibit formation of safe side slopes. One possible system is soldier pile and lagging. The feasibility of installing such protection systems should be assessed once further subsurface investigation is carried out during detail design.

Floodplain Access

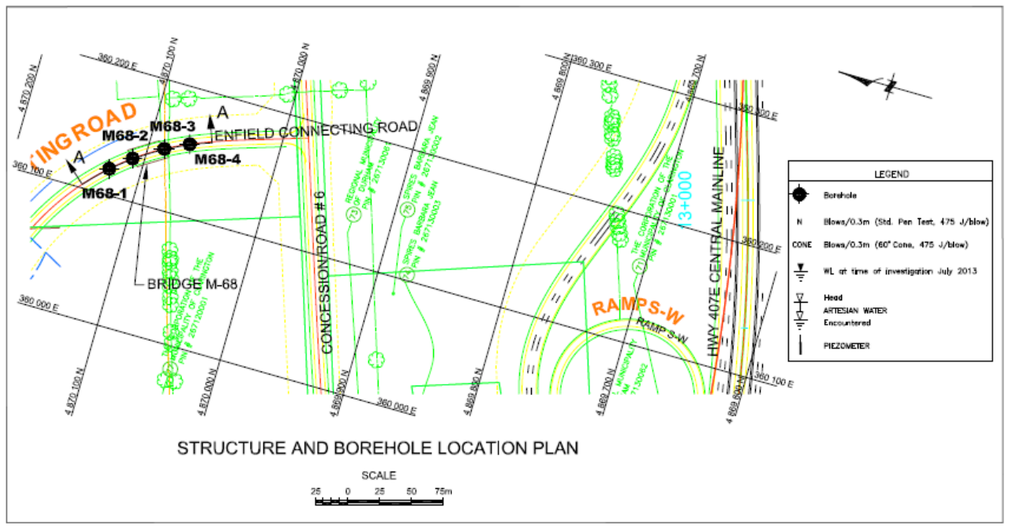
Potential environmental impacts will need to be minimized during construction access into the creek floodplain. Specific access preparation procedures including the use of gravel roadways underlain by geosynthetics should be considered.

- **RECOMMENDATIONS FOR ADDITIONAL WORK**

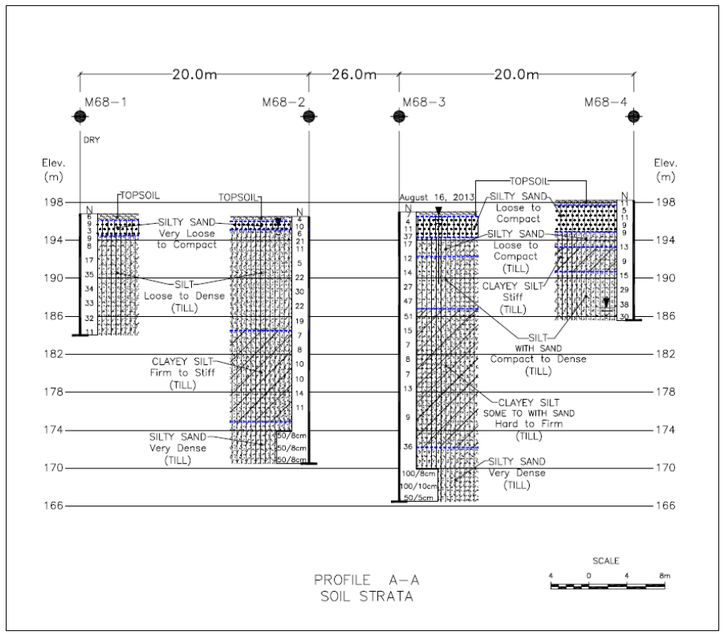
Further subsurface investigation, analysis and design should be carried out during detail design to confirm the subsoil conditions at the location of the bridge foundation elements. As a minimum, this will require additional boreholes at the actual abutment locations and at the approaches. It is recommended to advance boreholes to depths sufficient to confirm refusal. Artesian condition should be extensively investigated and foundation capacity and installation procedures re-assessed during detail design.

PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST – CENTRAL SECTION (EAST PART)
W.O. 07 – 20016

Structure Description: Enfield Connecting Road Over Farewell Creek
Location No: M-68 (CM-29e)
Highway 407 Proposed Grade: ~202.0 – 203.0 m
Existing Ground Elevation: ~197.0 m
Site Ranking: High
Station: 10+332



STRUCTURE AND BOREHOLE LOCATION PLAN
SCALE



PROFILE A–A
SOIL STRATA
SCALE

FOUNDATION INVESTIGATIONS

Site Description:

The proposed Enfield Connecting Road over Farewell Creek is located approximately 250 m east of Enfield Road and 100 m north of Concession Road 6 in the Municipality of Clarington, Ontario. The site is surrounded by farmland to the north and south, and abuts a small wooded area to the west. The topography is generally flat north of the creek and slopes upward from north to south at the south side of the creek.

Borehole Information:

Borehole No	Borehole Location	MTM NAD 83 – Northing	MTM NAD 83 – Easting	Borehole Elevation (m)	Borehole Depth (m)
M68-1	North Approach	4 870 124.7	360 120.4	196.8	12.8
M68-2	North Abutment	4 870 109.3	360 133.0	196.5	26.0
M68-3	South Abutment	4 870 087.5	360 147.2	197.0	30.5
M68-4	South Approach	4 870 069.6	360 156.1	198.2	12.6

Subsurface Conditions:

- **Topsoil:** A 0.5 to 0.7 m thick topsoil layer was present at the surface of all the boreholes and was penetrated at elevations 196.0 to 197.7.
- **Silty Sand:** A 0.9 to 2.8 m thick silty sand layer was encountered beneath the topsoil at 0.5 to 0.7 m (elevations 196.0 to 197.7) in all the boreholes that extended to 1.4 to 3.3 m (elevation 194.3 to 195.1). The silty sand was typically loose to compact (locally very loose in borehole M68-1) with SPT-'N' value 3 to 11 and appeared moist to wet (moisture contents of 10 to 27%).
- **Upper Silty Sand Till:** A 1.6 and 2.0 m thick silty sand till deposit was encountered below the silty sand at 3.3 and 2.7 m (elevation 194.9 and 194.3) in boreholes M68-4 and M68-3 that extended to 4.9 and 4.7 m (elevation 193.3 and 192.3). The deposit was compact (SPT-'N' value of 17) and had a moisture contents of 8%. Although no cobbles or boulders were noted within the deposit the possibility of their presence should not be discounted.
- **Silt Till:** A 5.1 to 10.6 m thick silt till deposit was encountered below the silty sand at 1.4 and 2.3 m (elevation 195.1 and 194.5) in boreholes M68-2 and M68-1, respectively, below the silty sand till at 4.7 m (elevation 192.3) in borehole M68-3 and below the clayey silt till at 7.5 m (elevation 190.7) in borehole M68-4. The silt till extended to 10.2 and 12.0 m (elevation 186.8 and 184.5) in boreholes M68-3 and M68-2, respectively and to the 12.6 and 12.8 m (elevation 185.6 and 184.0) in boreholes M68-4 and M68-3, respectively. The deposit was typically compact to dense (locally loose at the upper boundary in boreholes M68-1 and M68-2) with SPT-'N' values of 5 to 47 and moisture contents of 10 to 18%. Although no cobbles or boulders were noted within the deposit the possibility of their presence should not be discounted. The results of two grain size distribution analyses performed on samples of the deposit are presented on Figure M68-GS-1 (Appendix B).
- **Clayey Silt Till:** A 2.6 to 14.6 m thick clayey silt till deposit was encountered beneath the silt till at 10.2 and 12.0 m (elevation 186.8 and 184.5) in boreholes M68-3 and M68-2, respectively and beneath the silty sand at 4.9 m (elevation 193.3) in borehole M68-4. The clayey silt till extended to the silty sand till at 21.6 and 24.8 m (elevation 174.9 and 172.2) in boreholes M68-2 and M68-3 respectively and to the silt till at 7.5 m (elevation 190.7) in borehole M68-4. The material was firm to hard with SPT-'N' values of 7 to 51 and shear strength values of 32 to 62 kPa indicated in in-situ vane and penetrometer test. The material was drier than the plastic limit with moisture contents of 12 to 22% recorded. Although no cobbles or boulders were noted within the deposit the possibility of their presence should not be discounted. The results of five Atterberg Limit tests and grain size distribution analyses performed on samples of the deposit are presented in respective Figures M68-PC-1 and M68-GS-2 (Appendix B).
- **Lower Silty Sand Till:** A 4.4 and 5.7 m thick silty sand till deposit was encountered below the clayey silt till at 21.6 and 24.8 m (elevation 174.9 and 172.2) in boreholes M68-2 and M68-3, respectively that extended to the 26.0 and 30.5 m (elevation 170.5 and 166.5) termination depth. The deposit was very dense (SPT-'N' values of 50 blows for 8 cm to 100 blows for 10 cm) and moist to wet (based on visual and tactile observations). Although no cobbles or boulders were noted within the deposit the possibility of their presence should not be discounted.

Groundwater Conditions:

- **Borehole M68-1:** In the process of drilling and upon completion of drilling water was not encountered.
- **Borehole M68-2:** In the process of drilling, water was detected at 4.6 m (elevation 191.9) and upon completion of drilling, groundwater was measured at 1.2 m (elevation 195.3).
- **Borehole M68-3:** In the process of drilling, water was detected at 6.1 m (elevation 190.9) and upon completion of drilling the borehole was dry. The piezometric water level in borehole M68-3 was at 0.4 m (elevation 196.6) on August 2, 2013 and at 0.5 m (elevation 196.5) on August 16, 2013.
- **Borehole M68-4:** In the process of drilling, water was not detected and upon completion of drilling, groundwater was measured at 11.3 m (elevation 186.9).

PART B - PRELIMINARY FOUNDATION DESIGN REPORT
HWY 407 EAST – CENTRAL SECTION (EAST PART)
W.O. 07 – 20016

LOCATION No: M-68 (CM-29e)

FOUNDATION RECOMMENDATIONS

Note: The site-specific foundation recommendations are for planning purposes only. Refer to Section 6.0 of the Foundation Design Report for the project-wide foundation recommendations, design assumptions and limitations.

General: Based on a General Arrangement drawing prepared by AECOM in March 2009, Overpass M-68 will carry the proposed Enfield Connecting Road over Farewell Creek. The proposed overpass is a single span structure with a span of 26 m and approach embankments approximately 5 to 6 m high. Based on the existing subsurface information, the feasible foundation options for the proposed bridge abutments are listed below with advantages and disadvantages associated with each option. Spread footing were not considered feasible based on the relatively low bearing capacity available at the site.

Foundation Option	*Advantages*	*Disadvantages*
Steel H-Piles driven into "100 blow" silty sand till	• Allows for integral abutment design • Higher bearing resistance than for footings • Not affected by surficial soil variability	• Requires flange plate reinforcement to facilitate driving through the very dense sandy soils and glacial tills possibly containing cobbles and boulders • Dewatering may be required during construction (i.e. pile caps)
Caissons bored to found within "100-blow" silty sand till	• Higher bearing resistance than for footings • Not affected by surficial soil variability	• Drilling must be advanced through very dense sandy deposits and glacial tills possibly containing cobbles and boulders • May require temporary or permanent liner to prevent seepage inflow and softening of the caisson base • Dewatering may be required during construction (i.e. caisson caps), special techniques may be required if artesian conditions are encountered

A – Steel H-Piles: Steel HP 310x110 piles driven to found within the "100-blow" silty sand till at or below elevation 172.5 at the north abutment and elevation 168.5 at the south abutment are feasible for support of the foundation loads. Piles would be about 24.5 to 28.5 m long.

Location	*Pile*	*Geotechnical Axial Resistance*	
		Factored ULS	**SLS**
Abutments	HP 310x110	1,600 kN	1,400 kN

B – Caissons: Caissons should be founded a minimum 2 m within the "100-blow" silty sand till at or below elevation 171.5 at the north abutment and elevation 167.5 at the south abutment are feasible for support of the foundation loads. Caissons would be about 25.5 to 29.5 m long.

Location	*Caisson Diameter*	*Geotechnical Axial Resistance*	
		Factored ULS	**SLS**
Abutments	1.2 m	4,500 kN	3,500 kN
	1.5 m	6,500 kN	5,500 kN

Recommended Foundation Alternative: Steel H-Piles driven into the very dense silty sand till are recommended from a foundation engineering perspective

• ABUTMENT TYPE

The site soils are suitable for construction of conventional, integral and semi-integral abutments.

• APPROACHES

Height: Based on the GA drawing, the approach embankments will be approximately 5 to 6 m high. Based on the subsoil conditions encountered at the site, approach embankments consisting of up to 6 m high earth fill can be constructed. Sub-excavation of some 0.7 m of topsoil be required.

Stability: Approach embankments up to 6 m high, constructed of select subgrade materials or granular fill, with side slopes no steeper than 2 horizontal to 1 vertical (2H:1V) should have an adequate factor of safety against deep-seated slope instability. It is noted, however, that embankment stability must be confirmed during detail design.

Settlement: Assuming the use of conventional earth or granular embankment fills, where applicable, the total settlement at the approach embankments is assessed to be about 80 mm. About 50 per cent of the total settlement is expected to take place during and immediately after completion of construction (i.e. elastic settlement); the remaining settlement is anticipated to occur over a period of 3 to 6 months following construction. Further geotechnical analyses need to be carried out during the detailed design.

• CONSTRUCTION CONSIDERATIONS

Excavation: Excavation for the pile cap is expected to extend through the topsoil and into the loose to compact silty sand. Subject to adequate groundwater control, excavation of the soils should be feasible using conventional equipment. The loose to compact silty sand is considered as a Type 3 soil according to OHSA. Temporary excavations (i.e. open for a relatively short period of time) should be made with side slopes no steeper than 1H:1V in Type 3 soils where groundwater control measures are implemented as outlined below.

Groundwater / Surface Water Control It is anticipated that conventional sump pumping techniques will be sufficient to adequately control groundwater for the construction of the pile cap. Depending on the construction season, diversion of surface water from the excavation may need to be implemented as well. If artesian conditions are present, basal heave will need to be assessed and more elaborate dewatering measures will be required. Artesian groundwater conditions may be encountered when advancing deep foundations such as piles through the sandy deposits. Refer to Section 6.7.3 for options to control groundwater and migration of fines when driving piles at sites with possible artesian groundwater conditions.

Obstructions During Pile Driving: Flange plate reinforcement for steel H-Piles should be used to facilitate driving into or through the very dense soils and glacial tills possibly containing cobbles and boulders. Caisson drilling equipment must be capable of penetrating obstructions when cobbles / boulders are present in the deposits.

• RECOMMENDATIONS FOR ADDITIONAL WORK

Further subsurface investigation should be carried out during detail design to confirm the subsoil and groundwater conditions at the location of the overpass foundation elements.

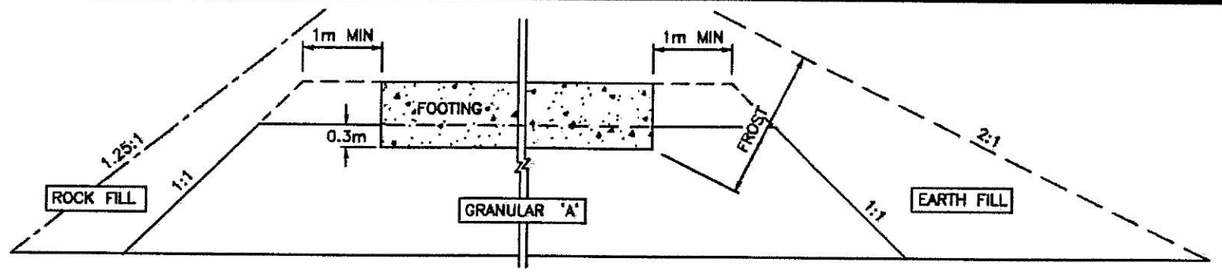
PRELIMINARY FOUNDATION INVESTIGATION REPORT – DEEP CUTS AND HIGH FILLS

PRELIMINARY FOUNDATION INVESTIGATION REPORT
DEEP CUTS
HWY 407 EAST - CENTRAL SECTION (EAST PART)
W.O. 07 - 20016

Deep Cut No.	Station (From - To)	Proposed Highway Grade	Maximum Cut Depth (m)	Reference Data	Subsurface Conditions	Preliminary Recommendations
Hwy 407	**Central Mainline**					
DC-C4	15+450 to 15+700	232.9 to 233.5	5.5	DCC4-1, CCM-03	**Stratigraphy:** Surficial topsoil (up to 600 mm thick) overlying a 2.1 to 3.5 m thick deposit of stiff to hard clayey silt / silty clay till underlain in boreholes DCC4-1 and CCM-03 at respective depths of 2.4 and 4.1 m (Elev. 236.3 and 233.0) by very dense silty sand / sand and silt till containing cobbles and extending to the termination of drilling at depths of 7.7 and 12.3 m (Elev. 231.0 and 224.8 m). **Groundwater:** Borehole DCC4-1 – depths of 3.0 and 1.2 m (Elev. 235.7 and 237.5 m) during and upon completion of drilling, respectively. Borehole CCM-03 – 3.4 m depth (Elev. 233.7 m) in piezometer on February 10, 2009.	**Design Slope Inclination:** Cut slopes up to 5.5 m deep may be constructed at an inclination no steeper than 2H:1V. **Drainage:** Groundwater seepage should be anticipated from more permeable zones in the clayey silt / silty clay till and from the silty sand / sand and silt till below the clayey till deposit. Special considerations for the design of groundwater drainage will likely be required. Side ditches should be adequate for surface drainage. **Surficial Instability:** Gravel sheeting or other measures may be required to control surficial erosion and instability in areas of persistent seepage. **Recommendations for Further Investigation:** Additional boreholes should be advanced to confirm the stratigraphy and groundwater conditions within the cut section.
DC-C9	16+550 to 16+670	230.0 to 230.4	6	DCC9-1, Hydrogeology Report	**Stratigraphy:** Surficial topsoil (300 mm thick) overlying loose to very dense sand and silt till containing cobbles and extending to the termination of drilling at 9.6 m depth (Elev. 226.4 m). **Groundwater:** Estimated near 3 m depth (233.0 m). Borehole DCC9-1 – a depth of 8.7 m (Elev. 227.3 m) upon completion of drilling.	**Design Slope Inclination:** Cut slopes up to 6 m deep may be constructed at an inclination no steeper than 2H:1V. **Drainage:** Excavation may extend into sand and silt till approximately 3 m below the groundwater table. Temporary and permanent drainage measures such as slope drains may be required. Side ditches should be adequate for surface drainage. **Surficial Instability:** Gravel sheeting or other measures may be required to control surficial erosion and instability in areas of persistent seepage. **Recommendations for Further Investigation:** Additional boreholes should be advanced to confirm the stratigraphy and groundwater levels within the cut section and further assess groundwater control measures.
DC-C7	11+650 to 12+360	202.4 to 207.7	7	DCC7-1, CM27-1, CM27-2, CM28-1, CM28-2	**Stratigraphy:** Surficial topsoil or fill (up to 700 mm thick) overlying compact to very dense cohesionless till (sand, silty sand, sand and silt, sandy silt) with cobbles and boulders, interlayered with compact sand, dense silt and hard clayey silt till / silty clay till, extending to the termination of drilling at depths of 7.8 to 24.4 m (Elev. 184.5 to 205.3 m). **Groundwater:** Borehole DCC7-1 – a depth of 3.0 m (Elev. 210.1 m) in the process of augering. The piezometric water level was at depths of 3.4 and 3.7 m (Elev. 209.7 and 209.4 m) on May 29 and July 3, 2013, respectively. Borehole CM27-1 – a depth of 4.6 m (Elev. 204.3 m) upon completion of drilling. The piezometric water level was at depths of 4.6 and 10.6 m (Elev. 204.3 and 198.3 m) on April 8 and 30, 2009, respectively. Borehole CM27-2 – a depth of 4.5 m (Elev. 204.4 m) upon completion of drilling. Borehole CM28-1 – depths of 2.4 to 3.7 m (Elev. 208.0 to 209.3 m) in piezometer on April 13 and 30 and on July 21, 2009. Borehole CM28-2 – a depth of 5.2 m (Elev. 206.1 m) upon completion of drilling.	**Design Slope Inclination:** Cut slopes up to 7 m deep may be constructed at an inclination no steeper than 2H:1V. Cut slopes deeper than 6 m should be designed with a 2 m wide bench. **Drainage:** Groundwater seepage should be anticipated from more permeable zones in the till soils. Side ditches should be adequate for surface drainage. **Surficial Instability:** Gravel sheeting or other measures may be required to control surficial erosion and instability in areas of persistent seepage. **Recommendations for Further Investigation:** Additional boreholes should be advanced to confirm the stratigraphy and groundwater table within the cut section.

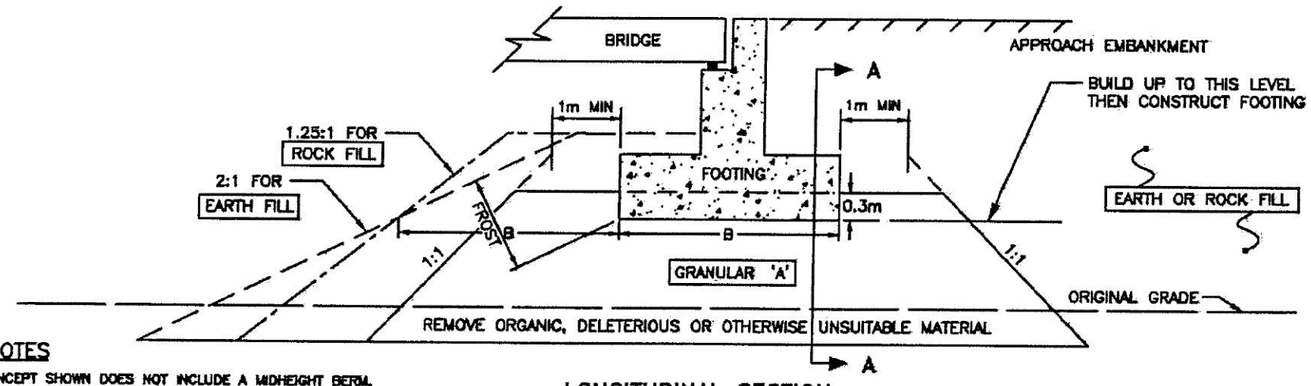
PRELIMINARY FOUNDATION INVESTIGATION REPORT
HIGH FILLS
HWY 407 EAST - CENTRAL SECTION (EAST PART)
W.O. 07 - 20016

High Fill No.	Station (From – To)	Proposed Highway Grade (m)	Maximum Fill Height (m)	Reference Data	Subsurface Conditions	Preliminary Recommendations
Hwy 407	**Central Mainline**					
HF-C9	17+100 to 10+300	221.0 to 228.4	9	HFC9-1, M61-1, M61-2, CM24-3, CM24-4, Hydrogeology Report	**Stratigraphy:** Surficial topsoil (100 to 500 mm thick) and firm/loose soils with organics overlying at depths of 0.1 to 1.0 m (Elev. 214.8 to 224.1 m) interlayered stiff to hard clayey silt till / silty clay till and dense to very dense cohesionless till (sand, silty sand, sand and silt, sandy silt) containing cobbles and extending to the termination of drilling at depths of 6.2 to 26.0 m (Elev. 197.1 to 211.3). **Groundwater:** Estimated near ground surface (Elev. 216.0 m). Borehole HFC9-1 – depths of 2.0 and 5.2 m (Elev. 215.5 and 212.3 m) during and upon completion of drilling, respectively. Borehole M61-1 – depths of 6.1 and 5.5 m (Elev. 209.9 and 210.5 m) during and upon completion of drilling, respectively. The piezometric water level was at depths of 0.3 and 0.5 m (Elev. 215.7 and 215.5 m) on July 3 and 30, 2013, respectively. Borehole M61-2 – depths of 4.3 and 7.3 m (Elev. 211.0 and 208.0 m) during and upon completion of drilling, respectively. Borehole CM24-3 – a depths of 14.3 m (Elev. 208.8 m) upon completion of drilling. Borehole CM24-4 – a depth of 12.8 m (Elev. 211.8 m) upon completion of drilling. The piezometric water level was at 10.9 m depth (Elev. 213.7 m) on June 26, 2008.	**Design Slope Inclination:** Fill embankments up to 9 m high may be constructed with slopes no steeper than 2H:1V and with a minimum 2 m wide mid-height bench for sections of the slope exceeding 8 m in height. **Stability:** No stability issues are anticipated along the embankment section. However, this needs to be confirmed when more subsurface information is made available. **Settlement: S**ettlements in the order of 200 mm are anticipated due to consolidation of the clayey foundation soils under a maximum 9 m high granular embankment. The settlements are expected to occur over a period of about 9 months. The surficial topsoil and soils with organics are to be removed prior to embankment construction. **Recommendations for Further Investigation:** Additional boreholes should be advanced and laboratory testing conducted to confirm the stratigraphy, further evaluate the magnitude of anticipated settlement and assess measures such as preloading.
HF-C7	11+325 to 11+510	202.8 to 205.4	8.5	HFC7-1, M62-1, M62-2, Hydrogeology Report	**Stratigraphy:** Soft to stiff clayey silt fill with organics (1.5 to 6.3 m thick) overlying loose to very dense cohesionless till (silty sand, sand and silt, sandy silt, silt) containing cobbles and extending to the termination of drilling at depths of 8.0 to 15.3 m (Elev. 183.8 to 191.8 m). **Groundwater:** Estimated near ground surface (Elev. 196.0 m). Borehole HFC7-1 – depths of 6.6 and 7.6 m (Elev. 196.5 and 195.5 m) during and upon completion of drilling, respectively. Borehole M62-1 – depths of 1.5 and 7.0 m (Elev. 198.3 and 192.8 m) during and upon completion of drilling, respectively. Borehole M62-2 – a depth of 4.6 m (Elev. 194.5 m) both during and upon completion of drilling. The piezometric water level was at depths of 2.9 and 2.7 m (Elev. 196.2 and 196.4 m) on May 29 and July 30, 2013, respectively.	**Design Slope Inclination:** Fill embankments up to 8.5 m high may be constructed with slopes no steeper than 2H:1V and with a maximum 2 m wide mid-height bench for sections of the slope exceeding 8 m in height. **Stability**: No stability issues are anticipated along the embankment section. **Settlement:** No settlement issues are anticipated (provided fill soils and deleterious materials are subexcavated). **Recommendations for Further Investigation:** Additional subsurface investigation with laboratory testing should be carried out to confirm the subsoil conditions and the extent of the clayey silt fill with organics. The fill may need to be excavated below settlement sensitive embankments.



CROSS SECTION A–A

NOT TO SCALE



LONGITUDINAL SECTION

NOT TO SCALE

NOTES

1. CONCEPT SHOWN DOES NOT INCLUDE A MIDHEIGHT BERM.
2. LIMITS OF GRANULAR 'A' CORE TO BE DEFINED BY A SITE SPECIFIC SURVEY.
3. REMOVE ORGANIC, DELETERIOUS OR OTHERWISE UNSUITABLE MATERIAL UNDER AREA OF COMPACTED GRANULAR 'A' AND EARTH OR ROCK FILL AS NOTED IN TEXT OF REPORT.
4. PLACE GRANULAR 'A' AND EARTH OR ROCK FILL ON APPROVED SUBGRADE TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M.T.O. STANDARDS.
5. CONSTRUCT CONCRETE FOOTING.
6. PLACE REMAINDER OF GRANULAR 'A' AND EARTH OR ROCK FILL INCLUDING MIDHEIGHT BENCHES, AS REQUIRED.
7. REFER TO TEXT OF REPORT FOR FROST DEPTH.

FIGURE 1: ABUTMENT ON COMPACTED FILL SHOWING GRANULAR A CORE

DRAWINGS

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

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

W.O. No. 07-20016

SHEET

HIGHWAY 407 EAST
CENTRAL SECTION (EAST PART)
PROJECT LOCATION PLAN

Peto MacCallum Ltd.
CONSULTING ENGINEERS

PLAN

SCALE APPROX.

0 1.6 3.2 4.8 Km

REFERENCE

This Key Plan is based on a drawing prepared by AECOM dated AUGUST 2009.

NO.	DATE	BY	REVISION

Geocres No.

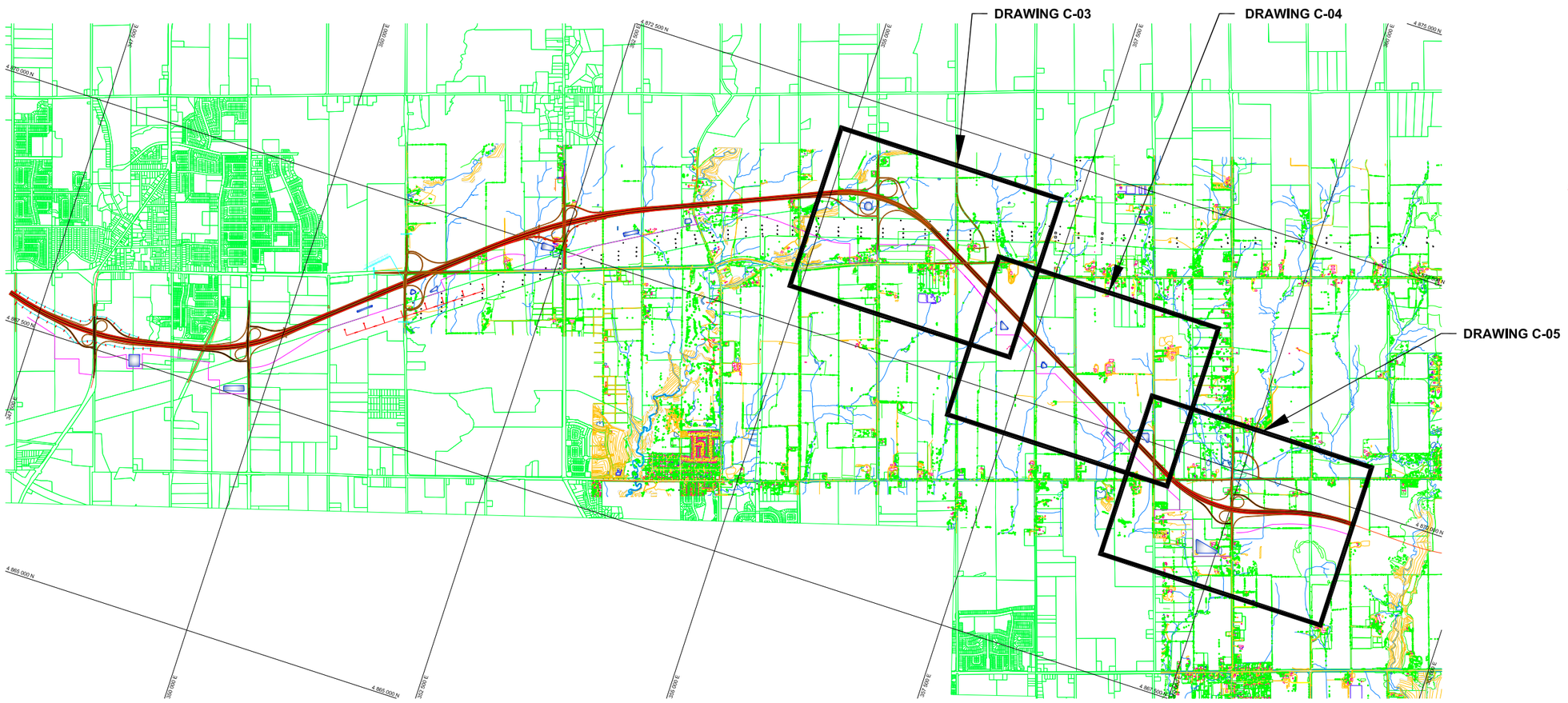
HWY. 407E	PROJECT NO. 12TF007A		DIST. Central
SUBM'D. NA	CHKD. AD / GD	DATE: Jan. 15, 2014	SITE:
DRAWN: NA	CHKD. BRG	APRD. CN	DWG. C-01

PLOT DATE: January 15, 2014
FILENAME: C:\Users\Victoriadin\Documents\2012 DMSS\2012 JOBS\12TF007A\Drawings\Report Drawings\12TF007A-C Key Plan FINAL.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

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



PLAN

SCALE
500 0 500 1000m

REFERENCE

Base plan and profiles provided in digital format by MTO, drawing file nos. "407E Eastern Section PRELIMINARY DESIGN_ULTIMATE.dwg", received January 15, 2013.

Peto MacCallum Ltd.
CONSULTING ENGINEERS

W.O. No. 07-20016

HIGHWAY 407 EAST
CENTRAL SECTION (EAST PART)
STRUCTURE LOCATION INDEX PLAN

SHEET

HWY. 407E		PROJECT NO. 12TF007A		DIST. Central	
SUBM'D. NA	CHKD. AD / GD	DATE: Jan. 15, 2014		SITE:	
DRAWN: NA	CHKD. BRG	APPD. CN		DWG. C-02	

PLOT DATE: January 15, 2014
FILENAME: C:\Users\Vizamudin\Documents\2013 DWGS\2012 JOBS\12TF007A\PML Jan 2013\12TF007A C-02 FINAL.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

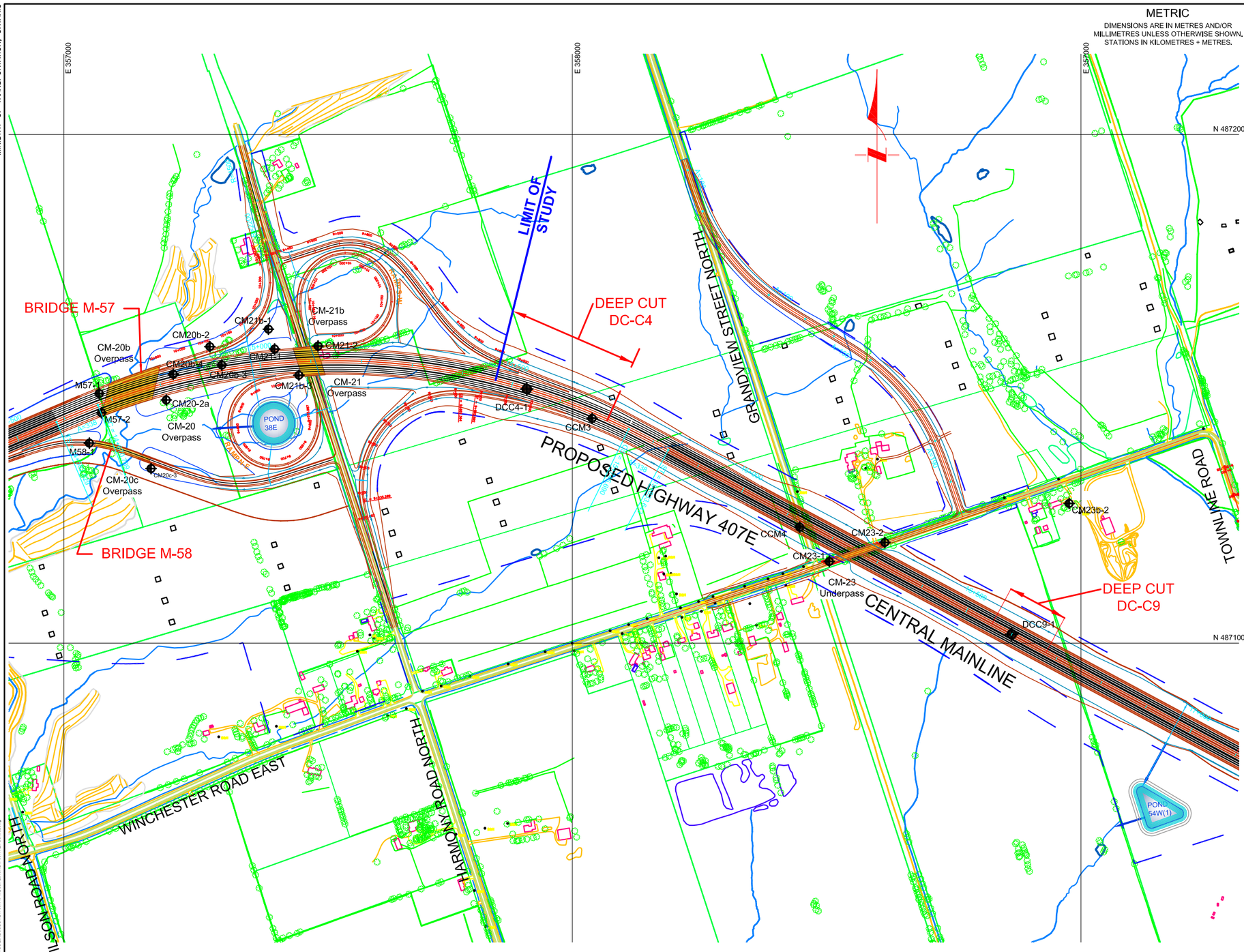
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

W.O. No. 07-20016

SHEET

HIGHWAY 407 EAST
CENTRAL SECTION (EAST PART)
BOREHOLE LOCATION - CENTRAL MAINLINE
Harmony Road North to Townline Road

Peto MacCallum Ltd.
CONSULTING ENGINEERS



PLAN

SCALE

100 0 100 200

LEGEND

- Borehole - Current Investigation
- Borehole - MTO Geocres

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
DCC4-1	238.7	4 871 499.7	355 910.3
DCC9-1	236.0	4 871 017.5	356 863.8
CCM-03	237.1	4 871 442.0	356 038.8

NOTES

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

The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plan and profiles provided in digital format by MTO, drawing file nos. "407E Eastern Section PRELIMINARY DESIGN_ULTIMATE.dwg", received January 15, 2013.

NO.	DATE	BY	REVISION

Geocres No.

HWY. 407E		PROJECT NO. 12TF007A	DIST. Central
SUBM'D. NA	CHKD. AD / GD	DATE: Jan. 15, 2014	SITE:
DRAWN: NA	CHKD. BRG	APRD. CN	DWG. C-03

PLOT DATE: January 15, 2014
FILENAME: C:\Users\Admin\Documents\2013 DWGS\2012 JOBS\12TF007A\PML Jan 2013\12TF007A Ex Central.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

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

E 357000 E 358000 E 359000

N 4871000 N 4870000

DEEP CUT
DC-C9

HIGH FILL
HF-C9

TOWNLINE ROAD

LESKARD ROAD

LANGMAID ROAD

PROPOSED HIGHWAY 407E CENTRAL MAINLINE

BRIDGE M-61

CULVERT M-62

HIGH FILL
HF-C7

CM23b-2
CM24-1
CM24-2
CM24-3
CM24-4
CM-24
Underpass
(Deleted)
HFC9-1
M61-1
M61-2
CCM61
CCM62
POND 54W(1)
POND 54W(2)
POND 56E(1)
POND 56W
M62-1
M62-2
HFC7-1
CM27-1
CM27-2
CM-27
Underpass
CM28-1
P25
P26

PLAN

SCALE

100 0 100 200

W.O. No. 07-20016

SHEET

HIGHWAY 407 EAST
CENTRAL SECTION (EAST PART)
BOREHOLE LOCATION - CENTRAL MAINLINE
Townline Road to Langmaid Road

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LEGEND

- Borehole - Current Investigation
- Borehole - MTO Geocres

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
M61-1	216.0	4 870 579.9	357 779.9
M61-2	215.3	4 870 495.6	357 807.1
M62-1	199.8	4 870 024.3	358 792.1
M62-2	199.1	4 869 959.9	358 753.6
HFC7-1	203.1	4 869 950.3	358 829.9
HFC9-1	217.5	4 870 592.6	357 654.4
CM24-3	223.1	4 870 726.8	357 483.9
CM24-4	224.6	4 870 604.9	357 526.3

NOTES

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REFERENCE

Base plan and profiles provided in digital format by MTO, drawing file nos. "407E Eastern Section PRELIMINARY DESIGN_ULTIMATE.dwg", received January 15, 2013.

NO.	DATE	BY	REVISION

Geocres No.

HWY. 407E	PROJECT NO. 12TF007A		DIST. Central
SUBM'D. NA	CHKD. AD / GD	DATE: Jan. 15, 2014	SITE:
DRAWN: NA	CHKD. BRG	APRD. CN	DWG. C-04

PLOT DATE: January 16, 2014
FILENAME: C:\Users\Nick.Smith\Documents\2013 DWGS\2013_JOBS\12TF007A\PML_Jan 2013\12TF007A Ex Central.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

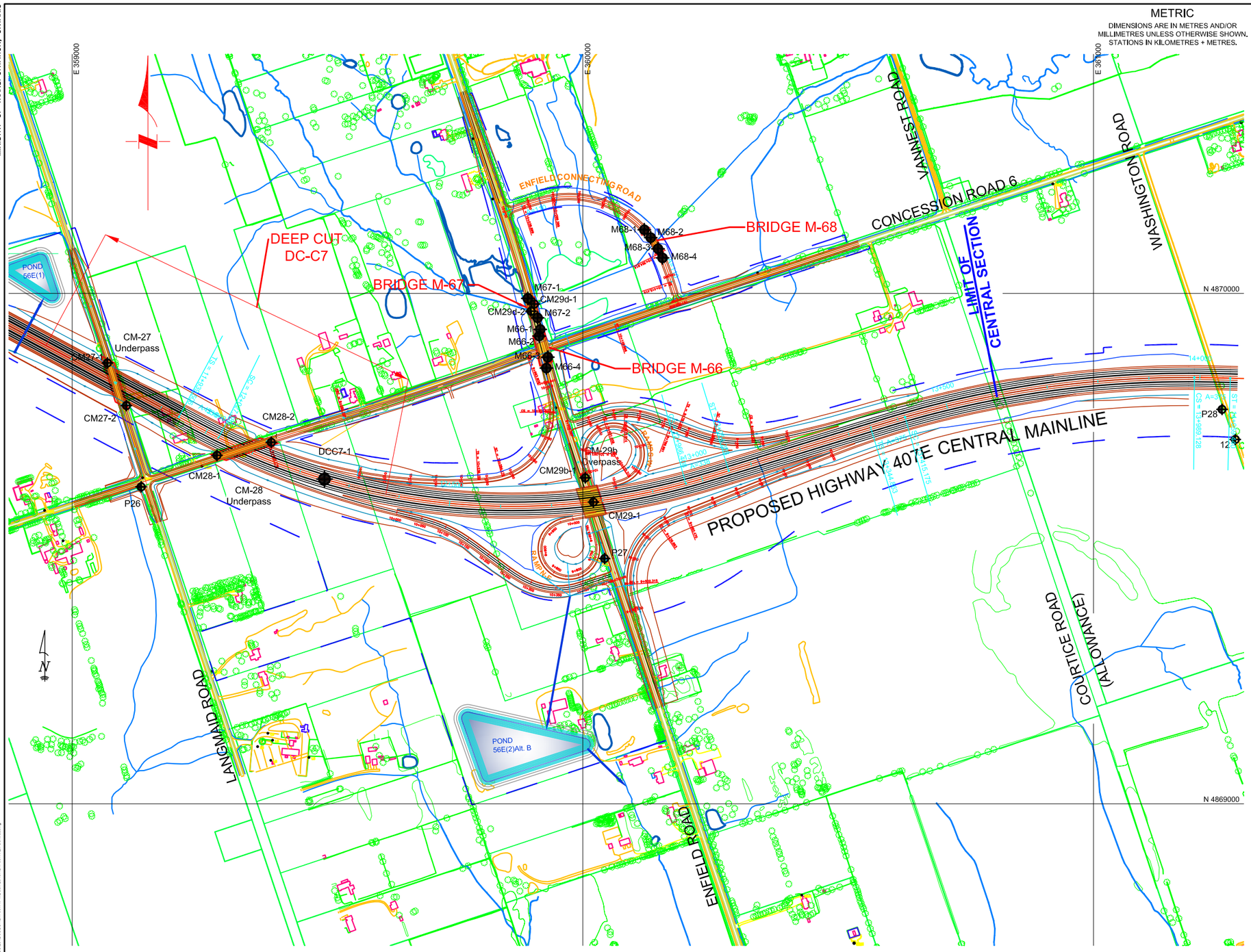
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

W.O. No. 07-20016

SHEET

HIGHWAY 407 EAST
CENTRAL SECTION (EAST PART)
BOREHOLE LOCATION - CENTRAL MAINLINE
Langmaid Road to Courtice Road (Allowance)

Peto MacCallum Ltd.
CONSULTING ENGINEERS



PLAN

SCALE

100 0 100 200

LEGEND

- Borehole - Current Investigation
- Borehole - MTO Geocres

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
M66-1	198.6	4 869 929.5	359 916.5
M66-2	198.5	4 869 916.5	359 914.5
M66-3	198.9	4 869 875.1	359 931.5
M66-4	199.2	4 869 853.8	359 928.7
M67-1	200.3	4 869 990.3	359 892.3
M67-2	196.3	4 869 952.2	359 911.4
M68-1	196.8	4 870 124.7	360 120.4
M68-2	196.5	4 870 109.3	360 133.0
M68-3	197.0	4 870 087.5	360 147.2
M68-4	198.2	4 870 069.6	360 156.1
DCC7-1	213.1	4 869 636.3	359 494.1
CM27-1	208.9	4 869 863.8	359 069.1
CM27-2	208.9	4 869 780.3	359 106.1
CM28-1	211.7	4 869 682.7	359 283.6
CM28-2	211.3	4 869 708.4	359 390.0
CM29d-1	198.6	4 869 979.3	359 905.2
CM29d-2	198.3	4 869 965.2	359 898.5

NOTES

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REFERENCE

Base plan and profiles provided in digital format by MTO, drawing file nos. "407E Eastern Section PRELIMINARY DESIGN_ULTIMATE.dwg", received January 15, 2013.

NO.	DATE	BY	REVISION

Geocres No.

HWY. 407E	PROJECT NO. 12TF007A		DIST. Central
SUBM'D. NA	CHKD. AD / GD	DATE: Jan. 15, 2014	SITE:
DRAWN: NA	CHKD. BRG	APRD. CN	DWG. C-05

PLOT DATE: January 15, 2014
FILENAME: C:\Users\Rpowell\Documents\2013 DWGS\2012 JOBS\12TF007A\Plot_Jan 2013\12TF007A Es Central.dwg

APPENDIX A

RECORD OF BOREHOLE SHEETS

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M61-1 1 of 1 METRIC

W.O. 07-20016 LOCATION Coords: 4 870 579.9 N; 357 779.9 E ORIGINATED BY S.A.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.D.

DATUM Geodetic DATE May 13, 2013 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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
216.0 / 0.0	Ground Surface										
215.8 / 0.2	Topsoil										
	Silty sand, organics Loose Brown Moist		1	SS	4						
215.1 / 0.9	Clayey silt, trace gravel cobbles Hard Brown Moist (TILL)		2	SS	43		215				
214.6 / 1.4	Sand, with silt trace clay, trace gravel cobbles Very dense Brown/ grey Moist (TILL)		3	SS	50/13cm						
			4	SS	50/13cm		214				
			5	SS	50/13cm		213				
211.5 / 4.5	Clayey silt some sand, trace gravel Hard Grey Moist (TILL)		6	SS	32		212				
210.0 / 6.0	Sand and silt trace to some clay trace gravel Very dense Grey Moist to wet (TILL)		7	SS	50/13cm	▽	211				
			8	SS	50/13cm	▼	210				
207.0 / 9.0	Silty sand, trace gravel Compact Grey Wet		9	SS	22		209				
205.9 / 10.1	Silty sand, trace gravel Very dense Grey Wet (TILL)		10	SS	50/8cm		208				
205.3 / 10.7	End of borehole						207				
							206				

* 2013 05 13

▽ Water level observed during drilling

▼ Water level measured after drilling

Piezometer Reading:

Date	Depth (m)	Elev.
July 03/'13	0.3	215.7
July 30/'13	0.5	215.5

Piezometer Legend:

Bentonite seal

Filter sand

Screen

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M61-2 1 of 1 METRIC

W.O. 07-20016 LOCATION Coords: 4 870 495.6 N; 357 807.1 E ORIGINATED BY S.A.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Sten Augers COMPILED BY A.D.

DATUM Geodetic DATE May 10, 2013 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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
215.3 / 0.0	Ground Surface										
214.8 / 0.5	Topsoil		1	SS	5		215				
	Clayey silt trace sand, trace gravel Stiff to hard Brown Moist (TILL)		2	SS	33						
213.9 / 1.4	Sand, with silt some clay, some gravel cobbles Very dense Brown/ grey Moist (TILL)		3	SS	90		214				19 40 29 12
			4	SS	50/10cm		213				
212.3 / 3.0	Clayey silt some sand, some gravel cobbles Hard Grey Moist (TILL)		5	SS	31/28cm		212				13 15 29 43
211.0 / 4.3	Sand and silt trace clay, trace gravel Very dense Grey Moist to wet (TILL)		6	SS	79	▽*	211				4 44 46 6
			7	SS	50/13cm		210				
			8	SS	108	▼*	209				
205.7 / 9.6			9	SS	106/25cm		208				
	End of borehole						207				
							206				

* 2013 05 10

▽ Water level observed during drilling

▼ Water level measured after drilling

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M62-1 1 of 1 METRIC

W.O. 07-20016 LOCATION Coords: 4 870 024.3 N; 358 792.1 E ORIGINATED BY S.A.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.D.

DATUM Geodetic DATE May 17, 2013 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
199.8	Ground Surface						
0.0	Clayey silt, organics Soft Dark brown Moist (FILL)		1	SS	WH**		
	sand seams		2	SS	1	▽*	199
198.3	Brown						
1.5	Silt, with to some sand trace clay, trace gravel Compact Brown/grey Wet (TILL)		3	SS	14		198
			4	SS	15		197
	some clay, trace sand		5	SS	33		196
193.8	Dense to very dense Grey Moist		6	SS	50/13cm		195
6.0	Silty sand trace clay, trace gravel cobbles Very dense Grey Moist (TILL)		7	SS	50/13cm		194
						▼*	193
191.8			8	SS	91/25cm		192
8.0	End of borehole						

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 (%) 20 40 60

UNIT WEIGHT γ kN/m³

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

* 2013 05 17

▽ Water level observed during drilling

▼ Water level measured after drilling

WH** denotes penetration due to weight of rods and hammer

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M62-2 1 of 2 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 959.9 N; 358 753.6 E ORIGINATED BY S.A.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid/Hollow Stem Augers COMPILED BY A.D.

DATUM Geodetic DATE May 16, 2013 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	GR SA SI CL
199.1	Ground Surface							
0.0	Clayey silt organics, rootlets Firm Dark brown Moist (FILL)		1	SS	3		199	
			2	SS	7		198	
	sand seams trace gravel		3	SS	5		197	
	Brown/grey		4	SS	7		196	
194.5			5	SS	4	▽ ▼	195	
4.6	Sand and silt some clay, trace gravel Loose to compact Brown/grey Moist to wet (TILL)		6	SS	8		194	8 41 40 11
193.3								
5.8	Silty sand trace to some clay trace gravel Dense to very dense Grey Wet (TILL)		7	SS	49		193	
			8	SS	57		191	9 45 36 10
190.6								
8.5	Silt, with sand some clay, some gravel cobbles Very dense Grey Moist (TILL)		9	SS	82/28cm		190	12 28 41 19
			10	SS	70		188	
			11	SS	75/15cm		187	
			12	SS	50/13cm		185	
	Cont'd							

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 (%) 20 40 60

UNIT WEIGHT γ kN/m³

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

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M62-2 2 of 2 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 959.9 N; 358 753.6 E ORIGINATED BY S.A.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid/Hollow Stem Augers COMPILED BY A.D.

DATUM Geodetic DATE May 16, 2013 CHECKED BY G.D.

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 + FIELD VANE ● QUICK TRIAXIAL × 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
184.1											
183.8			13	SS	50/10cm		184		○		
15.3	End of borehole										

2013 05 17

▽ water level observed during drilling

▼ water level measured after drilling

Piezometer Reading:

Date	Depth (m)	Elev.
May 29/'13	2.9	196.2
July 30/'13	2.7	196.4

Piezometer Legend:

- Bentonite seal
- Filter sand
- Screen
- Backfill

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M66-1 1 of 1 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 929.5 N; 359 916.5 E ORIGINATED BY F.P.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Sten Augers COMPILED BY A.D.

DATUM Geodetic DATE October 12, 2012 CHECKED BY G.D.

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 + FIELD VANE ● QUICK TRIAXIAL × 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
198.6	Ground Surface										
0.0	Sand and gravel Compact Brown Moist (FILL)		1	SS	16		198		○		
	Topsoil with wood debris Dark brown		2	SS	15		197		○		
	Silty sand, organic inclusions		3	SS	5	▽*			○		
196.4 2.2	Loose Grey										
	Silty sand, organics sandy silt seams Compact to loose Grey Moist to wet		4	SS	11		196		○		
195.1 3.5	Clayey silt, trace sand Stiff to very stiff Grey Moist		5	SS	5		195		○		
			6	SS	14		194	125	○		
	silt partings		7	SS	9	▼*	193		⊢⊣		0 7 42 51
				FV			192	—			
191.1 7.5	Clayey silt, with sand trace gravel Stiff Grey Moist (TILL)		8	SS	5		191		○		
				FV			190	—			
189.6 9.0	Sandy silt trace to some clay trace gravel Very loose Grey Wet to compact		9	SS	1		189		○		
			10	SS	16		188		○		
			11	SS	13		187				
185.8 12.8	End of borehole						186		○		3 38 46 13

* 2012 10 12

▽ Water level observed during drilling

▼ Water level measured after drilling

■ Penetrometer test

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M66-2 1 of 3 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 916.5 N; 359 914.5 E ORIGINATED BY F.P./S.A.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.D.

DATUM Geodetic DATE October 12, 16 & 17, 2012 CHECKED BY G.D.

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	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
198.5	Ground Surface							SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100			
0.0	Sand and gravel Compact Brown Moist (FILL)		1	SS	11		198		o		
	Silty sand, some gravel Loose Grey Moist		2	SS	8				o		
197.1							197				
1.4	Topsoil		3	SS	5	▽*			o		
196.4											
2.1	Sand and silt, trace clay trace gravel Compact Grey Moist to wet		4	SS	12		196		o		2 47 47 4
195.5											
3.0	Clayey silt, trace sand Stiff Grey Moist		5	SS	10		195		o		
			6	SS	12		194		o		
							193				
			7	SS	9		192		o		
				FV					—		
191.2							191				
7.3	Clayey silt, sandy trace gravel Stiff Grey Moist (TILL)		8	SS	6				H		6 33 37 24
				FV					—		
189.7							190		o		
8.8	Sandy silt, trace clay Loose to compact Grey Wet		9	SS	6		189		o		
			10	SS	10		188		o		
							187				
	silt layers		11	SS	11		186		o		
							185				
	sand layers		12	SS	22		184		o		
183.5	Cont'd										

ON MTO HWY 407E 12TF007A - CENTRAL STRUCTURES.GPJ ON_MOT.GDT 8/21/2013 12:24:12 PM

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M66-2 2 of 3 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 916.5 N; 359 914.5 E ORIGINATED BY F.P./S.A.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Sten Augers COMPILED BY A.D.

DATUM Geodetic DATE October 12, 16 & 17, 2012 CHECKED BY G.D.

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	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
183.5								SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100			
15.0	Clayey silt with sand, trace gravel Hard to stiff Grey Moist (TILL)		13	SS	33		183		H		4 28 40 28
							182				
							181				
			14	SS	38		180		o		
	sand and silt seams						179				
							178				
			15	SS	13		177		H		3 45 39 13
							176				
							175				
			16	SS	7		174		o		
	trace sand silty clay layers						173				
							172				
			17	SS	15		171		H		2 8 34 56
							170				
							169				
168.5	Cont'd										

ON MTO HWY 407E 12TF007A - CENTRAL STRUCTURES.GPJ ON_MOT.GDT 8/21/2013 12:24:12 PM

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M66-2 3 of 3 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 916.5 N; 359 914.5 E ORIGINATED BY F.P./S.A.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.D.

DATUM Geodetic DATE October 12, 16 & 17, 2012 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"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
168.5											
30.0	Sand, with silt trace to some gravel trace clay, cobbles Dense to very dense Grey Moist to wet (TILL)		18	SS	44		168	○	○		
			19	SS	110/25cm		167				
							166				
							165		○		
			20	SS	148/23cm		164				
							163		○		
			21	SS	143/28cm		162		○		17 55 24 4
161.5											
37.0	End of borehole * 2012 10 12 ▽ Water level observed during drilling										

ON MTO HWY 407E 12TF007A - CENTRAL STRUCTURES.GPJ ON_MOT.GDT 8/21/2013 12:24:13 PM

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M66-3 1 of 3 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 875.1 N; 359 931.5 E ORIGINATED BY S.A.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Sten Augers COMPILED BY A.D.

DATUM Geodetic DATE October 25 & 26, 2012 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"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
198.9	Ground Surface										
0.0	Gravelly sand Compact Dark brown/black Moist Sand and gravel cobbles		1	SS	17		198		○		
	Compact Brown Moist Silty sand, cobbles rootlets, peat inclusions		2	SS	20		197		○		
	Compact Grey Moist to locse (FILL)		3	SS	6						
196.4							196				
2.5	Clayey silt, trace sand Very stiff Brown Moist to firm		4	SS	7			125	○		0 2 48 50
			5	SS	10	▽*	195		⊢○⊣		
			6	SS	WH**		194		○		
193.4											
5.5	Sand, trace silt Compact Brown/grey Wet to dense		7	SS	31		193		○		0 92 (8)
			8	SS	32		192		○		
190.4							191		○		
8.5	Sand, with silt some gravel, trace clay cobbles Compact Grey Wet to dense (TILL)		9	SS	24		190		○		14 51 28 7
			10	SS	42		189				
							188		○		
			11	SS	50/6cm		187				
	silty some to with clay trace gravel						186				
			12	SS	33		185		○		6 38 35 21
	Cont'd						184				

ON MTO HWY 407E 12TF007A - CENTRAL STRUCTURES.GPJ ON_MOT.GDT 8/21/2013 12:24:14 PM

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M66-3 2 of 3 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 875.1 N; 359 931.5 E ORIGINATED BY S.A.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.D.

DATUM Geodetic DATE October 25 & 26, 2012 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	WATER CONTENT (%) (20 40 60)				GR SA SI CL
183.9	Sand, with silt some gravel, trace clay Compact Grey Wet (TILL)		13	SS	13		183						
181.8 17.1	Clayey silt, with sand trace gravel Very stiff Grey Moist (TILL)		14	SS	15		180	o					
			15	SS	25		177	o					
	sandy		16	SS	22		174	H o					0 35 38 27
172.7 26.2	Sand, with silt trace to some gravel trace clay Very dense Grey Wet (TILL)		17	SS	110/21cm		171						
	Cont'd		18	SS	100/6cm		169						

ON MTO HWY 407E 12TF007A - CENTRAL STRUCTURES.GPJ ON_MOT.GDT 8/21/2013 12:24:15 PM

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M66-3 3 of 3 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 875.1 N; 359 931.5 E ORIGINATED BY S.A.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Sten Augers COMPILED BY A.D.

DATUM Geodetic DATE October 25 & 26, 2012 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	WATER CONTENT (%) (20 40 60)				GR SA SI CL
168.9	Sand, with silt trace to some gravel trace clay												
168.1 30.8	Very dense Grey Wet (TILL) (Cont'd.)		19	SS	100/17cm								
	End of borehole												

* 2012 10 25

▽ Water level observed during drilling

WH** denotes penetration due to weight of rods and hammer

■ Penetrometer test

ON MTO HWY 407E 12TF007A - CENTRAL STRUCTURES.GPJ ON_MOT.GDT 8/21/2013 12:24:15 PM

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M66-4 1 of 1 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 853.8 N; 359 928.7 E ORIGINATED BY F.P./S.A.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.D.

DATUM Geodetic DATE October 15 & 24, 2012 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"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
199.2	Ground Surface						199				
0.0	Sand and gravel Loose Brown Moist		1	SS	8						
	Silty sand, some gravel Compact Grey Moist		2	SS	10		198				
197.8	(FILL)										
1.4	Peat, fine fibrous Dark brown		3	SS	11				307		
197.4	Silty sand, trace gravel						197				
1.8	Compact Grey Moist										
197.0	Clayey silt, trace sand		4	SS	9	▽*					
2.2	Stiff to firm Brown Moist						196				
			5	SS	7						
193.6			6	SS	WH**		195				
5.6	Sand trace to some silt trace gravel, trace clay						194				
	Compact Brown Wet		7	SS	19		193				3 91 (6)
							192				
			8	SS	23						0 75 20 5
190.7							191				
8.5	Sand, with silt some to with clay trace gravel		9	SS	55		190				
	Dense to Brown/ Wet very dense grey						189				
	(TILL)		10	SS	44		188				
186.4			11	SS	75		187				
12.8	End of borehole										

* 2012 10 15 Water level observed during drilling

WH** denotes penetration due to weight of rods and hammer

■ Penetrometer test

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M67-1 1 of 3 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 990.3 N; 359 892.3 E ORIGINATED BY S.A.

DIST Durham HWY 407E BOREHOLE TYPE C.F.S.S.A. and Casing COMPILED BY A.D.

DATUM Geodetic DATE October 18, 19 and 22, 2012 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"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
200.3	Ground Surface						200				
0.0	Gravelly sand Grey/ black Moist		1	SS	14						
	Silty sand, trace clay Compact Grey Moist		2	SS	10		199				
	Sandy silt, asphalt debris organic inclusions										
	Loose Grey/ black Moist		3	SS	4		198				
198.1	(FILL)					▽*					
2.2	Sand and silt trace to some gravel trace clay		4	SS	23		197				
	Compact Grey Wet		5	SS	20						
196.2							196				
4.1	Clayey silt Stiff Grey Moist		6	SS	14						0 0 56 44
							195				
	some sand, trace gravel		7	SS	12		194				
							193				
			8	SS	11						
							192				
			9	SS	4		191				4 20 49 27
				FV				+3			
							190				
			10	SS	4		189				
186.8							188				
13.5	Silty sand some clay, trace gravel		11	SS	6		187				
	Very dense Grey Moist		12	SS	74						
	(TILL)						186				
	Cont'd										

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M67-1 2 of 3 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 990.3 N; 359 892.3 E ORIGINATED BY S.A.

DIST Durham HWY 407E BOREHOLE TYPE C.F.S.S.A. and Casing COMPILED BY A.D.

DATUM Geodetic DATE October 18, 19 and 22, 2012 CHECKED BY G.D.

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	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
185.3	Silty sand some clay, trace gravel Very dense Grey Moist (TILL)		13	SS	70		185	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100						7 43 34 16
182.3							184							
18.0	Clayey silt, trace sand Firm to stiff Grey Moist		14	SS	6		183							
176.3				PV			182	2						
21.0	Sand, some silt trace gravel, trace clay Dense Grey Wet			PV			181	3						
			15	SS	30		180							6 69 17 8
							179							
							178							
176.3							177							
24.0	Clayey silt, with sand trace gravel Very stiff Grey Moist to stiff (TILL)		16	SS	25		176							
							175							
							174							
			17	SS	12		173	■						2 21 37 40
							172							
	Cont'd						171							

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No M67-1 3 of 3 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 990.3 N; 359 892.3 E ORIGINATED BY S.A.

DIST Durham HWY 407E BOREHOLE TYPE C.F.S.S.A. and Casing COMPILED BY A.D.

DATUM Geodetic DATE October 18, 19 and 22, 2012 CHECKED BY G.D.

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	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
170.3	Clayey silt, with sand trace gravel Very stiff Grey Moist to stiff (TILL)		18	SS	11		170	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100						
167.3							169							
33.0	Silty sand, trace gravel trace clay, cobbles Very dense Grey Wet (TILL)		19	SS	77		168							
							167							7 45 39 9
			20	SS	117		166							
							165							
			21	SS	100/5cm		164							
							163							
161.9			22	SS	116/23cm		162							
38.4	End of borehole													

* 2012 10 18

▽ Water level observed during drilling

■ Penetrometer test

ON MTO HWY 407E 12TF007A - CENTRAL STRUCTURES.GPJ ON_MOT.GDT 8/21/2013 12:24:19 PM

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M67-2 1 of 3 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 952.2 N; 359 911.4 E ORIGINATED BY S.A.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.D.

DATUM Geodetic DATE October 31 and November 01, 2012 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.3	Ground Surface						196		
0.0	Gravelly sand, crushed gravel		1	SS	15				
	Silty sand, some gravel cobbles								
	Compact Brown Moist		2	SS	17		195		
	Sandy silt rootlets, organics cobbles, wood debris								
	Compact Dark brown/black Moist		3	SS	10				
	(FILL)						194		
	wet seams		4	SS	9	▽*			
193.3 3.0	Silty sand some clay, trace gravel		5	SS	12		193		7 44 31 18
192.8 3.5	Compact Brown Moist								
	Clayey silt, trace sand						192		
	Stiff to very stiff Grey Moist		6	SS	15				
							191		
			7	SS	12		190		0 3 51 46
							189		
			8	SS	13				
							188		
	Firm		9	SS	10		187		
				FV					
							186		
185.8 10.5	Silt, some sand some clay, trace gravel		10	SS	17		185		
	Compact Grey Moist to wet								
	(TILL)						184		
			11	SS	13				1 16 71 12
							183		
	Very dense		12	SS	69				
	Cont'd						182		

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 (%) 20 40 60

Numbers refer to Sensitivity 20 15 10 5

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M67-2 2 of 3 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 952.2 N; 359 911.4 E ORIGINATED BY S.A.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Sten Augers COMPILED BY A.D.

DATUM Geodetic DATE October 31 and November 01, 2012 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.3	Silt, some sand some clay, trace gravel		13	SS	69		181		
	Compact Grey Moist to wet								
	(TILL)						180		
178.9 2.4	Clayey silt, trace sand sand seams						179		
	Stiff to firm Grey Moist		14	SS	17				
							178		
							177		
							176		
			15	SS	10		175		
				FV					
							174		
173.0 8.3	Clayey silt with sand, trace gravel						173		
	Firm to stiff Grey Moist to wet		16	SS	11		172		1 26 46 27
	(TILL)								
							171		
							170		
			17	SS	13		169		
							168		
	Cont'd						167		

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 (%) 20 40 60

Numbers refer to Sensitivity 20 15 10 5

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M67-2 3 of 3 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 952.2 N; 359 911.4 E ORIGINATED BY S.A.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.D.

DATUM Geodetic DATE October 31 and November 01, 2012 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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
166.3	Clayey silt with sand, trace gravel Very stiff Grey Moist to wet (TILL)		18	SS	25		166				
163.7							165				
32.6	Silty sand trace clay, trace gravel Very dense Grey Wet (TILL)		19	SS	100/10cm		164				
							163				
			20	SS	100/8cm		162				
							161				
							160				
159.4			21	SS	50/8cm						
36.9	End of borehole										

* 2012 10 31

▽ Water level observed during drilling

■ Penetrometer test

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M68-1 1 of 1 METRIC

W.O. 07-20016 LOCATION Coords: 4 870 124.7 N; 360 120.4 E ORIGINATED BY A.L.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Sten Augers COMPILED BY A.D.

DATUM Geodetic DATE July 29, 2013 CHECKED BY B.R.G.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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
196.8	Ground Surface					*					
0.0	Topsoil		1	SS	6		196				
196.1											
0.7	Silty sand trace clay, trace gravel Loose to very loose Greyish brown Moist to wet		2	SS	9		195				
			3	SS	3						
194.5							194				
2.3	Silt, some sand some clay, trace gravel Loose to dense Grey Moist to wet (TILL)		4	SS	9						
			5	SS	8		193				
			6	SS	17		192				
	silty sand layers		7	SS	35		191				
			8	SS	34		190				
			9	SS	33		189				
			10	SS	32		188				
			11	SS	11		187				
184.0	clayey silt layers						186				
12.8	End of borehole						185				
							184				

* Borehole dry

■ Penetrometer test

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M68-2 1 of 2 METRIC

W.O. 07-20016 LOCATION Coords: 4 870 109.3 N; 360 133.0 E ORIGINATED BY A.L.

DIST Durham HWY 407E BOREHOLE TYPE C.F.S.S.A. + 'N' Casing + Wash Boring COMPILED BY A.D.

DATUM Geodetic DATE July 25 and 26, 2013 CHECKED BY B.R.G.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.5	Ground Surface							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	WATER CONTENT (%) (20 40 60)		
0.0 196.0	Topsoil		1	SS	4		196				
0.5	Silty sand Loose to compact Brown Moist		2	SS	10	▼*	195				
195.1 1.4	Silt, some sand some clay, trace gravel Loose to compact Grey/brown Wet (TILL)		3	SS	6		194				
			4	SS	21		193				
	silty sand layers		5	SS	11	▽*	192				
			6	SS	5**		191				
			7	SS	22		190				
			8	SS	30		189	o			1 16 68 15
			9	SS	22		188				
			10	SS	19		187				
							186				
184.5 12.0	Clayey silt some to with sand Firm to stiff Grey Wet (TILL)		11	SS	7		185				
				FV			184				
			12	SS	8		183	+2			
	trace gravel			FV			182				
	Cont'd										

ON MTO HWY 407E 12TF007A - CENTRAL STRUCTURES.GPJ ON_MOT.GDT 8/28/2013 9:55:11 AM

Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M68-2 2 of 2 METRIC

W.O. 07-20016 LOCATION Coords: 4 870 109.3 N; 360 133.0 E ORIGINATED BY A.L.

DIST Durham HWY 407E BOREHOLE TYPE C.F.S.S.A. + 'N' Casing + Wash Boring COMPILED BY A.D.

DATUM Geodetic DATE July 25 and 26, 2013 CHECKED BY B.R.G.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.5								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	WATER CONTENT (%) (20 40 60)		
	Clayey silt some to with sand trace gravel Stiff Grey Wet (TILL) (Cont'd.)		13	SS	10		181	+3			2 22 43 33
				FV							
			14	SS	10		180				
			15	SS	14		179				
							178				
			16	SS	11		177				0 15 38 47
				FV			176	+3			
174.9 21.6	Silty sand trace clay, trace gravel Very dense Grey Moist (TILL)		17	SS	50/8cm		175				
							174				
	sandy silt seams		18	SS	50/8cm		173				
							172				
170.5 26.0	End of borehole		19	SS	50/8cm		171				

* 2013 07 25 & 26

▽ Water level observed during drilling

▼ Water level measured after drilling

■ Penetrometer test

** Low 'N' value suspectible to hydraulic disturbance

ON MTO HWY 407E 12TF007A - CENTRAL STRUCTURES.GPJ ON_MOT.GDT 8/28/2013 9:55:12 AM

Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M68-3 1 of 3 METRIC

W.O. 07-20016 LOCATION Coords: 4 870 087.5 N; 360 147.2 E ORIGINATED BY A.L.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.D.

DATUM Geodetic DATE July 23 and 24, 2013 CHECKED BY B.R.G.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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
197.0	Ground Surface										
0.0 / 196.5	Topsoil		1	SS	7		196		o		
0.5 / 194.3	Silty sand trace clay, trace gravel Loose to compact Brown to Wet greyish brown		2	SS	4				o		
			3	SS	11		195		o		
2.7 / 192.3	Silty sand trace clay, trace gravel Compact Grey Moist to wet (TILL)		4	SS	37		194		o		
			5	SS	17		193		o		
4.7	Silt, with sand some clay, trace gravel Compact to dense Grey Moist to wet (TILL)		6	SS	12		192		o		
			7	SS	14		191		o		3 23 62 12
			8	SS	27		190		o		
			9	SS	47		189		o		
186.8 / 10.2	Clayey silt some to with sand trace gravel Hard to firm Grey Wet (TILL)		10	SS	51		188		o		
			11	SS	15		187		o		
			12	SS	7		186		o		
	Cont'd			FV			185		o		
							184				
							183				2 11 40 47

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M68-3 2 of 3 METRIC

W.O. 07-20016 LOCATION Coords: 4 870 087.5 N; 360 147.2 E ORIGINATED BY A.L.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Sten Augers COMPILED BY A.D.

DATUM Geodetic DATE July 23 and 24, 2013 CHECKED BY B.R.G.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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
182.0	Clayey silt some to with sand trace gravel Firm to stiff Grey Wet (TILL) (Cont'd.)		13	SS	8		181	2	o		
				FV							
			14	SS	7		180	2	o		6 22 43 29
				FV			179				
	silty sand seams		15	SS	13		178		o		
			16	SS	9		177				
				FV			176				3 21 31 45
							175	3			
							174				
172.2 / 24.8	Silty sand Very dense Grey Wet (TILL)		17	SS	36		173		o		
							172				
	trace to some gravel		18	SS	100/8cm		171				
							170				
							169				
	Cont'd		19	SS	100/10cm		168				

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M68-3 3 of 3 METRIC

W.O. 07-20016 LOCATION Coords: 4 870 087.5 N; 360 147.2 E ORIGINATED BY A.L.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Sten Augers COMPILED BY A.D.

DATUM Geodetic DATE July 23 and 24, 2013 CHECKED BY B.R.G.

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 + FIELD VANE ● QUICK TRIAXIAL × 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
167.0											
166.5			20	SS	50/5cm						
30.5	End of borehole										

* 2013 07 23 & 24

▽ Water level observed during drilling

■ Penetrometer test

Water Level Readings

Date	Depth (m)	Elev.
Aug 02, 2013	0.4	196.6
Aug 16, 2013	0.5	196.5

Piezometer Legend:

Native fill

Bentonite seal

Filter sand

Screen

NOTE: Dynamic cone penetration test was carried out 1m north of borehole M68-3.

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No M68-4 1 of 1 METRIC

W.O. 07-20016 LOCATION Coords: 4 870 059.6 N; 360 156.1 E ORIGINATED BY A.L.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.D.

DATUM Geodetic DATE July 24, 2013 CHECKED BY B.R.G.

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 + FIELD VANE ● QUICK TRIAXIAL × 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
198.2	Ground Surface										
0.0	Topsoil		1	SS	11						
197.7											
0.5	Silty sand trace clay, trace gravel Loose to compact Brown to Wet light brown		2	SS	5						
			3	SS	11						
	sandy silt seams		4	SS	9						
194.9											
3.3	Silty sand trace clay, trace gravel Loose to compact Grey Moist (TILL)		5	SS	9						
193.3											
4.9	Clayey silt trace to some sand trace gravel Stiff Grey Moist to wet (TILL)		6	SS	13						
			7	SS	9						
190.7											
7.5	Silt some to with sand some clay, trace gravel Compact to dense Grey Wet (TILL)		8	SS	15						
			9	SS	29						
			10	SS	38						
185.6			11	SS	30						
12.6	End of borehole										

* 2013 07 24

▼ Water level measured after drilling

■ Penetrometer test

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No DCC4-1 1 of 1 METRIC

W.O. 07-20016 LOCATION Coords: 4 871 499.7 N ; 355 910.3 E ORIGINATED BY A.L.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.D.

DATUM Geodetic DATE April 30, 2013 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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
238.7	Ground Surface										
0.0 / 238.4	Topsoil										
0.3	Clayey silt with sand to sandy trace gravel Stiff to hard Greyish brown Moist (TILL)		1	SS	7		238				
			2	SS	65	▼*					
			3	SS	59		237				6 32 43 19
236.3											
2.4	Silty sand some clay, trace gravel Very dense Greyish brown Moist to wet (TILL)		4	SS	50/10cm						
			5	SS	50/13cm	▽*	236				
	Wet										
	cobbles		6	SS	50/8cm		235				
	Grey		7	SS	50/8cm		234				
							233				
							232				
231.0 / 7.7			8	SS	50/10cm		231				
	End of borehole Samples 4 to 8: Sampler bouncing										

* 2013 04 30

▽ Water level observed during drilling

▼ Water level measured after drilling

ON MTO HWY 407E 12TF007A - CENTRAL HFS.GPJ ON_MOT.GDT 8/21/2013 4:52:18 PM

Numbers refer to Sensitivity 20 / 15 / 10 / 5

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No DCC7-1 1 of 1 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 636.3 N ; 359 494.1 E ORIGINATED BY A.L.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Sten Augers COMPILED BY A.D.

DATUM Geodetic DATE May 27, 2013 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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
213.1	Ground Surface										
0.0 / 212.6	Topsoil		1	SS	4		213				
0.5	Silty sand some gravel, trace clay Compact to Brown Wet very dense cobbles Greyish brown (TILL)		2	SS	41		212				13 49 30 8
			3	SS	50/10cm						
			4	SS	72	▽	211				
210.1											
3.0	Sand, with silt trace clay, trace gravel Very dense Grey Wet (TILL)		5	SS	98/25cm		210				1 71 25 3
			6	SS	58/15cm		209				
			7	SS	50/10cm		208				
							207				
							206				
205.3 / 7.8			8	SS	50/13cm						
	End of borehole Samples 3, 5 to 8: Sampler bouncing										

* 2013 05 27

▽ Water level observed during drilling

Water Level Readings:

Date	Depth (m)	Elev.
May 29, 2013	3.4	209.7
July 3, 2013	3.7	209.4

Piezometer Legend:

Native

Bentonite seal

Filter sand

Screen

ON MTO HWY 407E 12TF007A - CENTRAL HFS.GPJ ON_MOT.GDT 8/21/2013 4:54:47 PM

Numbers refer to Sensitivity 20 / 15 / 10 / 5

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No DCC9-1 1 of 1 METRIC

W.O. 07-20016 LOCATION Coords: 4 871 017.5 N ; 356 863.8 E ORIGINATED BY A.L.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.D.

DATUM Geodetic DATE April 30, 2013 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"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
236.0	Ground Surface										
0.0 / 235.7	Topsoil										
0.3	Sand and silt some clay, trace gravel Loose to dense Greyish Brown Moist (TILL)		1	SS	4						
			2	SS	36		235				7 39 39 15
			3	SS	40		234				
			4	SS	42		233				
	with gravel, trace clay cobbles Very dense		5	SS	80/28cm		232				25 36 31 8
			6	SS	50/10cm		231				
	some clay Grey		7	SS	56		230				
			8	SS	77	▼*	229 228				
			9	SS	47		227				
226.4 / 9.6	End of borehole										

* 2013 04 30

▼ Water level measured after drilling

Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No HFC7-1 1 of 1 METRIC

W.O. 07-20016 LOCATION Coords: 4 869 950.3 N ; 358 829.9 E ORIGINATED BY S.A.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.D.

DATUM Geodetic DATE May 21, 2013 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"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
203.1	Ground Surface										
0.0	Clayey silt, organics rootlets Firm to stiff Dark brown Moist (FILL)		1	SS	1		203				
			2	SS	1		202				
			3	SS	14		201				
	sand seams Brown		4	SS	11		200				
			5	SS	5						
			6	SS	6		199				
			7	SS	7		198				
196.8 / 6.3	Silty sand some clay, trace gravel Loose to compact Brown Moist to wet (TILL)		8	SS	7	▽*	197				3 44 36 17
195.6 / 7.5	Sandy silt some clay, trace gravel Compact to dense Brown Wet (TILL)		9	SS	11	▼*	196 195				3 39 44 14
	some gravel cobbles Grey		10	SS	44		194				
			11	SS	26		193 192				
191.8 / 11.3	End of borehole										

* 2013 05 21

▽ Water level observed during drilling

▼ Water level measured after drilling

■ Penetrometer test

Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No HFC9-1 1 of 1 METRIC

W.O. 07-20016 LOCATION Coords: 4 870 592.6 N ; 357 654.4 E ORIGINATED BY S.A.

DIST Durham HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.D.

DATUM Geodetic DATE May 09, 2013 CHECKED BY G.D.

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 + 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 (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
217.5	Ground Surface										
0.0 / 217.1	Topsoil		1	SS	3		217				
0.4 / 216.5	Clayey silt, trace sand organic inclusions Firm Brown Moist		2	SS	11				○		
1.0	Clayey silt, trace gravel sand seams Stiff to hard Mottled Moist grey/brown		3	SS	37	▽*	216		○		
215.5 / 2.0	(TILL) Sand, some silt some gravel, trace clay		4	SS	33		215		○		
214.9 / 2.6	Dense Brown/grey Wet (TILL)		5	SS	66		214		○		9 43 34 14
	Silty sand some to trace clay trace gravel Very dense Brown/grey Moist to wet (TILL)		6	SS	84/23cm	▼*	213		○		5 52 34 9
211.3			7	SS	50/13cm		212				
6.2	End of borehole Samples 6 & 7: Sampler bouncing										

* 2013 05 09

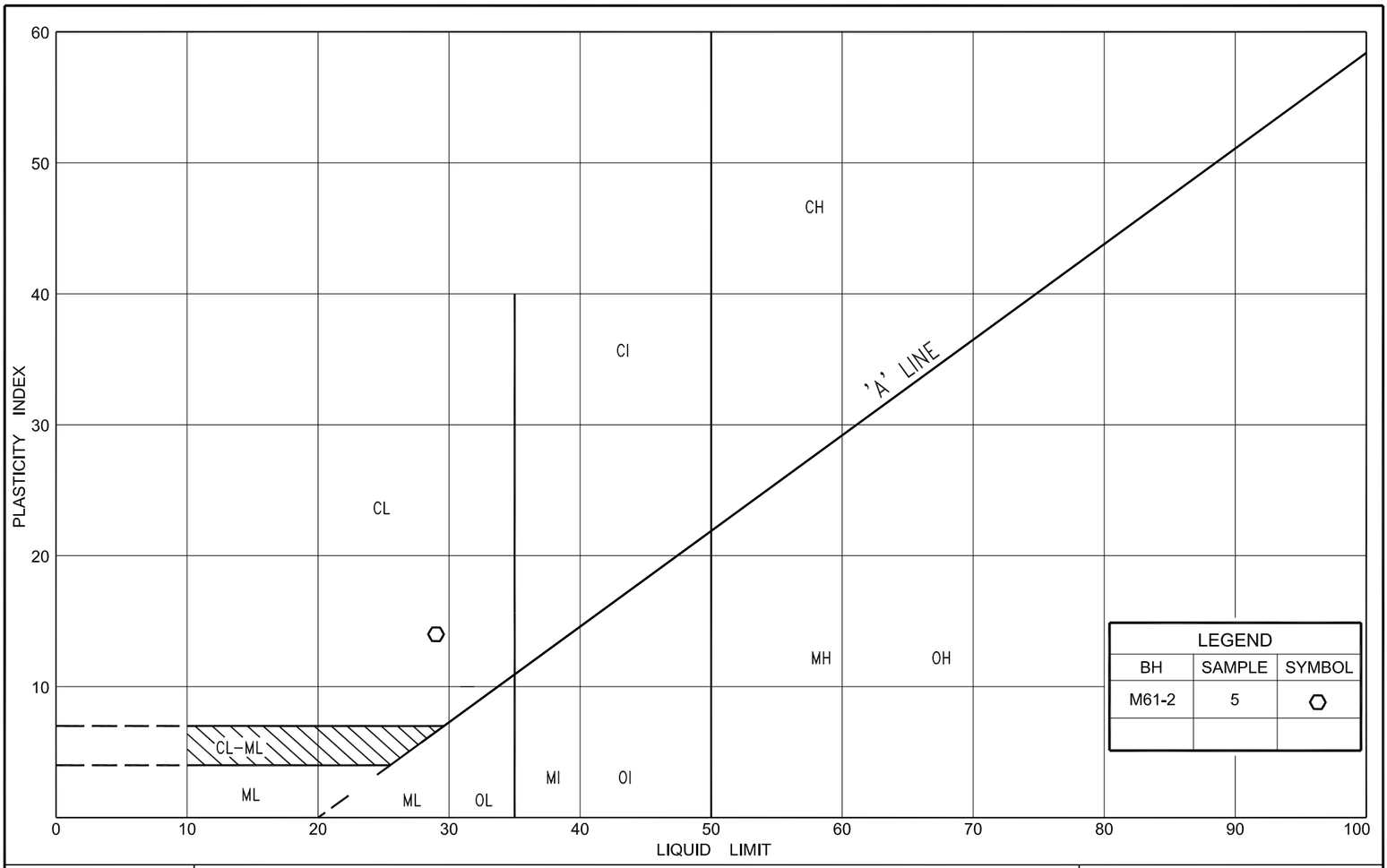
▽ Water level observed during drilling

▼ Water level measured after drilling

Numbers refer to Sensitivity 7 5 3 (%) STRAIN AT FAILURE 5 10 15 20

APPENDIX B

LABORATORY TEST RESULTS

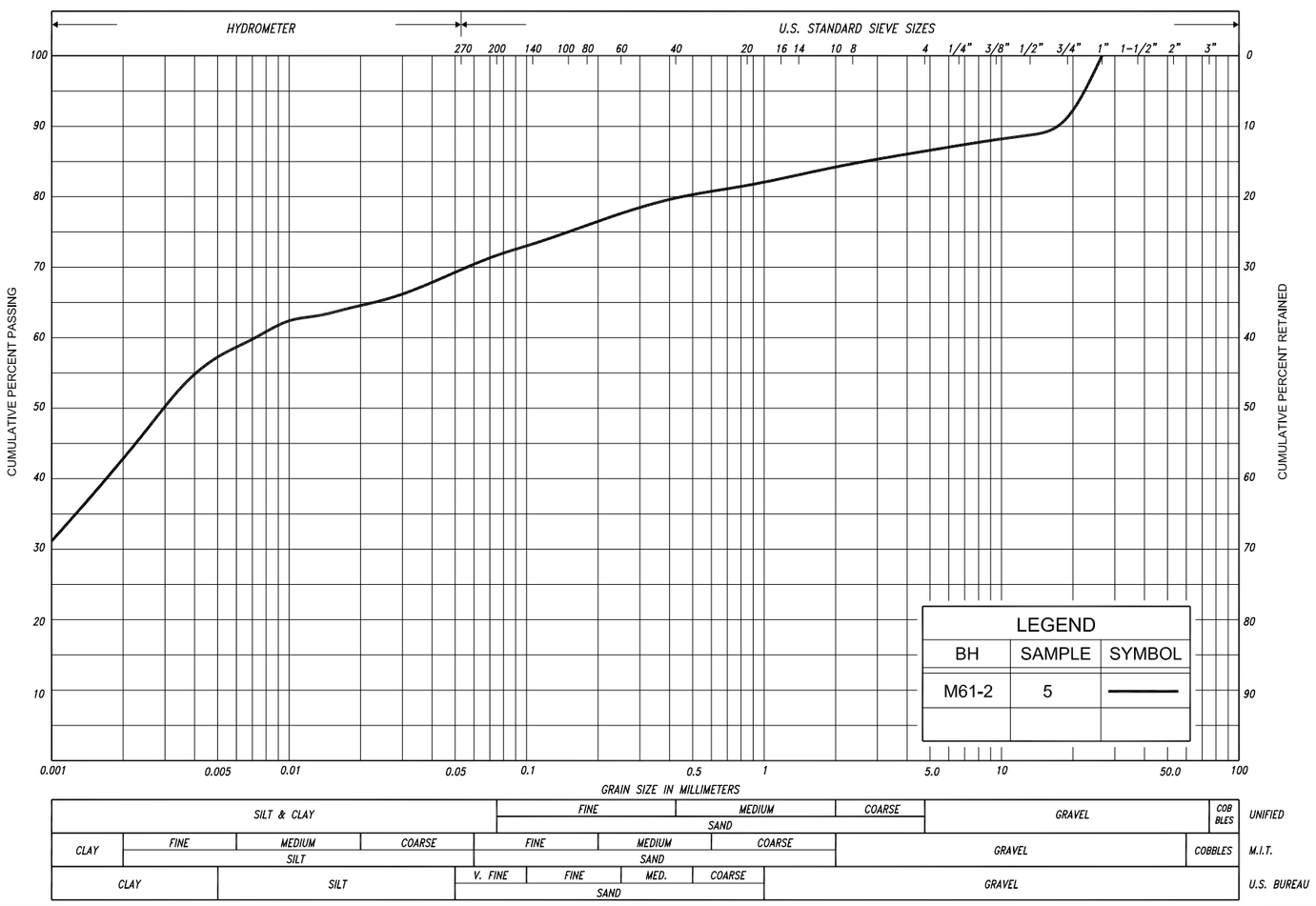


Ontario
Peto MacCallum Ltd. CONSULTING ENGINEERS

PLASTICITY CHART

CLAYEY SILT, some sand, some gravel
(TILL)

FIG No.	M61-PC-1
HWY:	407E
W.P. No.	07-20016

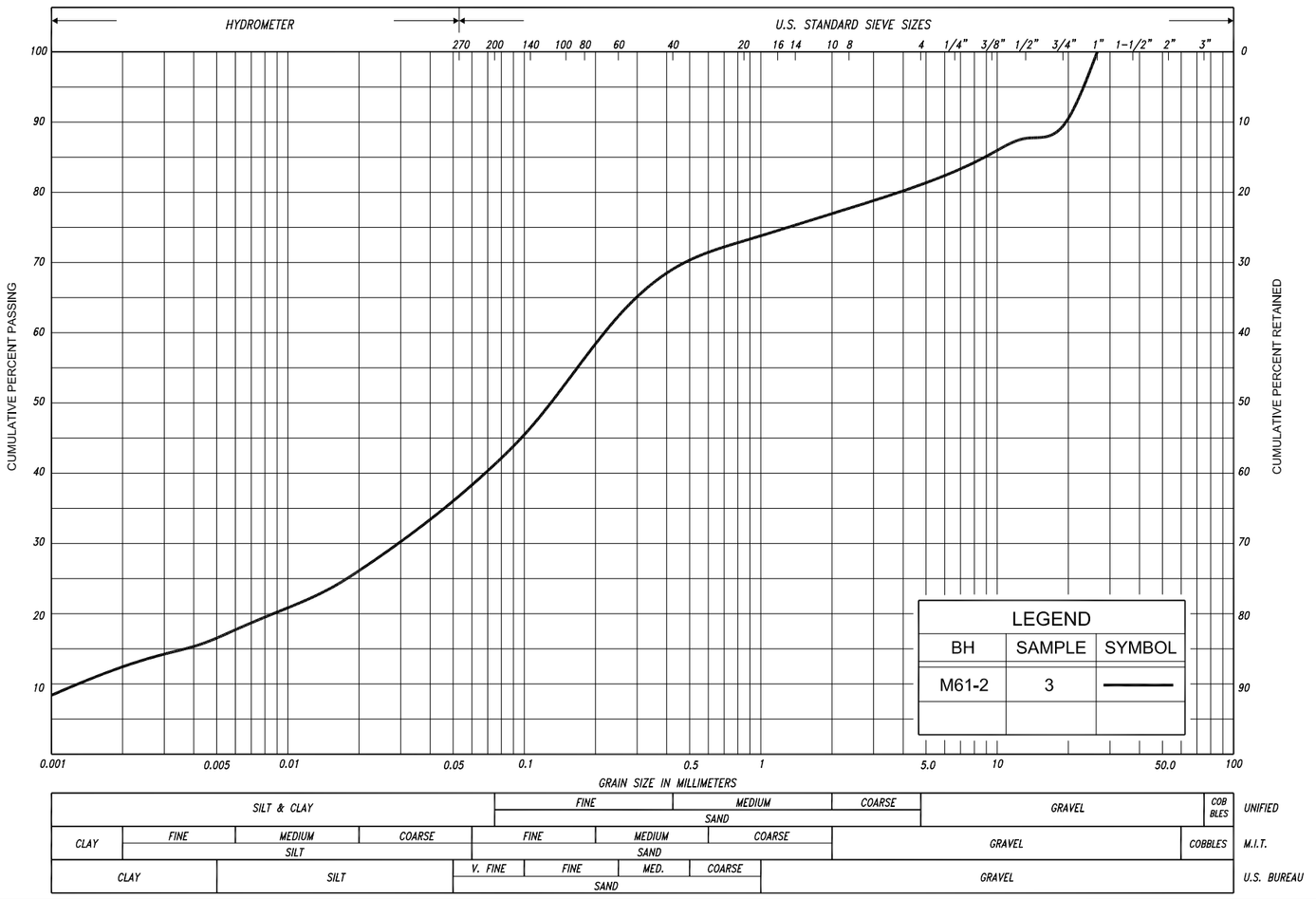


Ontario
Peto MacCallum Ltd. CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

CLAYEY SILT, some sand, some gravel
(TILL)

FIG No.	M61-GS-1
HWY:	407E
W.P. No.	07-20016

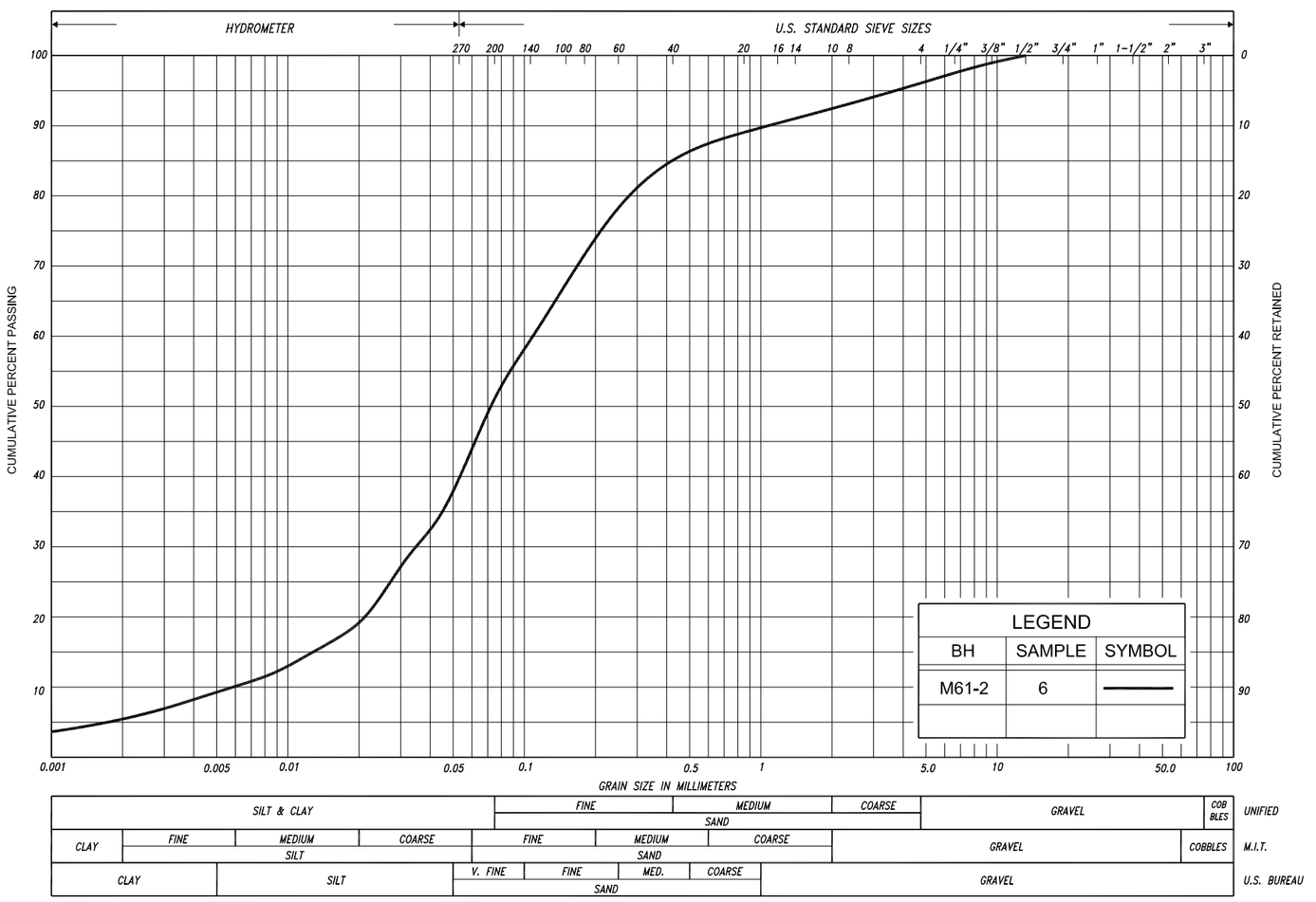


Ontario
Peto MacCallum Ltd.
CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SAND, with silt, some clay, some gravel
(TILL)

FIG No.	M61-GS-2
HWY:	407E
W.P. No.	07-20016

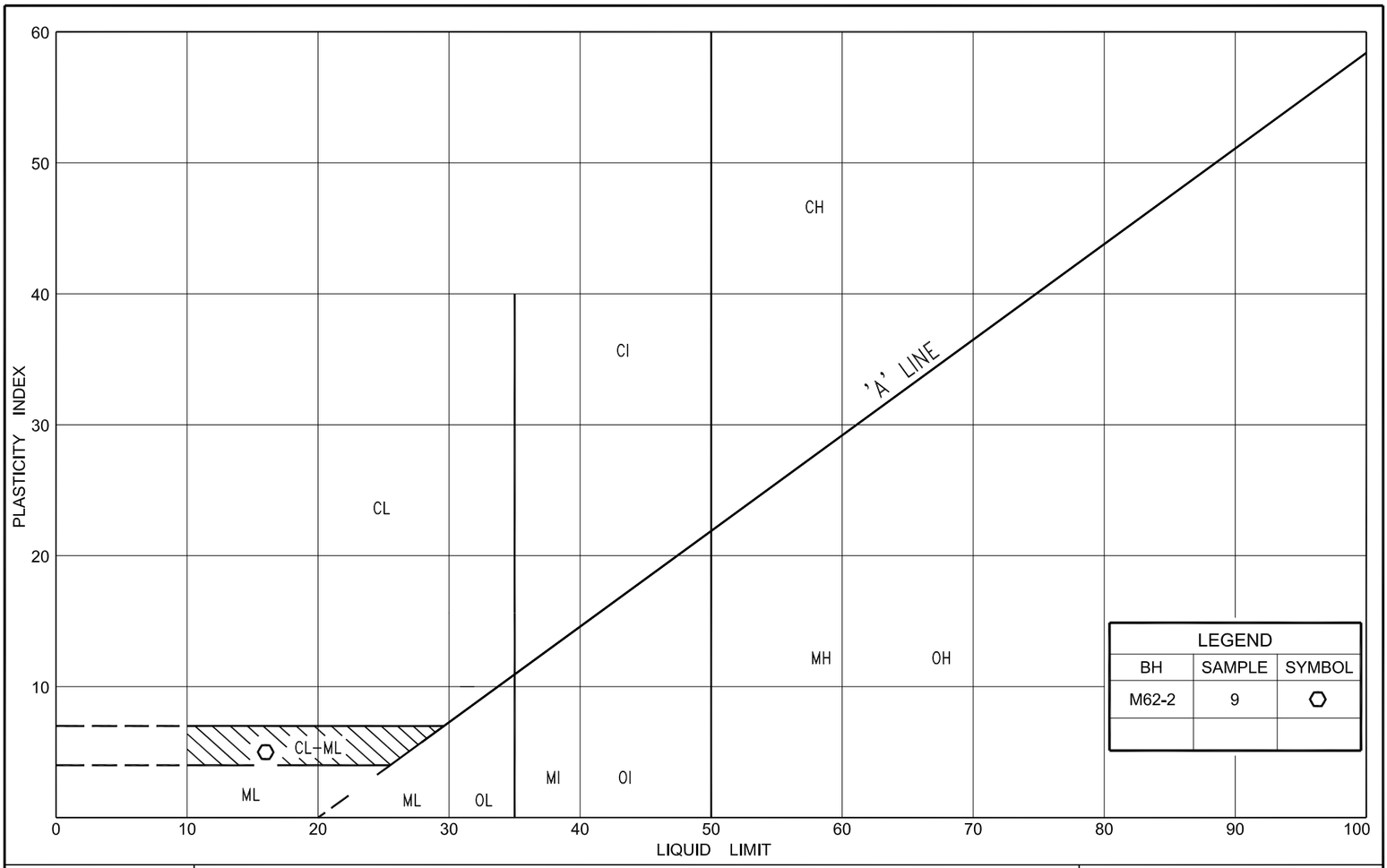


Ontario
Peto MacCallum Ltd.
CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SAND and SILT, trace clay, trace gravel
(TILL)

FIG No.	M61-GS-3
HWY:	407E
W.P. No.	07-20016

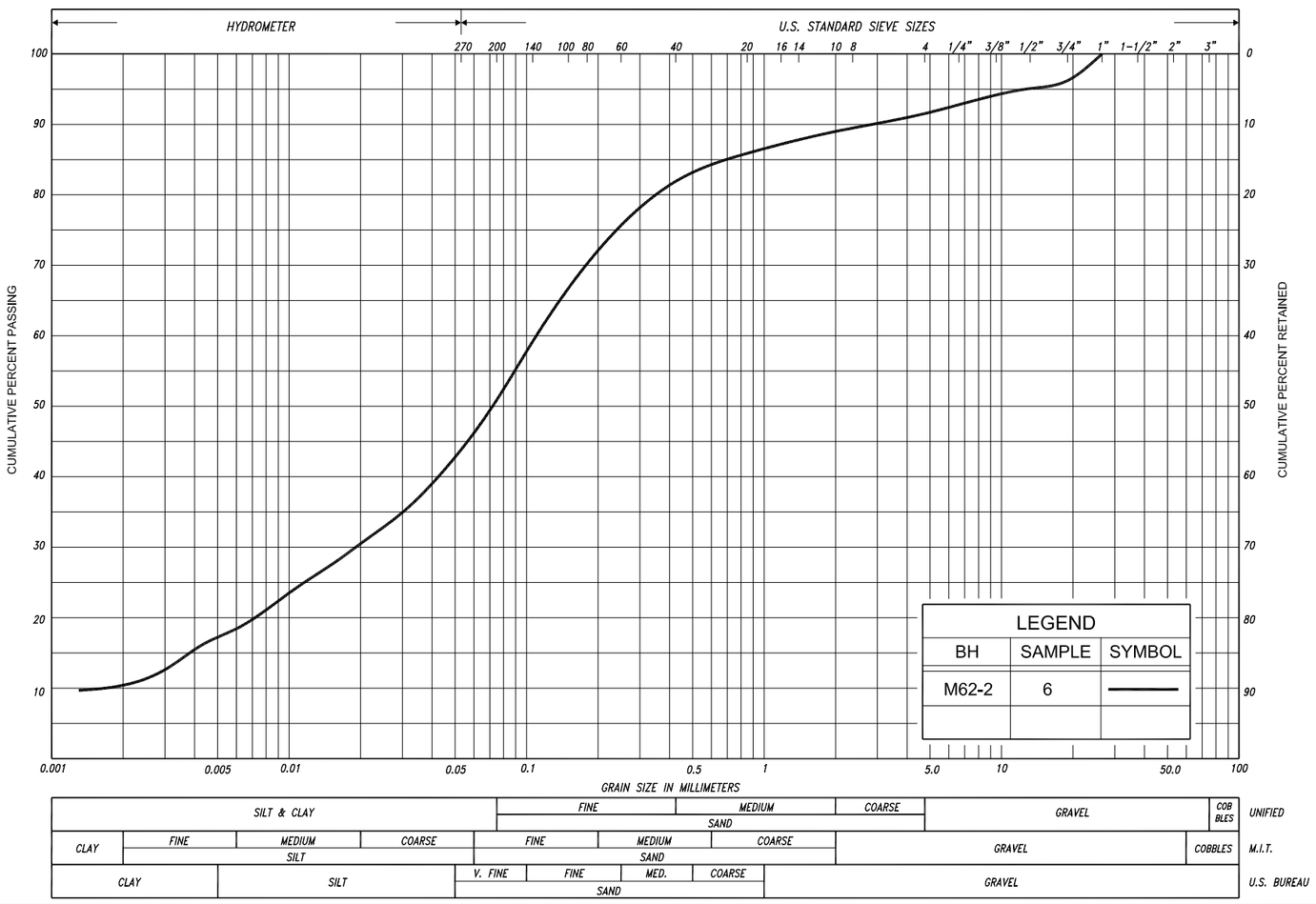


Ontario
Peto MacCallum Ltd. CONSULTING ENGINEERS

PLASTICITY CHART

SILT, with sand, some clay, some gravel
(TILL)

FIG No.	M62-PC-1
HWY:	407E
W.P. No.	07-20016

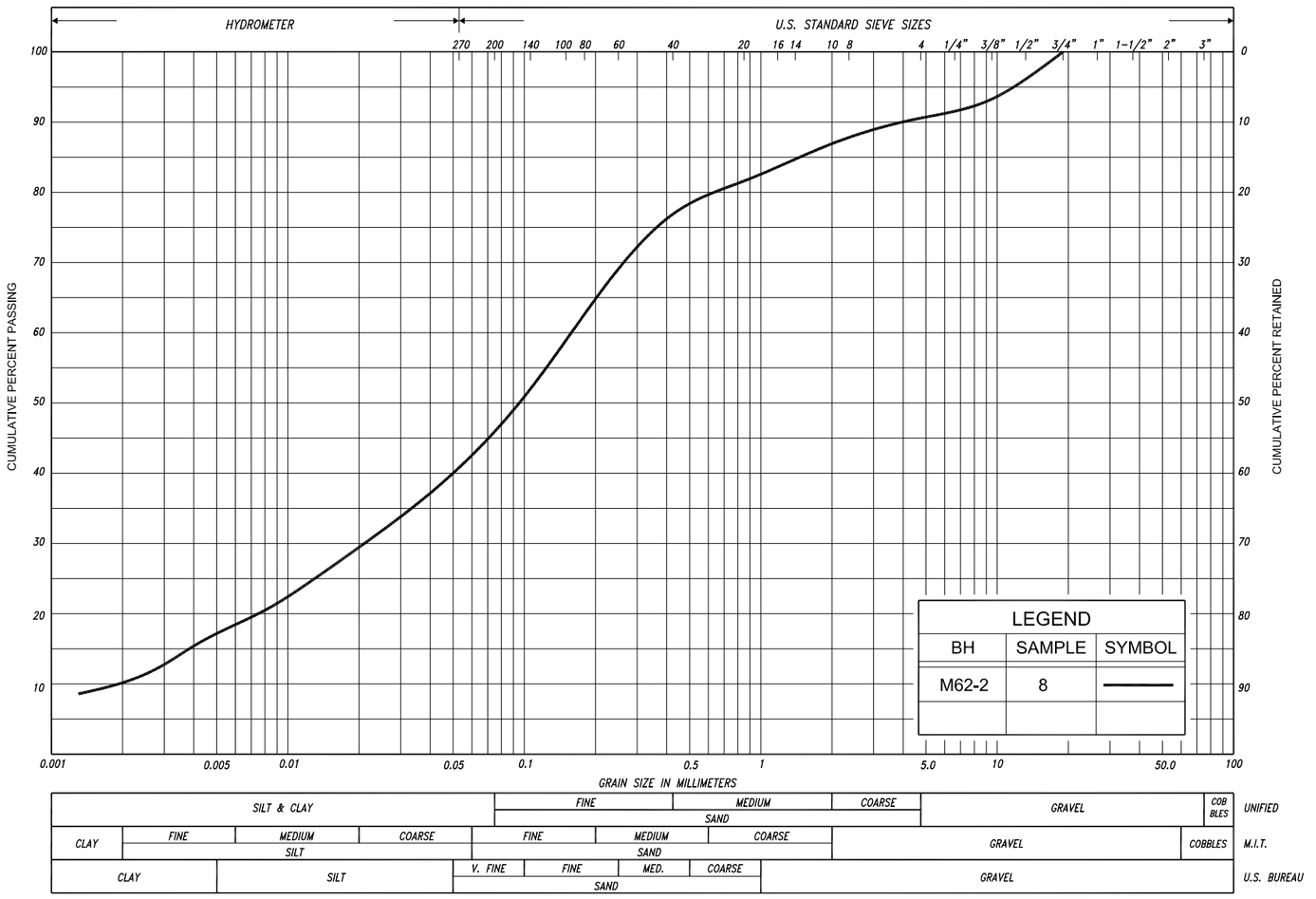


Ontario
Peto MacCallum Ltd. CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SAND and SILT, some clay, trace gravel
(TILL)

FIG No.	M62-GS-1
HWY:	407E
W.P. No.	07-20016



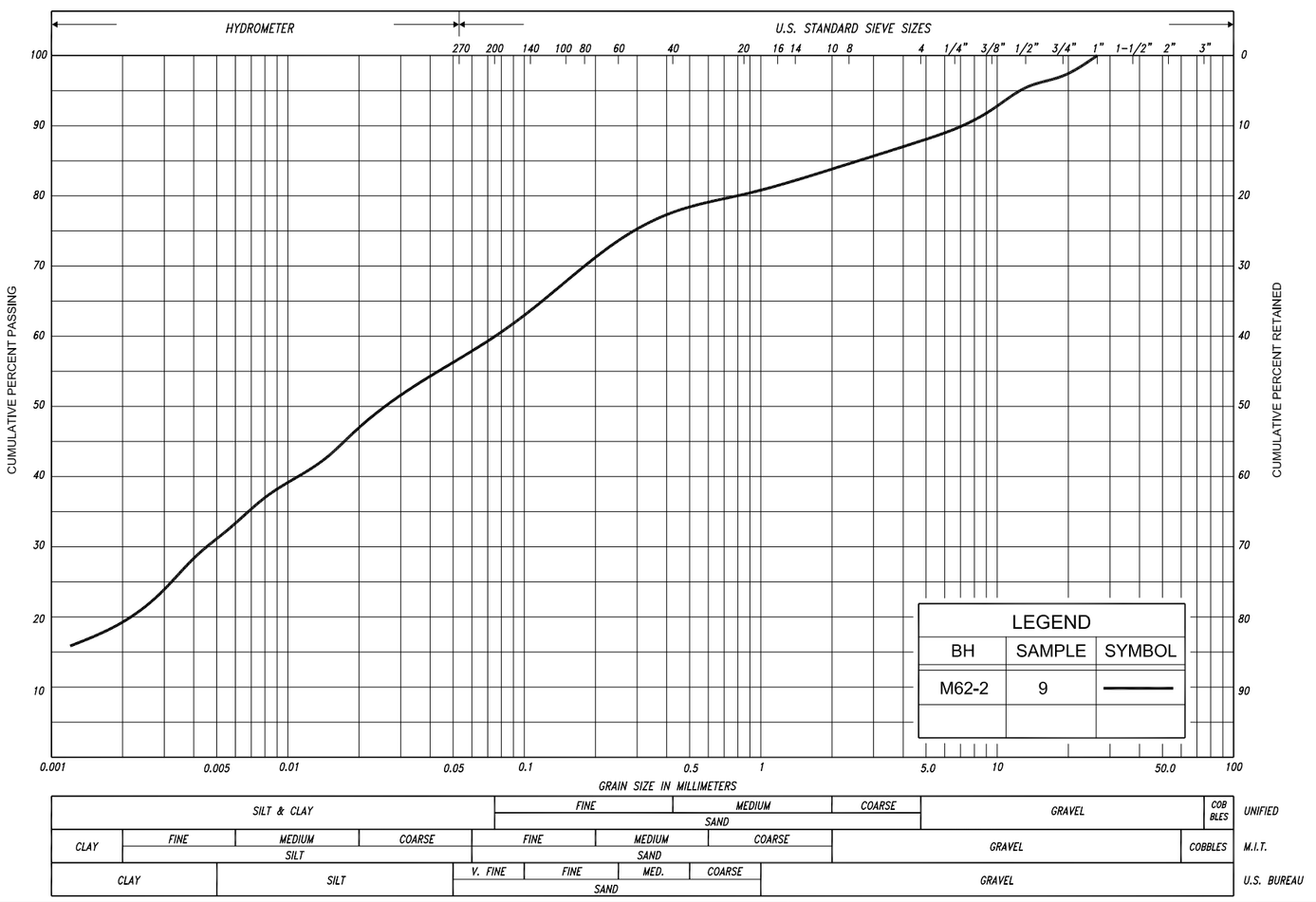
Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SILTY SAND, trace to some clay, trace gravel
(TILL)

FIG No.	M62-GS-2
HWY:	407E
W.P. No.	07-20016



Ontario

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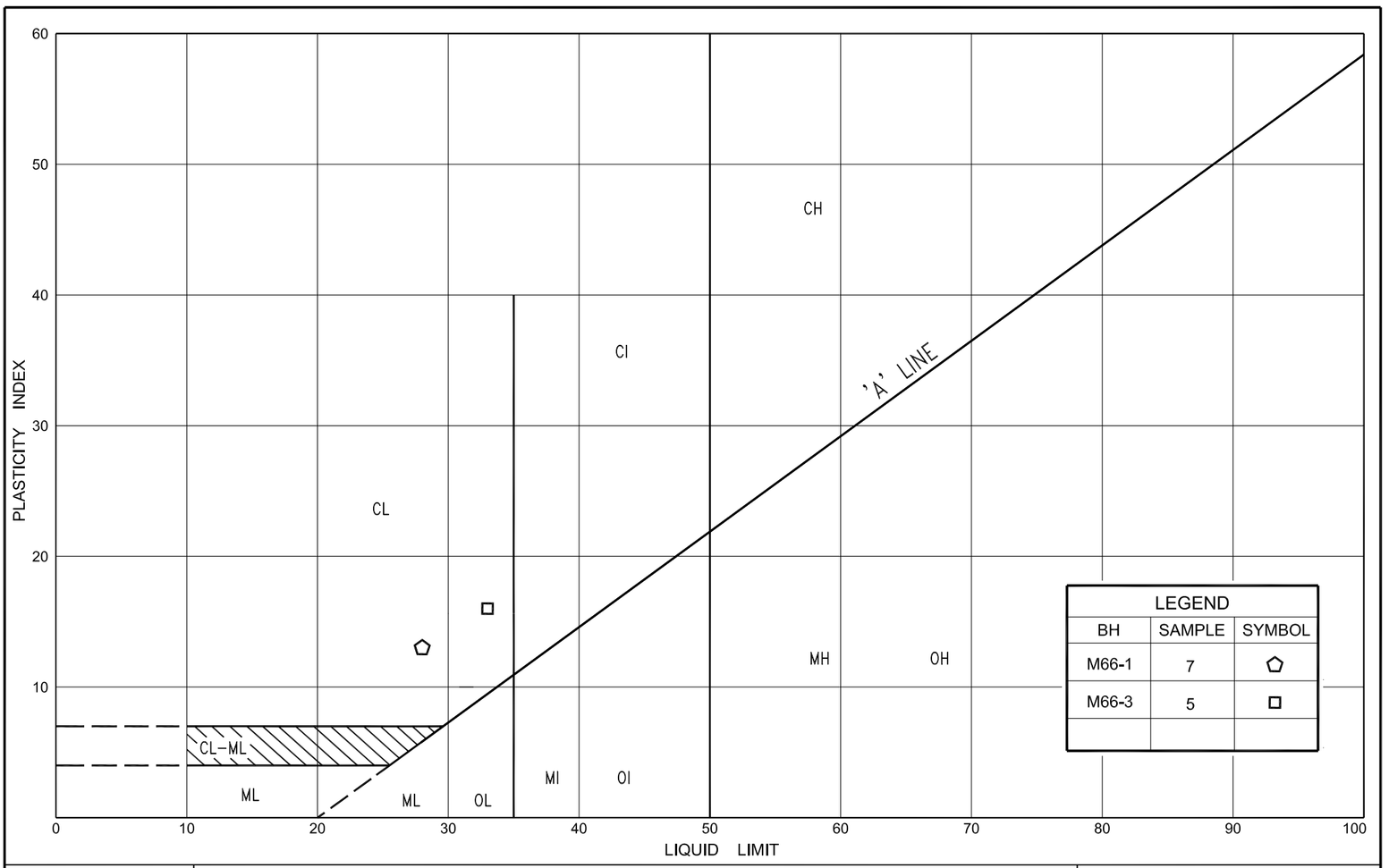
GRAIN SIZE DISTRIBUTION

SILT, with sand, some clay, some gravel
(TILL)

FIG No.	M62-GS-3
HWY:	407E
W.P. No.	07-20016



Ontario

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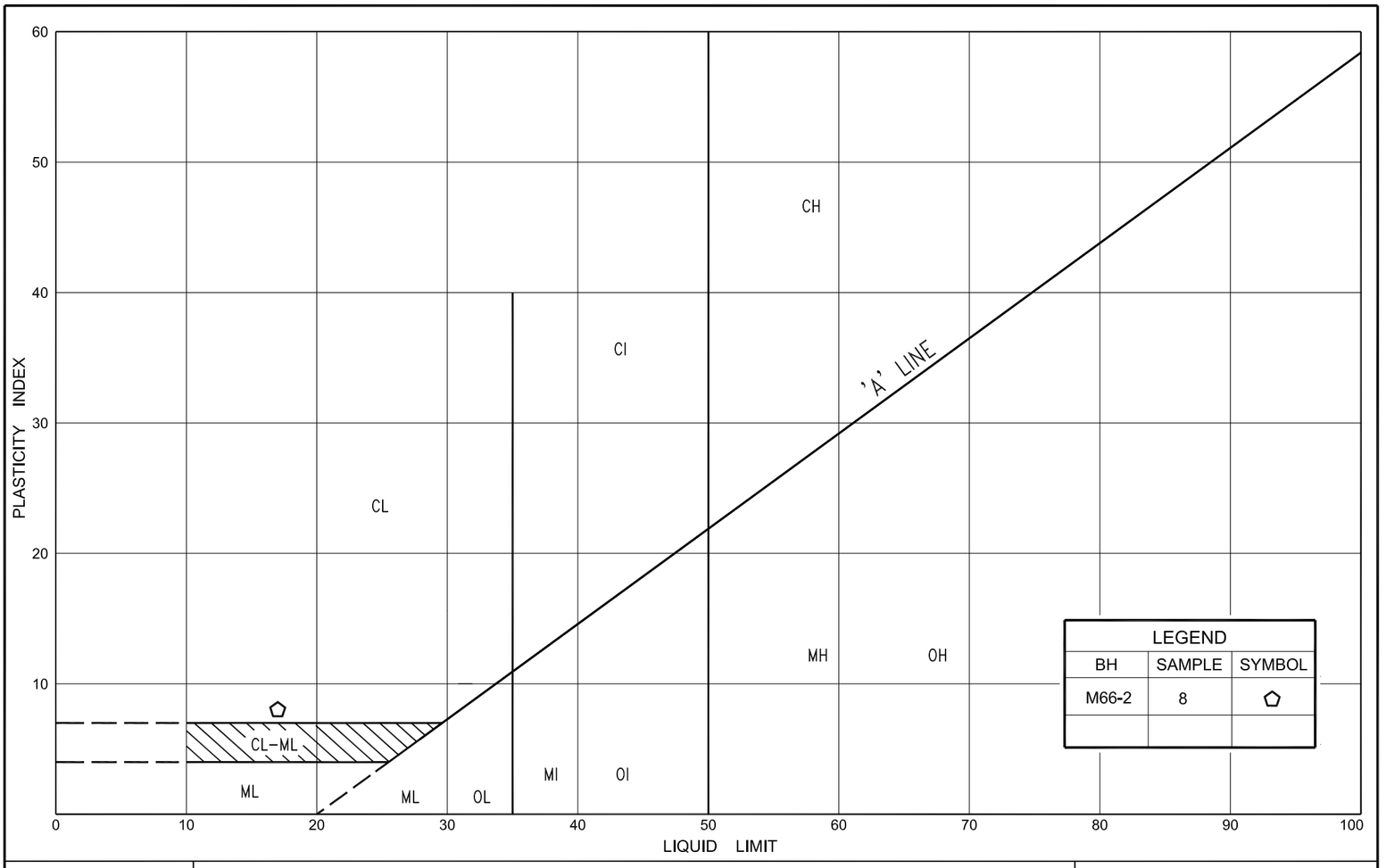
PLASTICITY CHART

CLAYEY SILT, trace sand

FIG No.	M66-PC-1
HWY:	407E
W.P. No.	07-20016



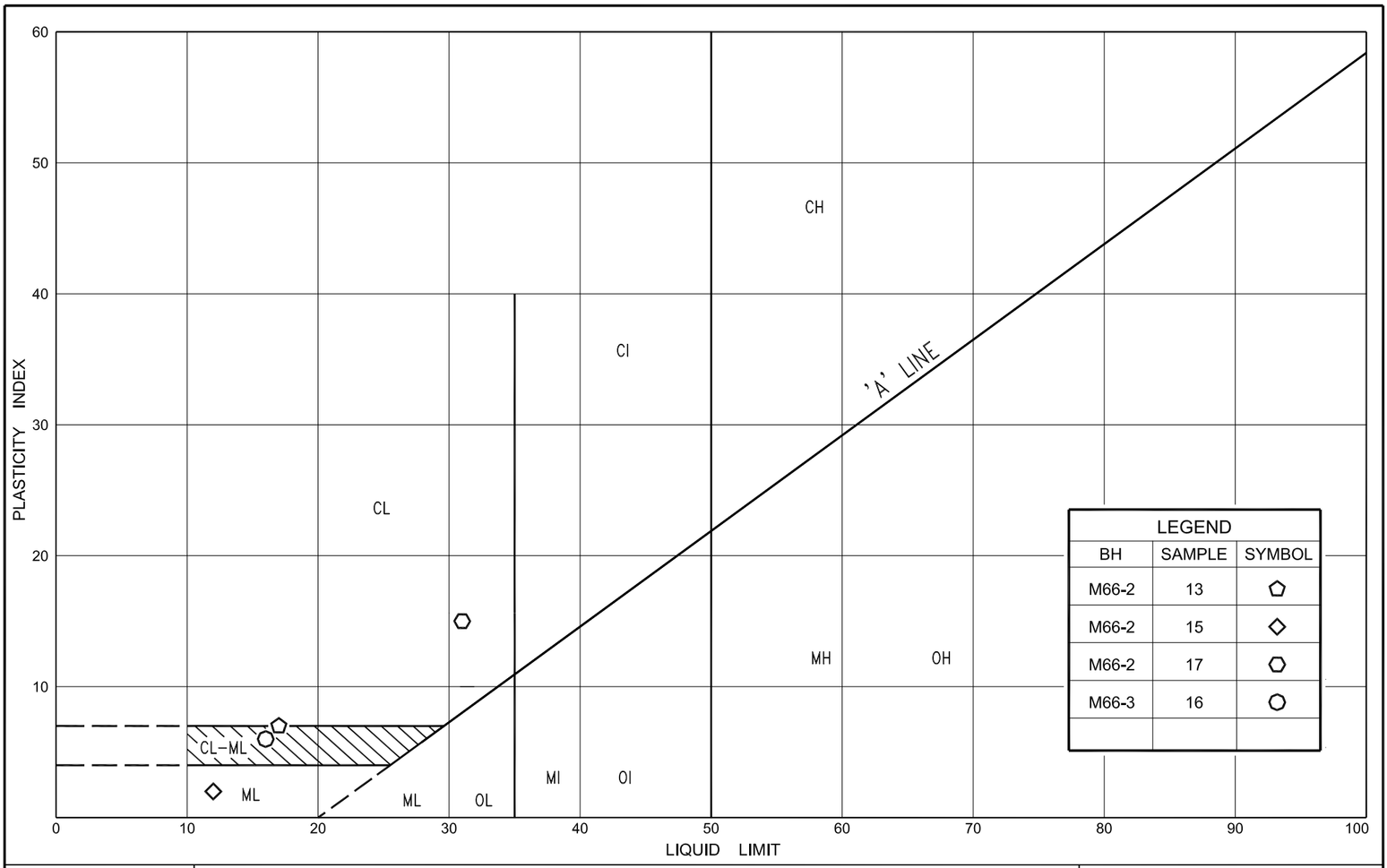
Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

PLASTICITY CHART

CLAYEY SILT, sandy, trace gravel
(TILL)

FIG No.	M66-PC-2
HWY:	407E
W.P. No.	07-20016

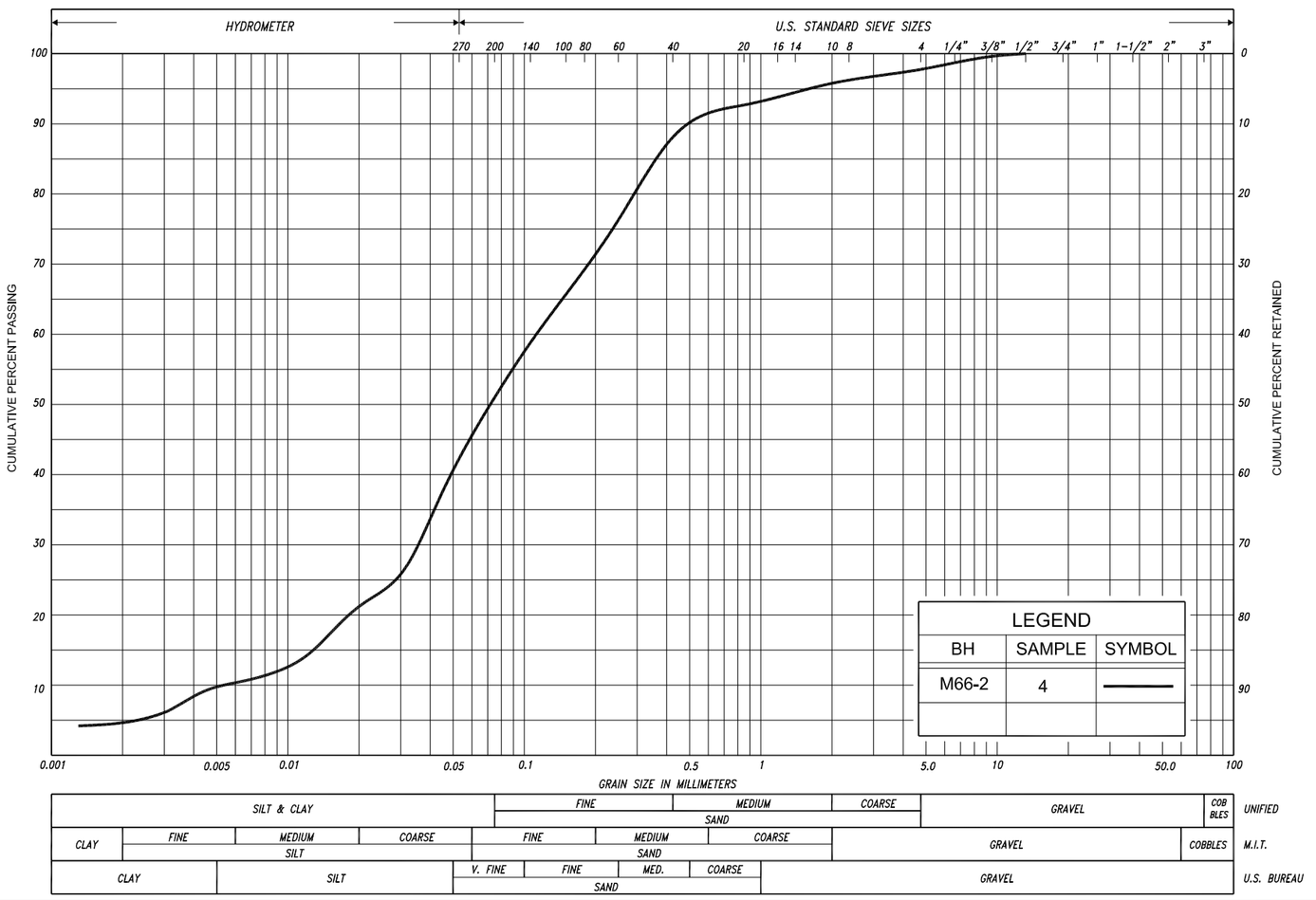


Ontario
Peto MacCallum Ltd. CONSULTING ENGINEERS

PLASTICITY CHART

CLAYEY SILT, trace sand to sandy, trace gravel
(TILL)

FIG No.	M66-PC-3
HWY:	407E
W.P. No.	07-20016

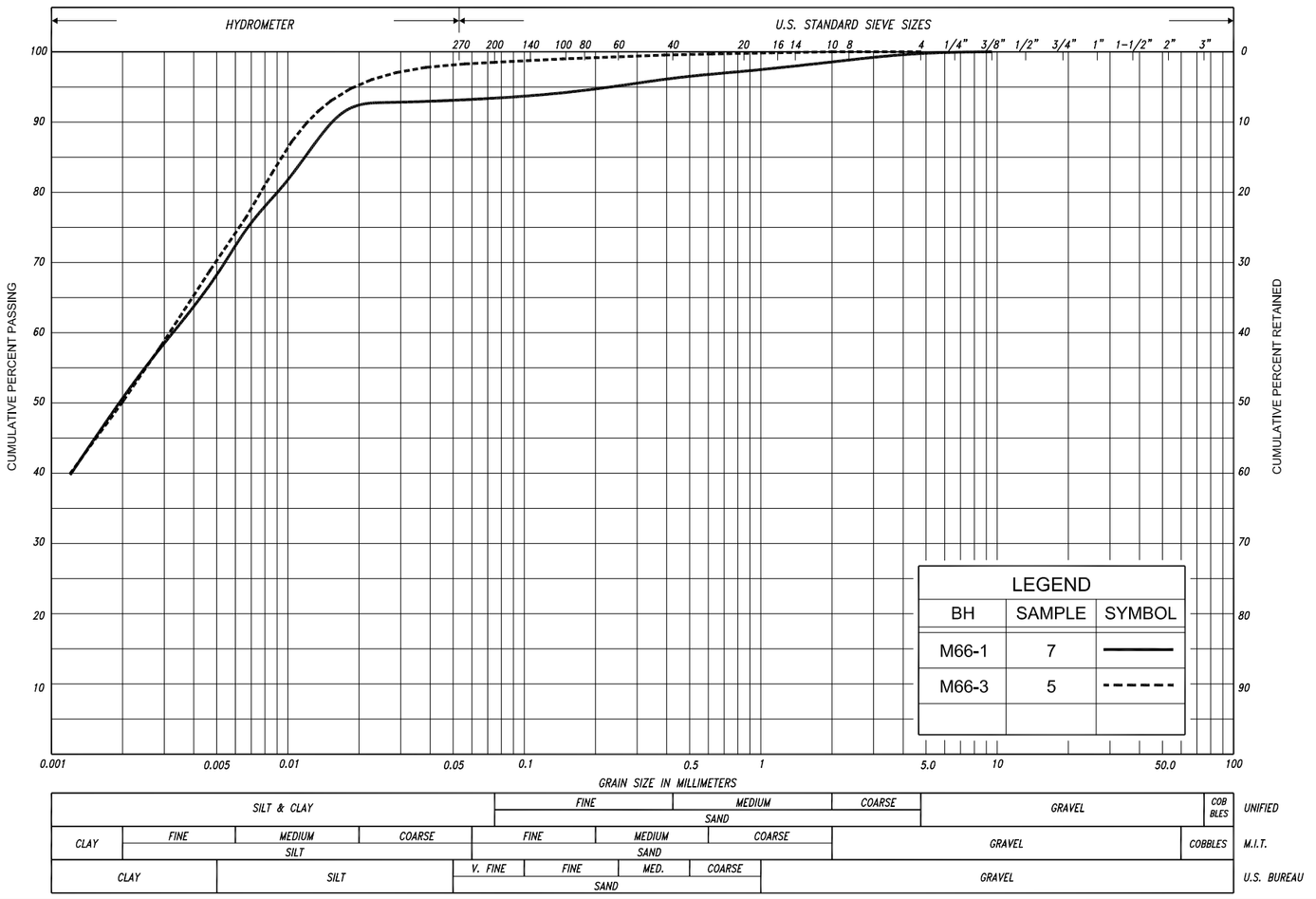


Ontario
Peto MacCallum Ltd. CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SAND and SILT, trace clay, trace gravel

FIG No.	M66-GS-1
HWY:	407E
W.P. No.	07-20016

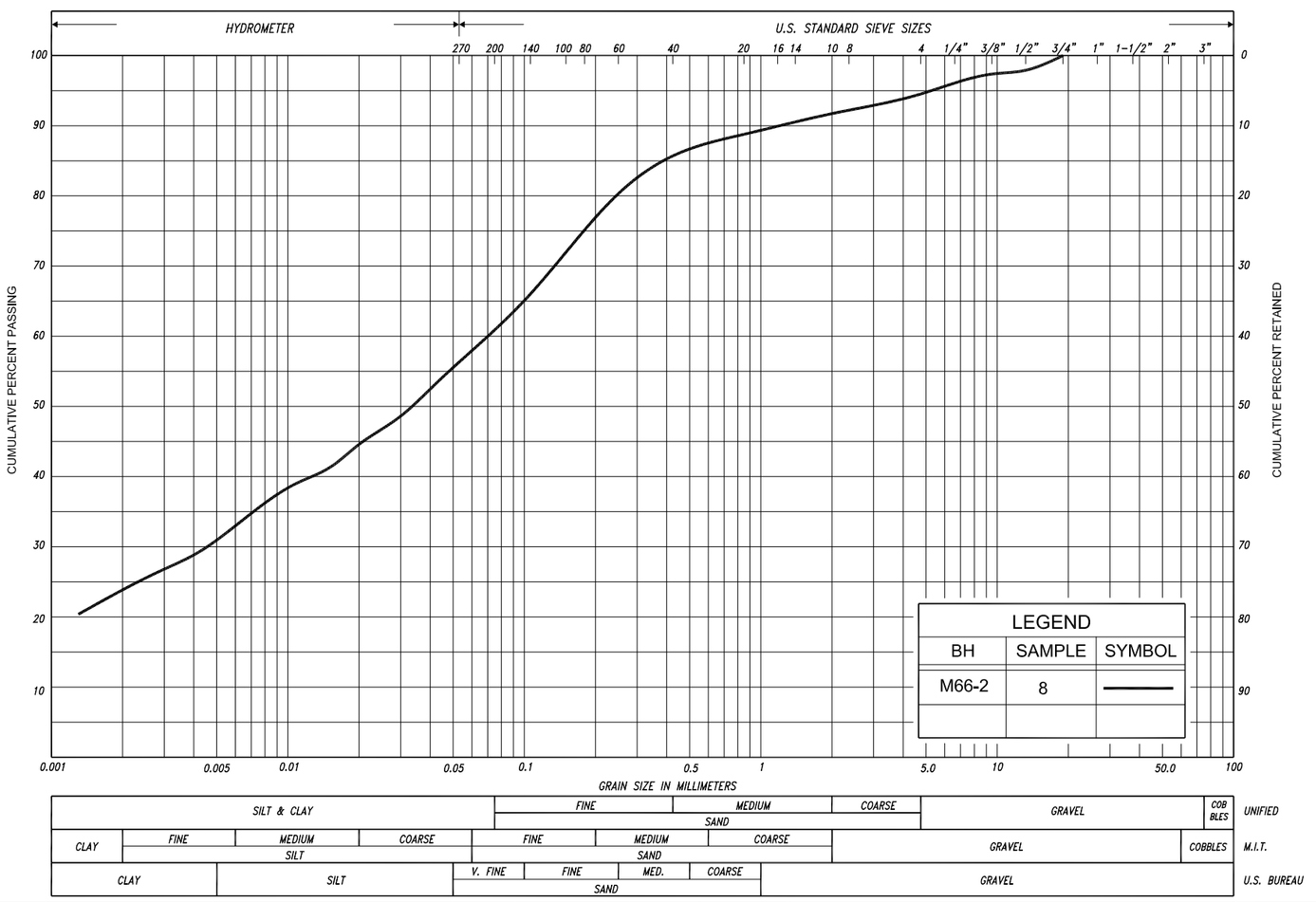


Ontario
Peto MacCallum Ltd. CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

CLAYEY SILT, trace sand

FIG No.	M66-GS-2
HWY:	407E
W.P. No.	07-20016

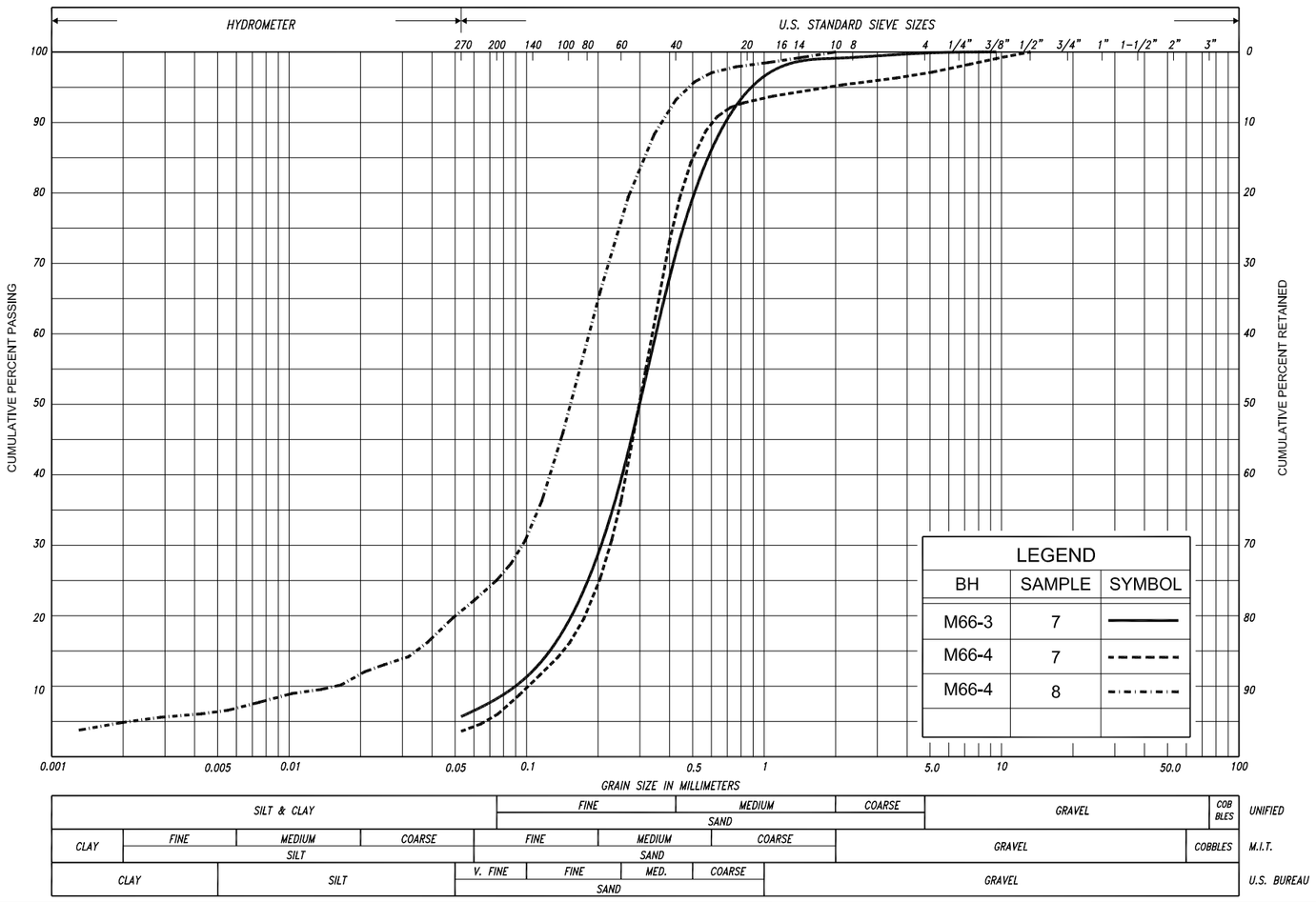


Ontario
Peto MacCallum Ltd. CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

CLAYEY SILT, sandy, trace gravel
(TILL)

FIG No.	M66-GS-3
HWY:	407E
W.P. No.	07-20016

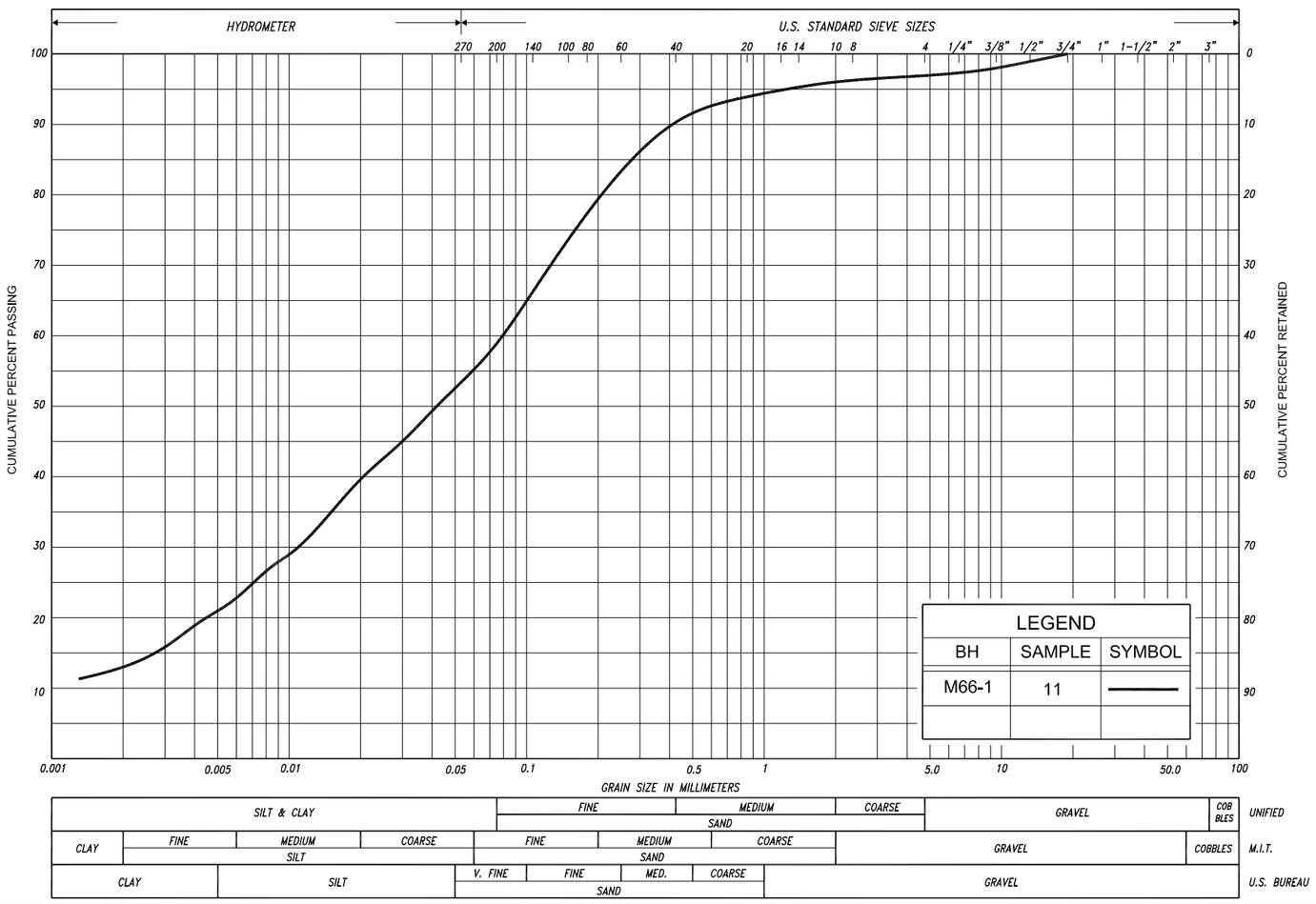


Ontario
Peto MacCallum Ltd.
CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SAND, trace to some silt, trace clay, trace gravel

FIG No.	M66-GS-4
HWY:	407E
W.P. No.	07-20016

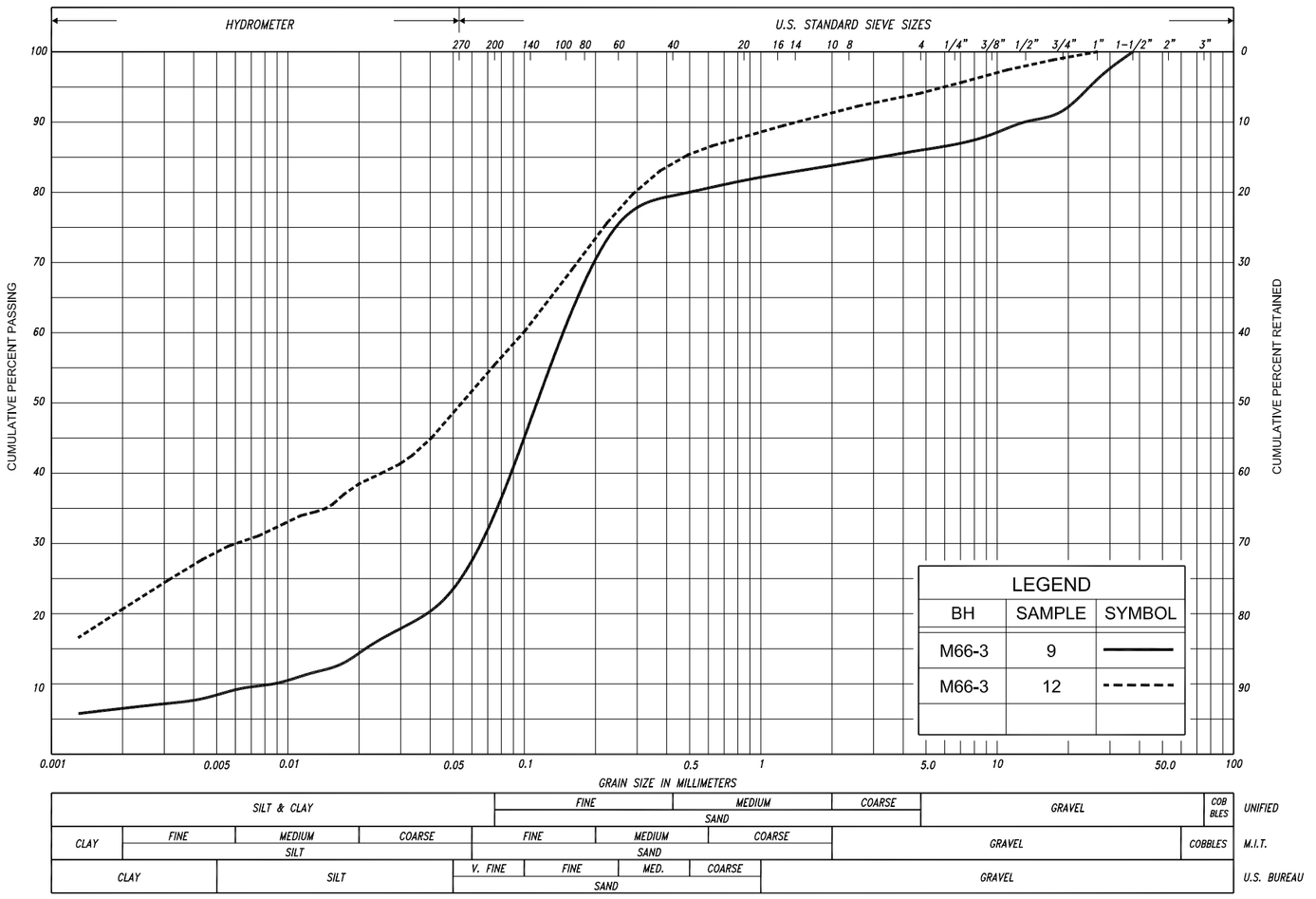


Ontario
Peto MacCallum Ltd.
CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SANDY SILT, some clay, trace gravel

FIG No.	M66-GS-5
HWY:	407E
W.P. No.	07-20016

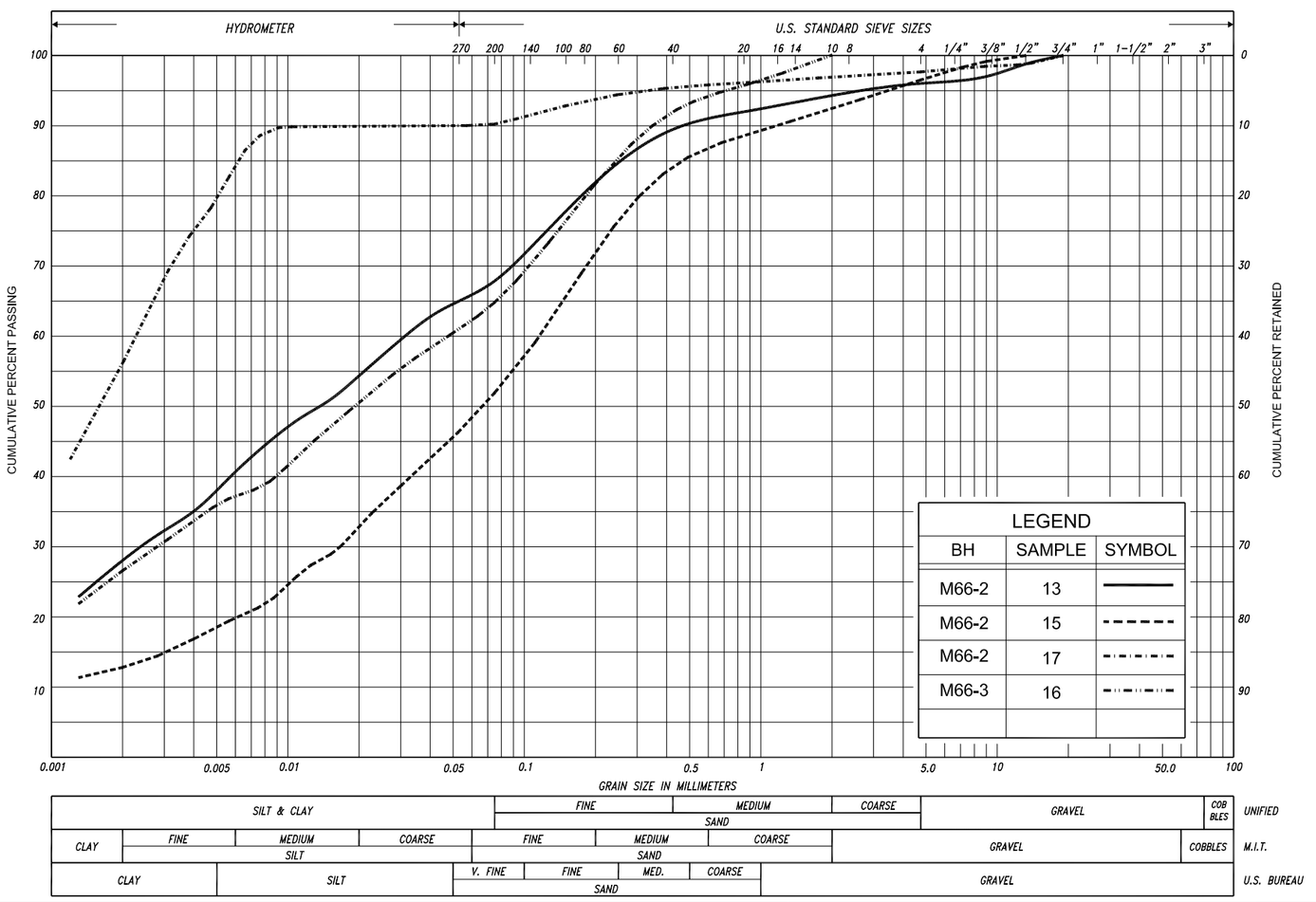


Ontario
Peto MacCallum Ltd.
CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SAND, with silt to silty, trace to with clay, trace to some gravel
(TILL)

FIG No.	M66-GS-6
HWY:	407E
W.P. No.	07-20016

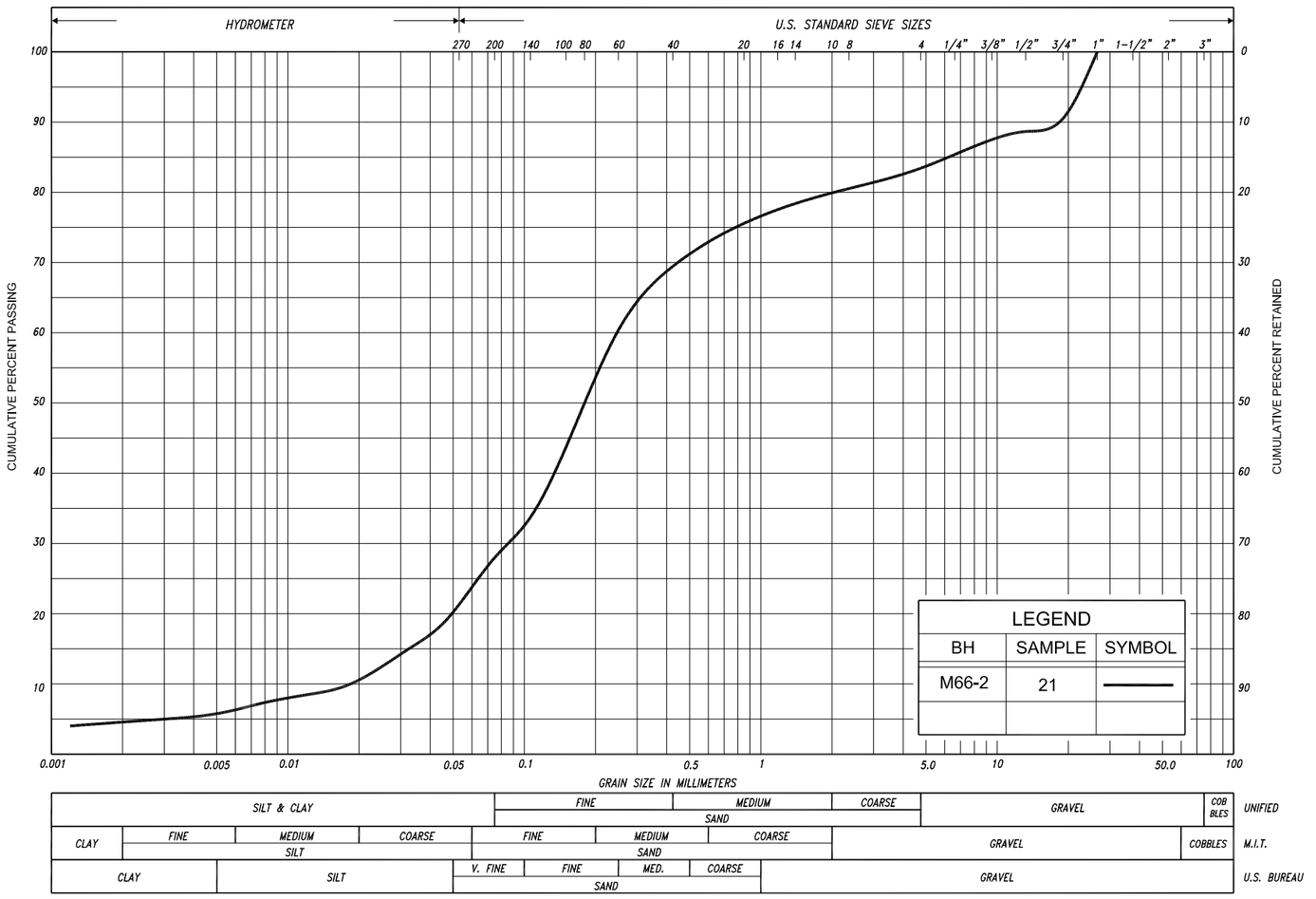


Ontario
Peto MacCallum Ltd.
CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

CLAYEY SILT, trace sand to sandy, trace gravel
(TILL)

FIG No.	M66-GS-7
HWY:	407E
W.P. No.	07-20016



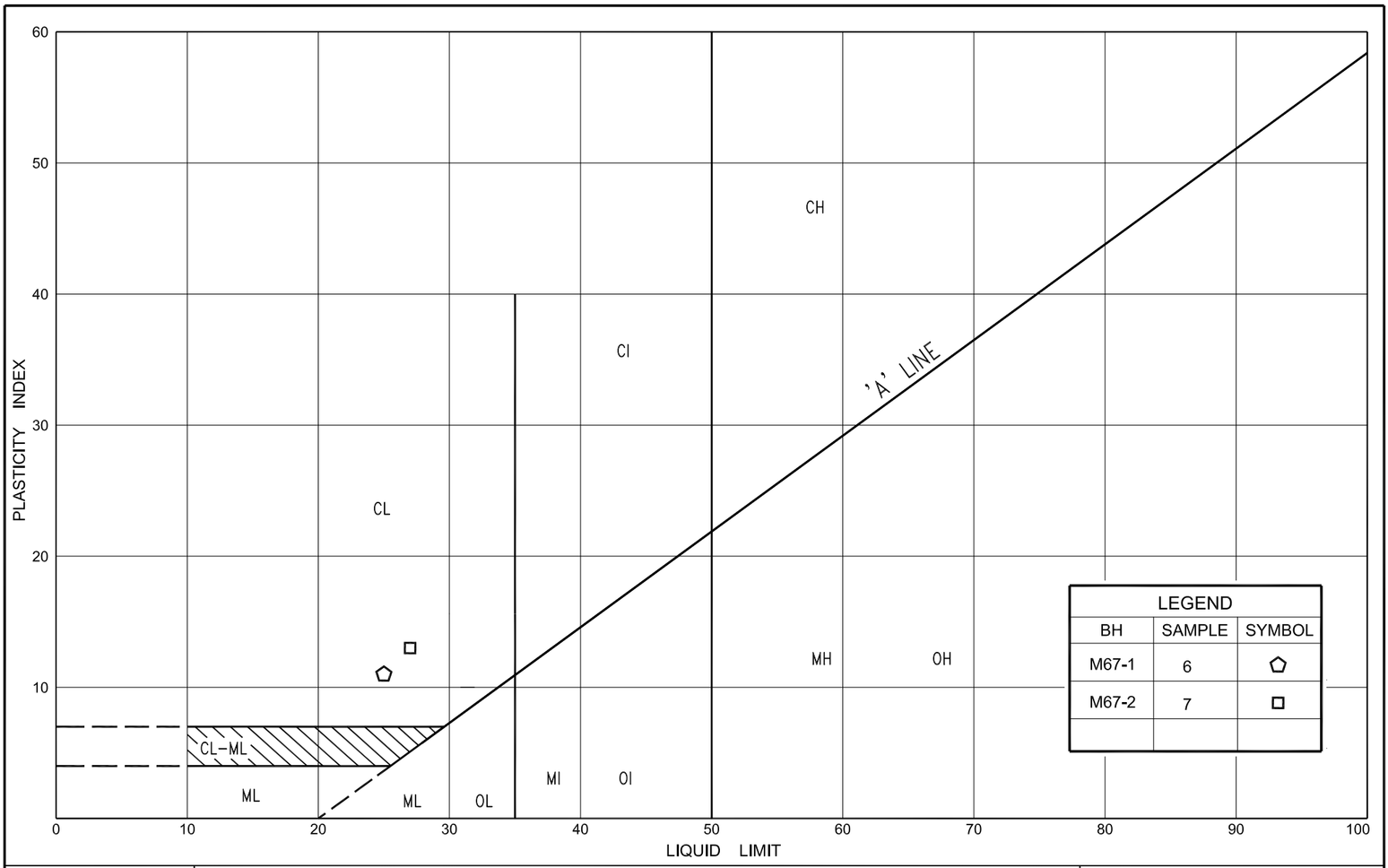
Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SAND, with silt, some gravel, trace clay
(TILL)

FIG No.	M66-GS-8
HWY:	407E
W.P. No.	07-20016



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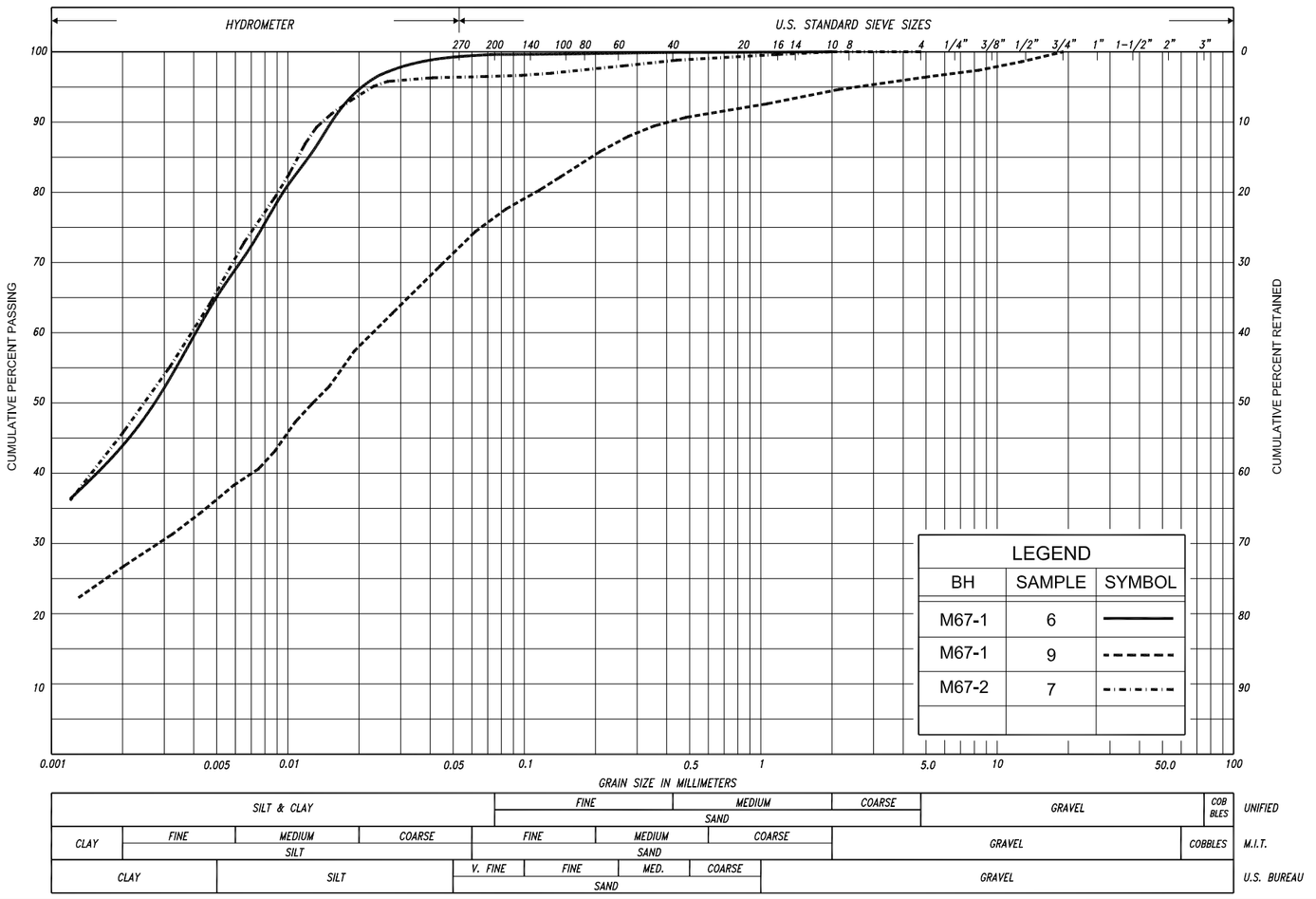
Peto MacCallum Ltd. CONSULTING ENGINEERS

PLASTICITY CHART

CLAYEY SILT, trace sand

FIG No.	M67-PC-1
HWY:	407E
W.P. No.	07-20016



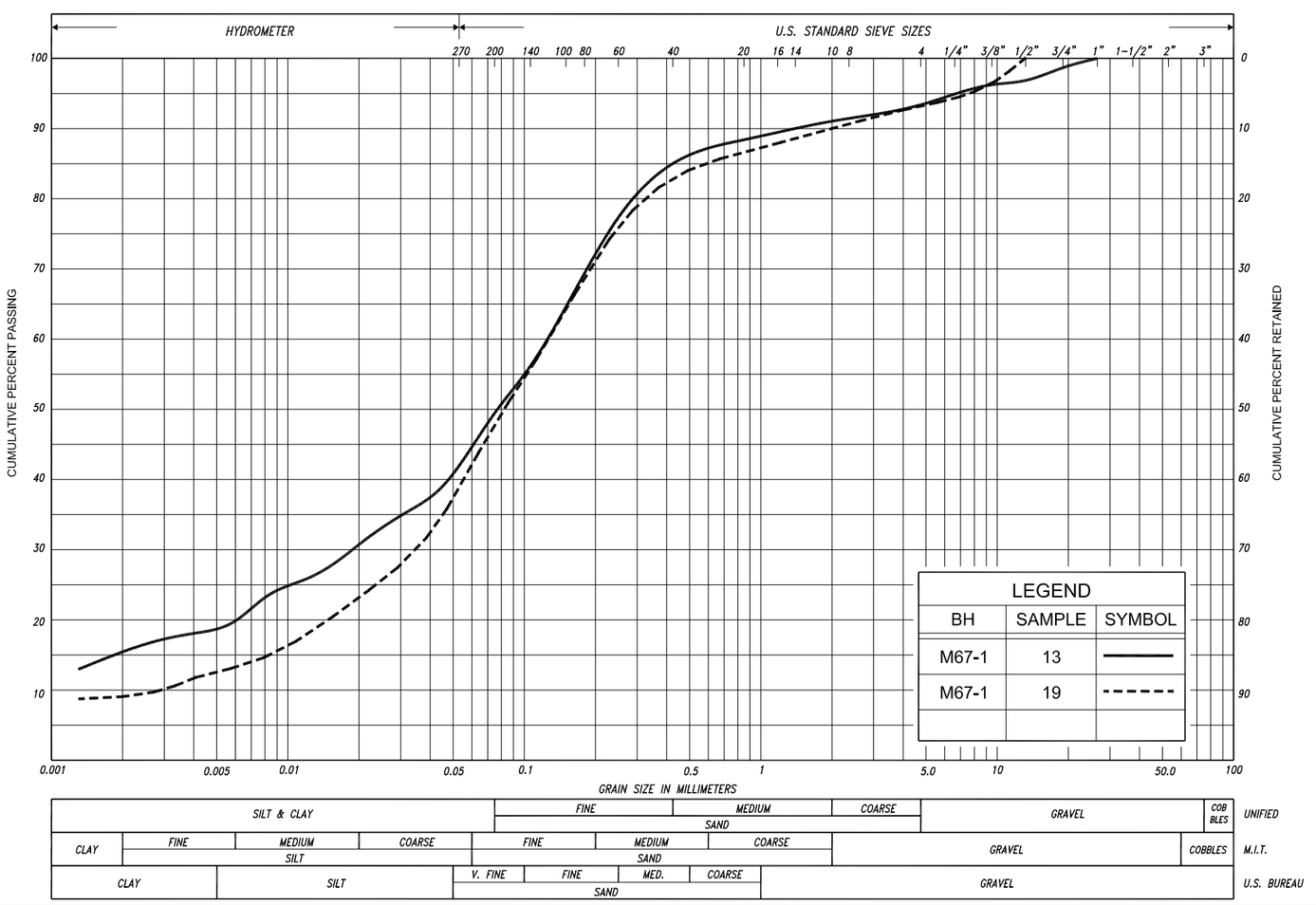
Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

CLAYEY SILT, trace to some sand, trace gravel

FIG No.	M67-GS-2
HWY:	407E
W.P. No.	07-20016



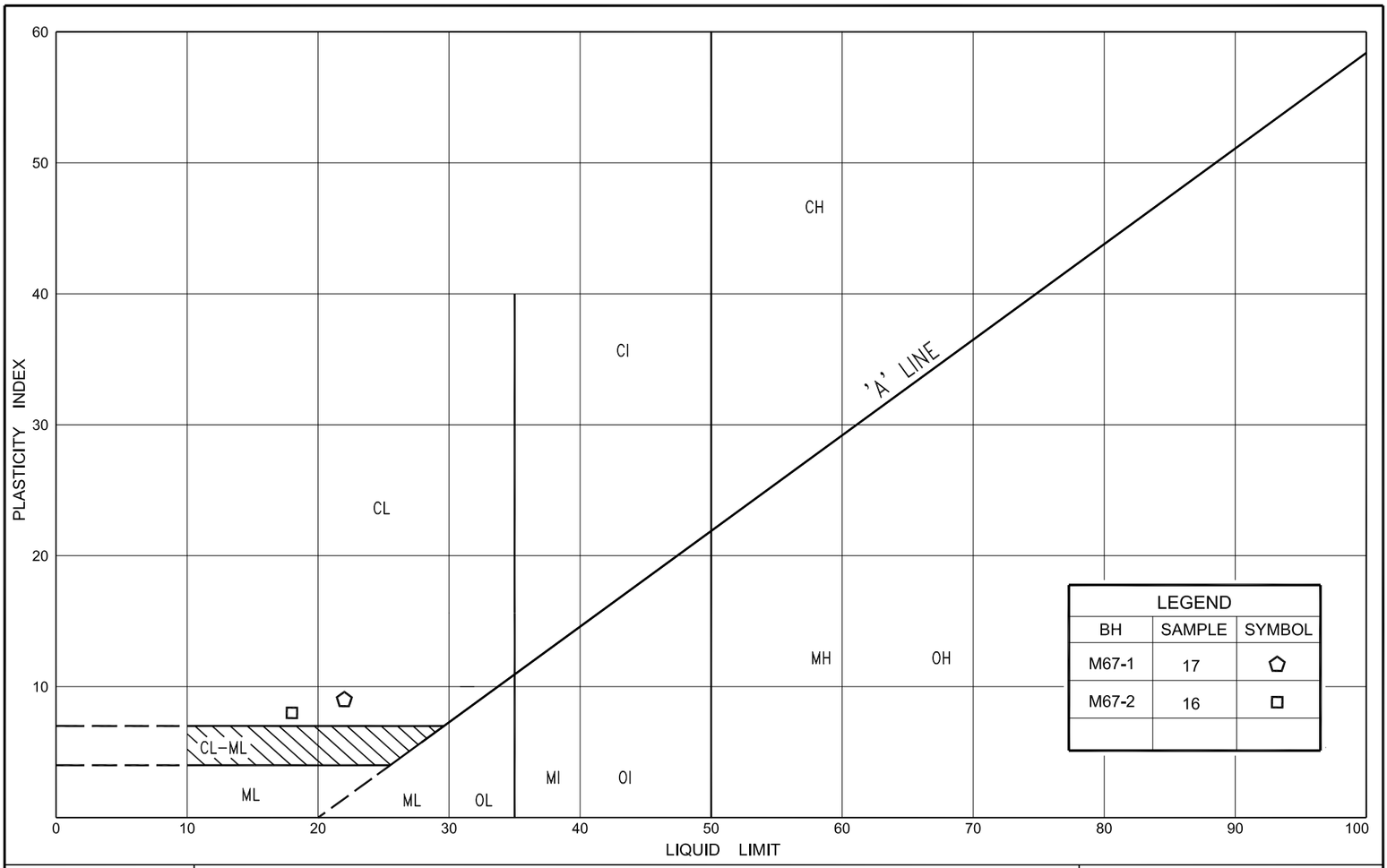
Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

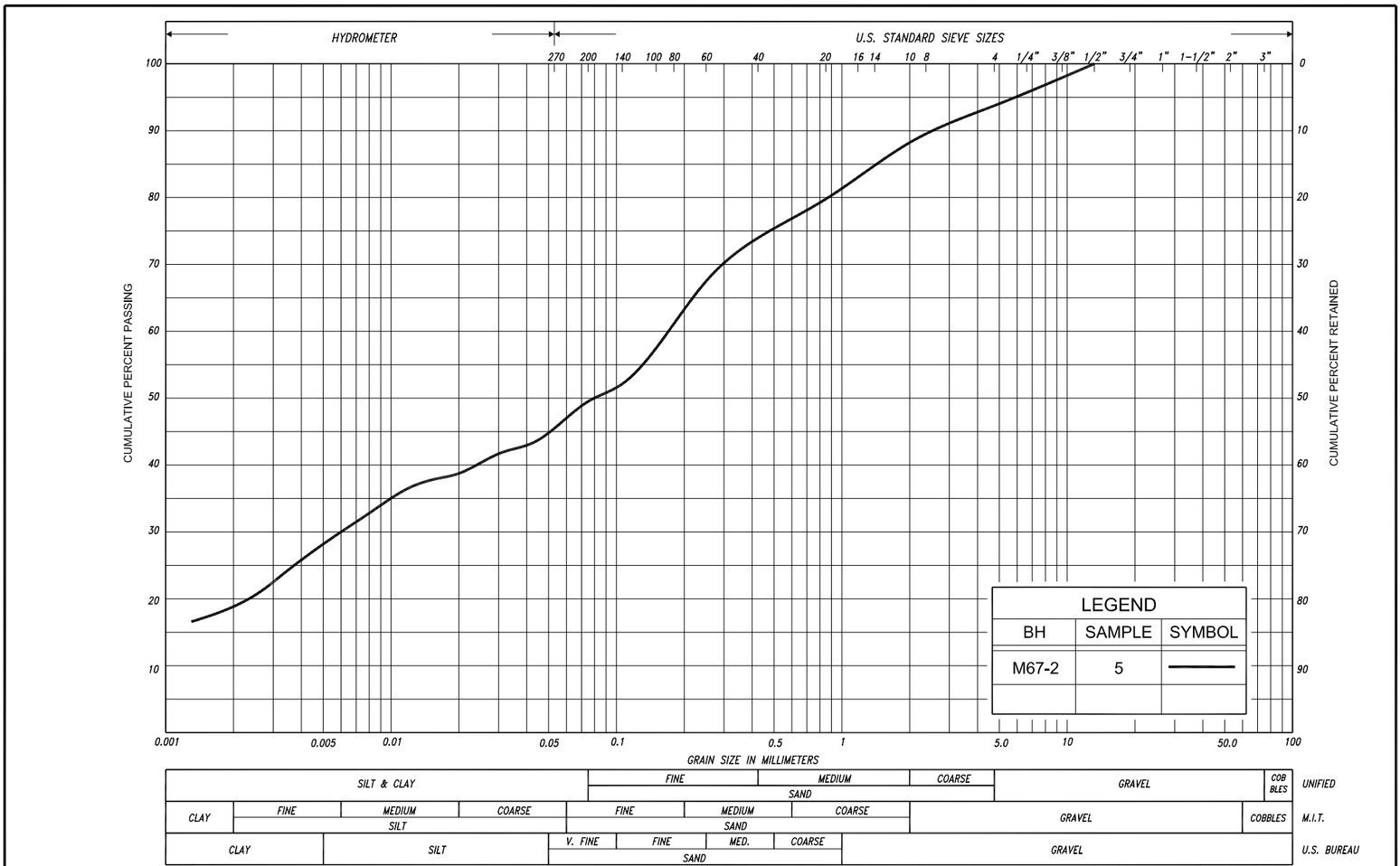
GRAIN SIZE DISTRIBUTION

SILTY SAND, trace to some clay, trace gravel
(TILL)

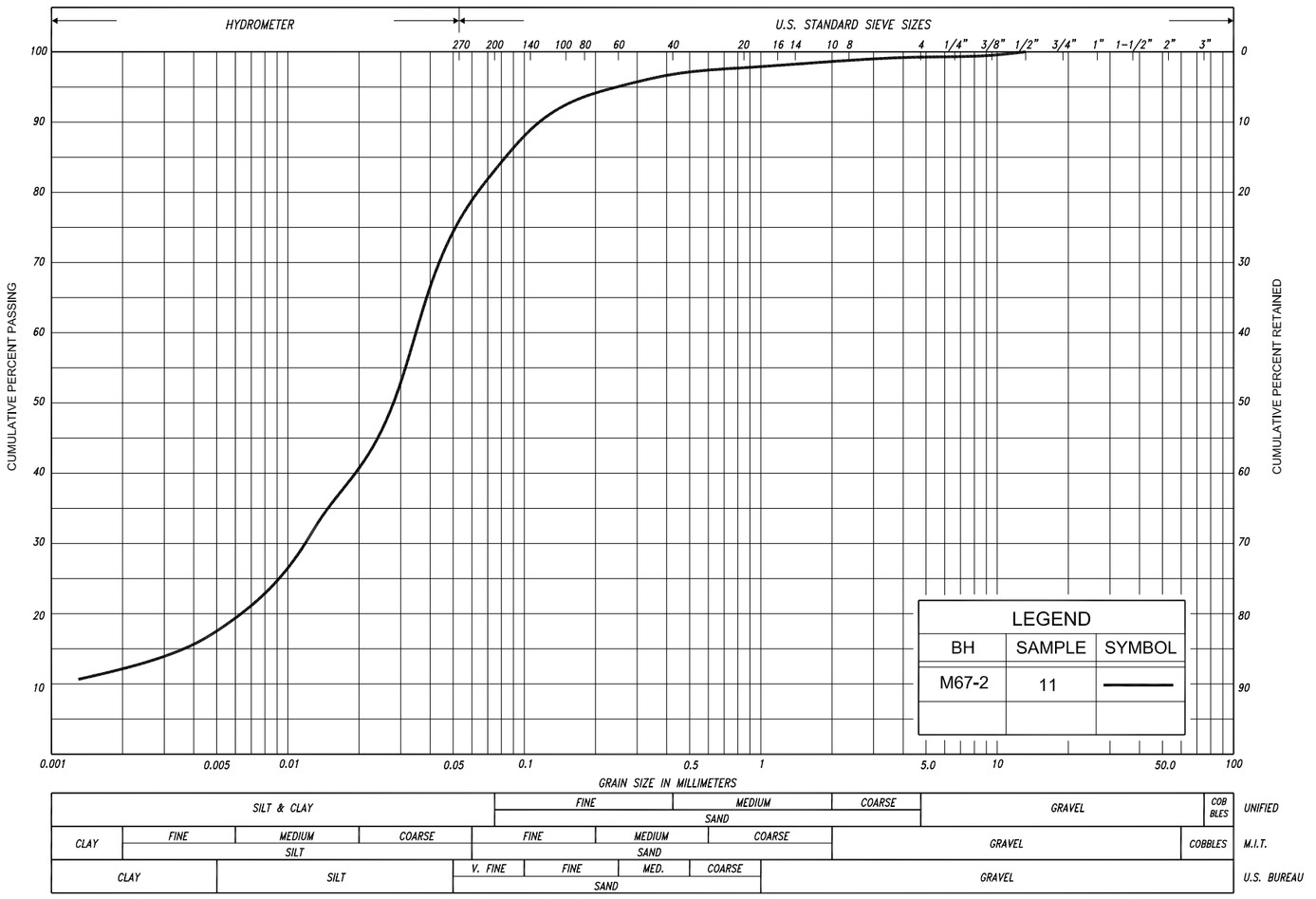
FIG No.	M67-GS-3
HWY:	407E
W.P. No.	07-20016



Ontario / Peto MacCallum Ltd. Consulting Engineers	PLASTICITY CHART CLAYEY SILT, with sand, trace gravel (TILL)	FIG No. M67-PC-2 HWY: 407E W.P. No. 07-20016



Ontario / Peto MacCallum Ltd. Consulting Engineers	GRAIN SIZE DISTRIBUTION SILTY SAND, some clay, trace gravel	FIG No. M67-GS-1 HWY: 407E W.P. No. 07-20016



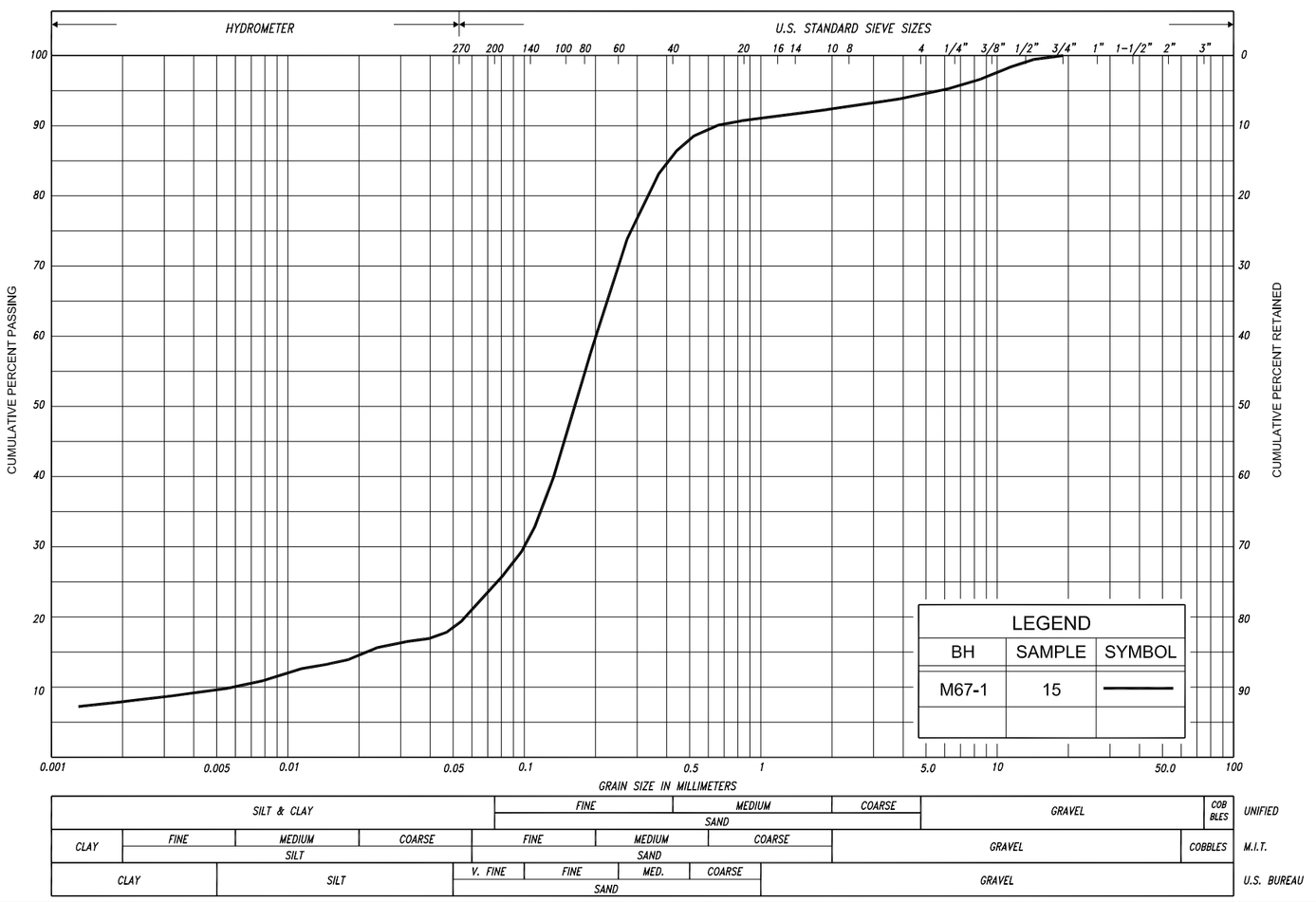
Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SILT, some sand, some clay, trace gravel
(TILL)

FIG No.	M67-GS-4
HWY:	407E
W.P. No.	07-20016



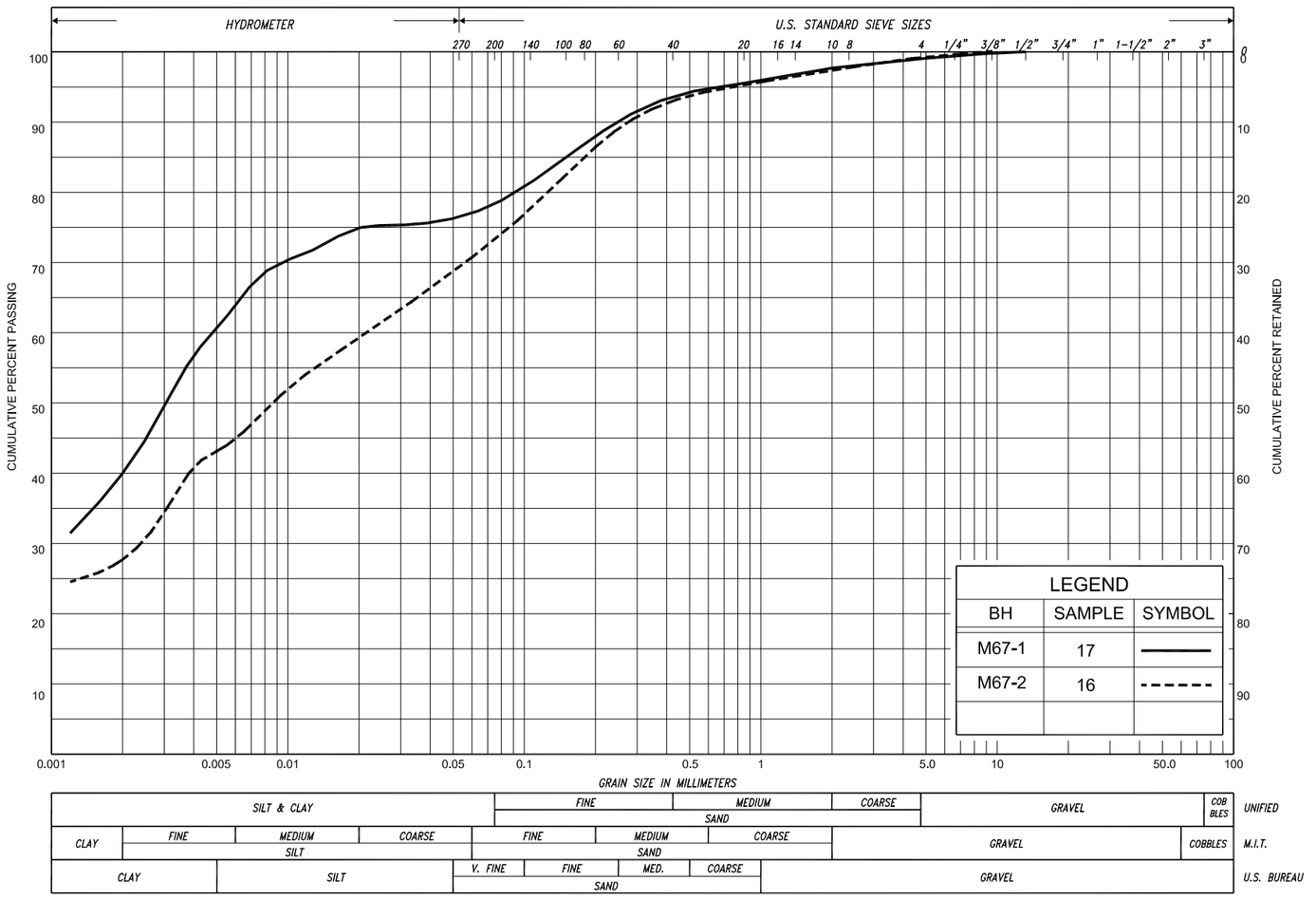
Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SAND, some silt, trace clay, trace gravel

FIG No.	M67-GS-5
HWY:	407E
W.P. No.	07-20016

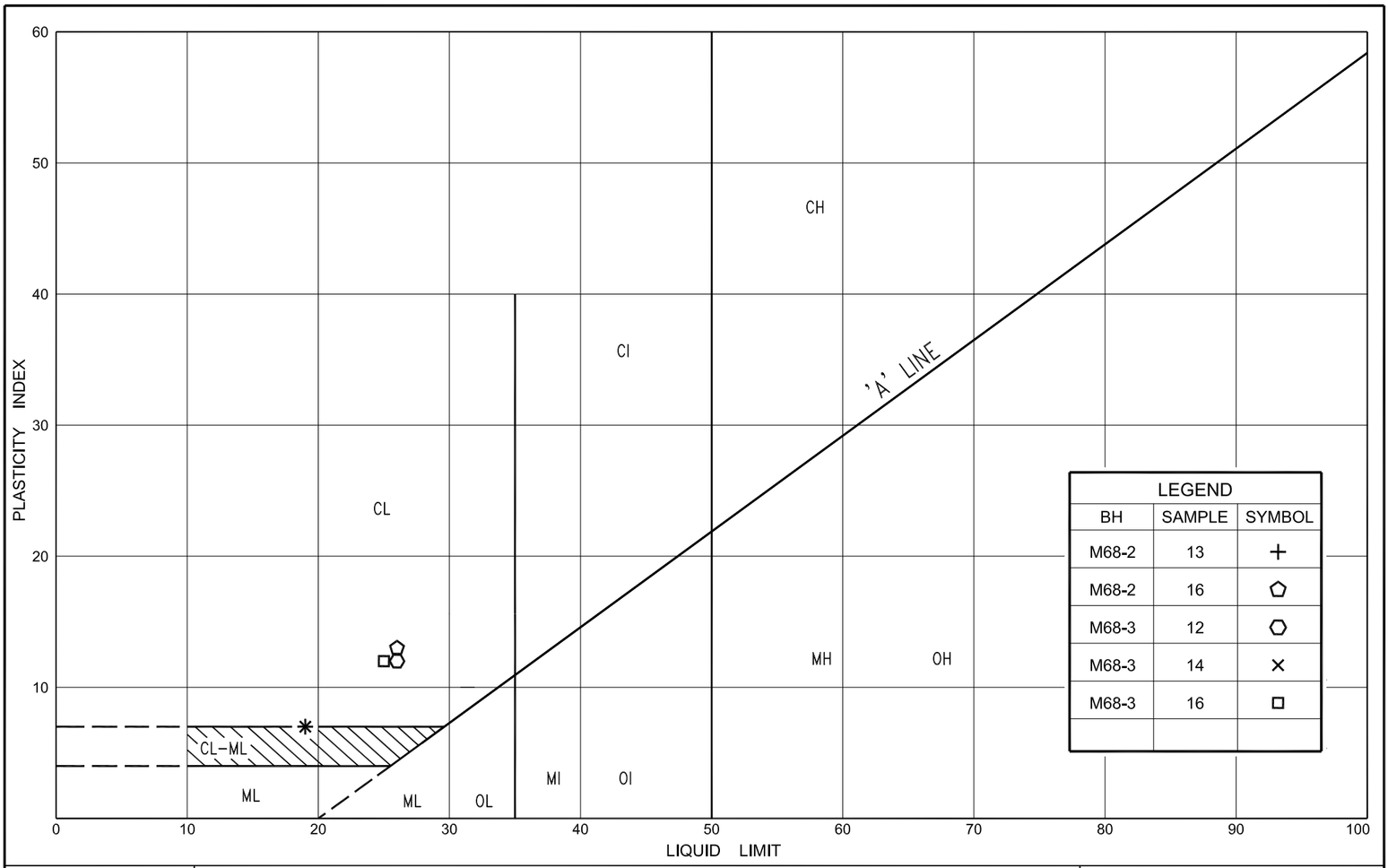


Ontario
Peto MacCallum Ltd.
CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

CLAYEY SILT, with sand, trace gravel
(TILL)

FIG No.	M67-GS-6
HWY:	407E
W.P. No.	07-20016

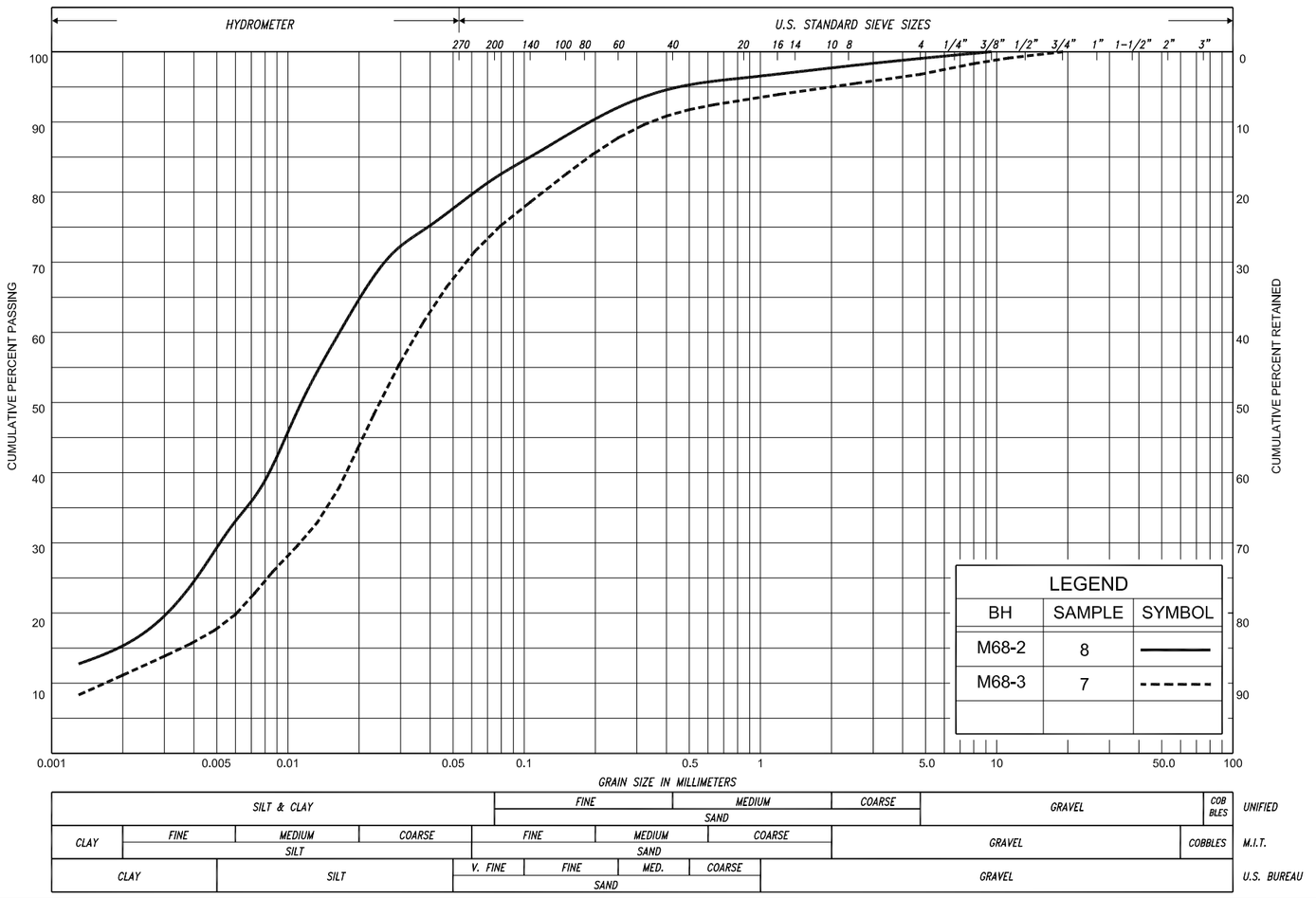


Ontario
Peto MacCallum Ltd.
CONSULTING ENGINEERS

PLASTICITY CHART

CLAYEY SILT, some to with sand, trace gravel
(TILL)

FIG No.	M68-PC-1
HWY:	407E
W.P. No.	07-20016



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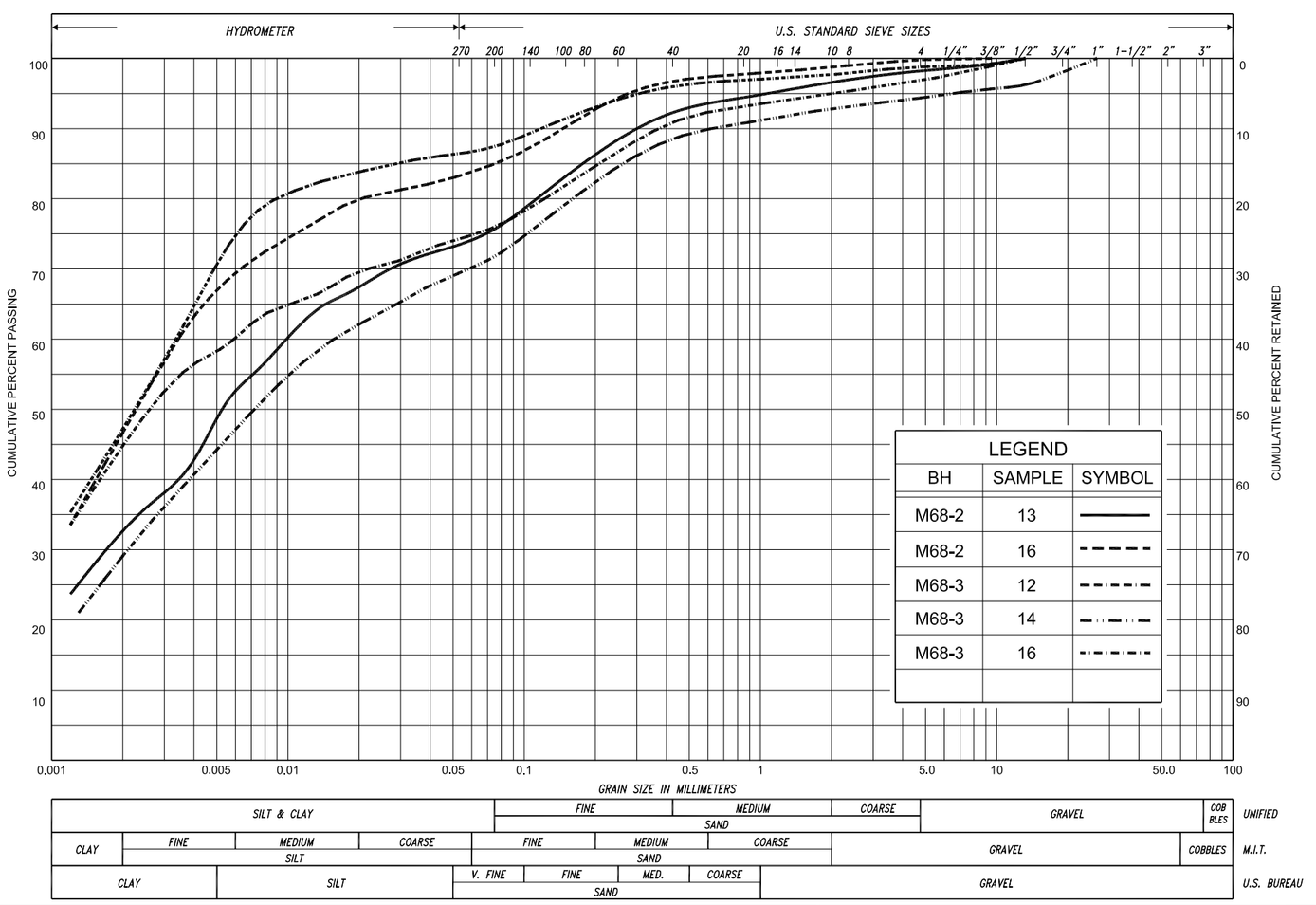
Peto MacCallum Ltd. CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SILT, some to with sand, some clay, trace gravel
(TILL)

FIG No.	M68-GS-1
HWY:	407E
W.P. No.	07-20016



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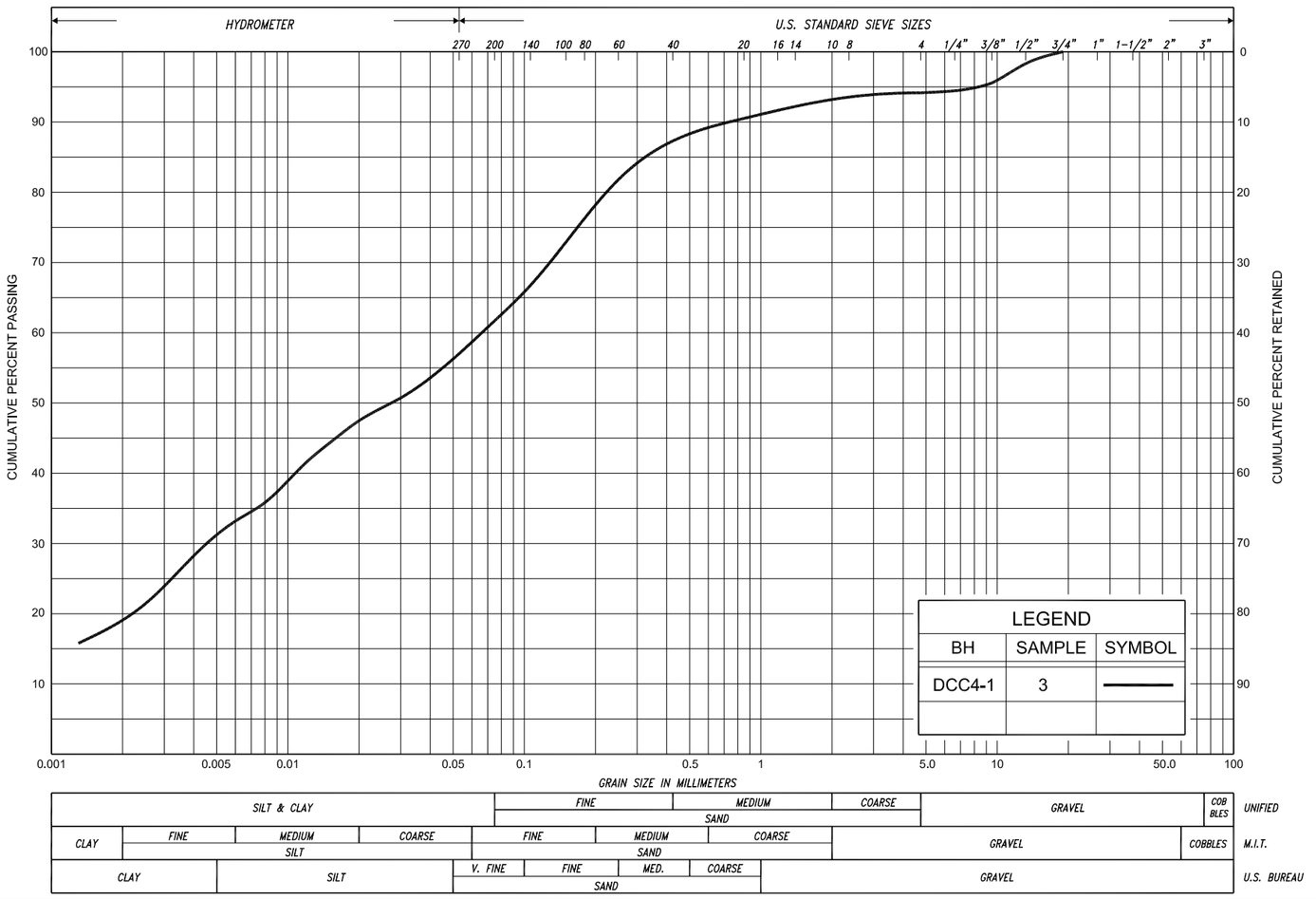
GRAIN SIZE DISTRIBUTION

SILT, trace to some clay, trace sand

FIG No.	M68-GS-2
HWY:	407E
W.P. No.	07-20016



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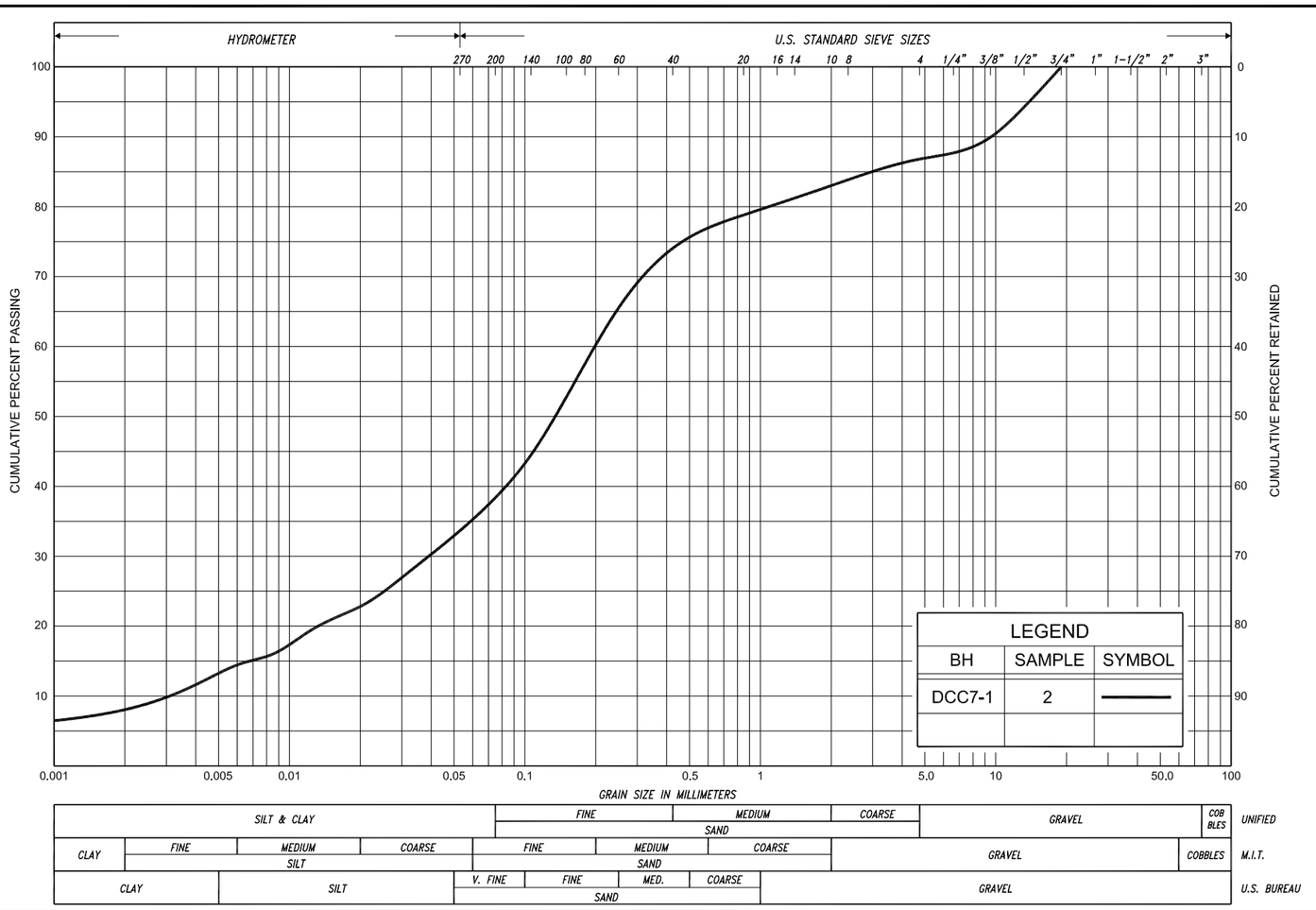
GRAIN SIZE DISTRIBUTION

CLAYEY SILT, sandy, trace gravel
(TILL)

FIG No.	DCC4-GS-1
HWY:	407E
W.P. No.	07-20016



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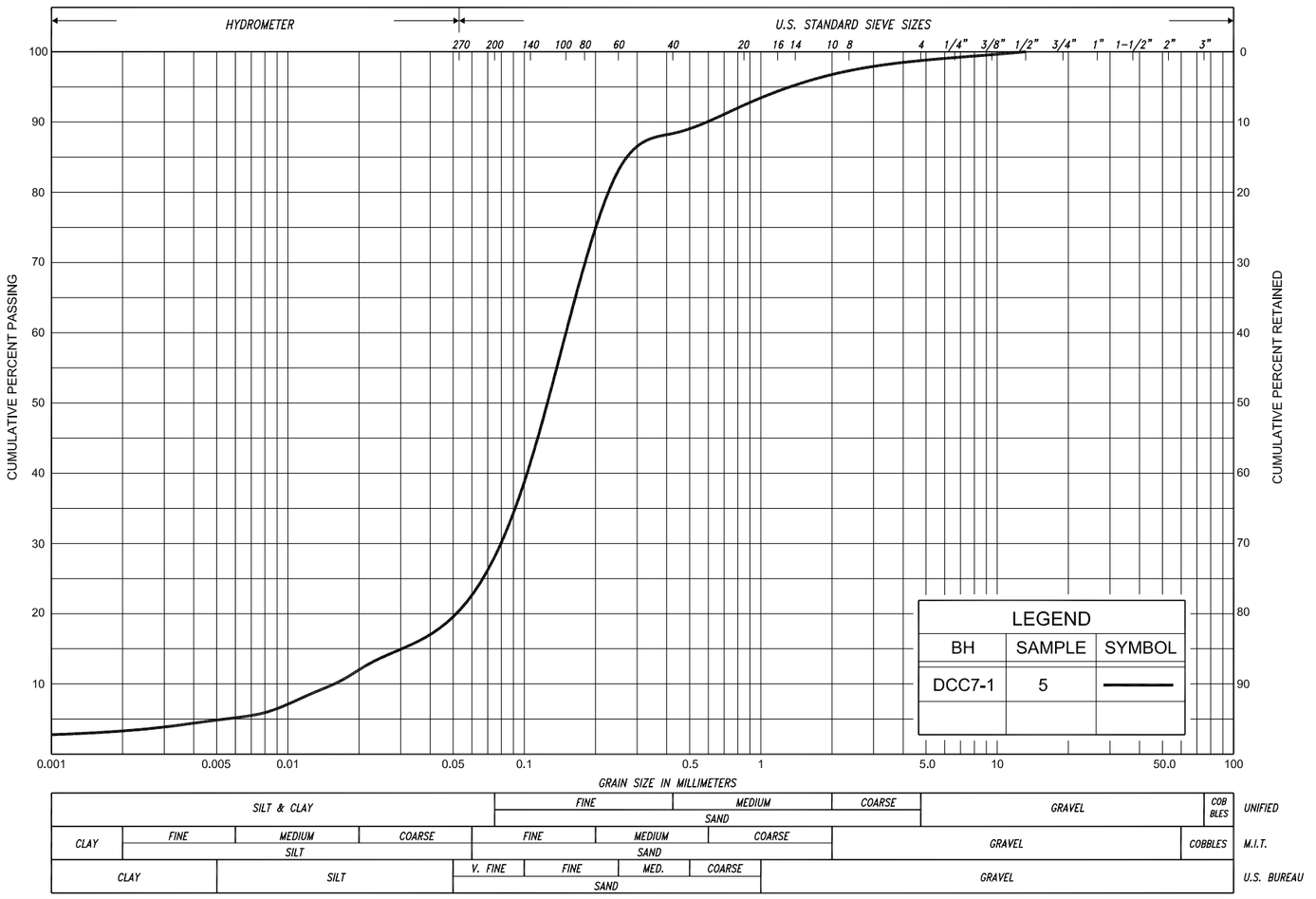
GRAIN SIZE DISTRIBUTION

SILTY SAND, some gravel, trace clay
(TILL)

FIG No.	DCC7-GS-1
HWY:	407E
W.P. No.	07-20016



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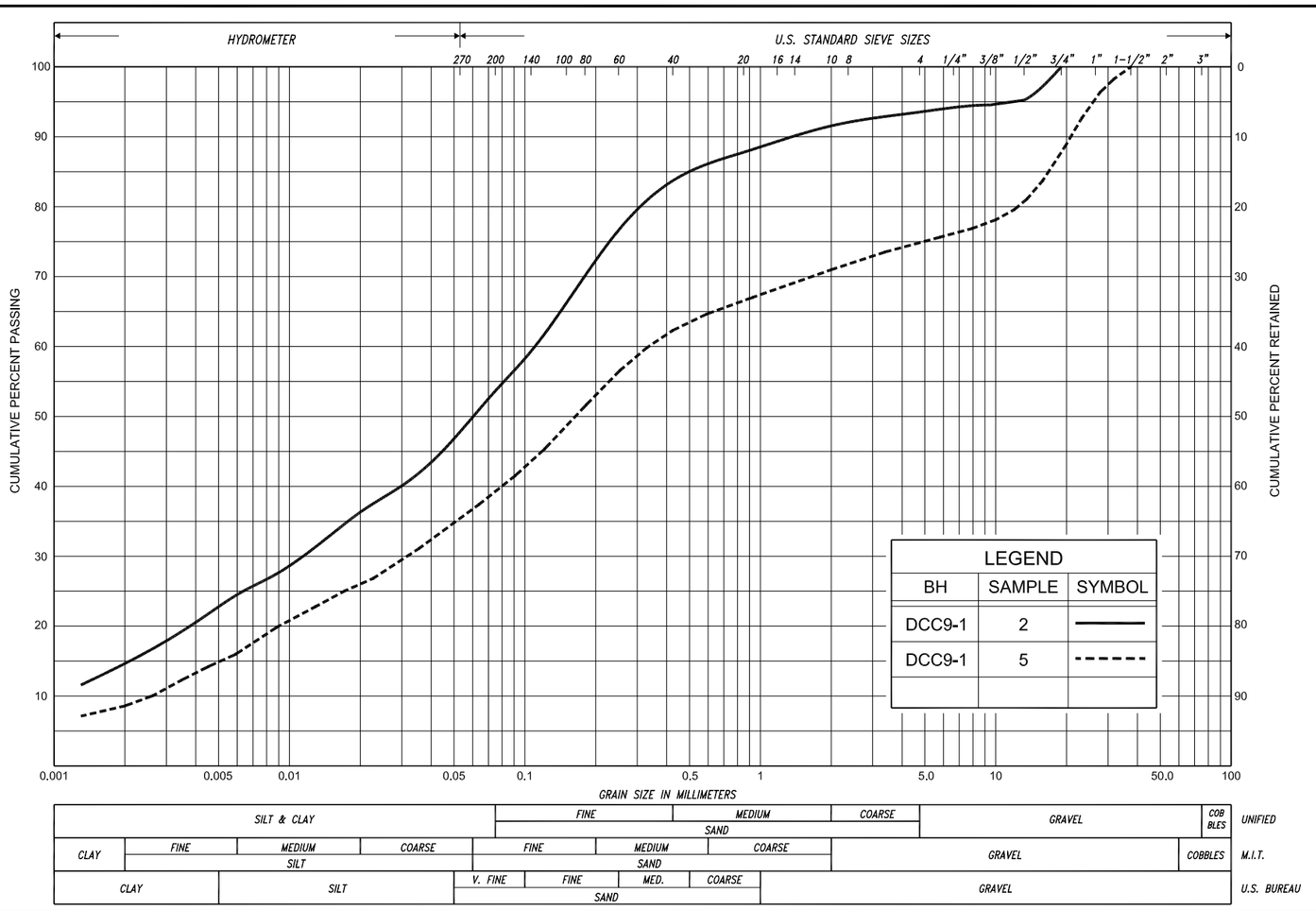
CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SAND, with silt, trace clay, trace gravel
(TILL)

FIG No.	DCC7-GS-2
HWY:	407E
W.P. No.	07-20016



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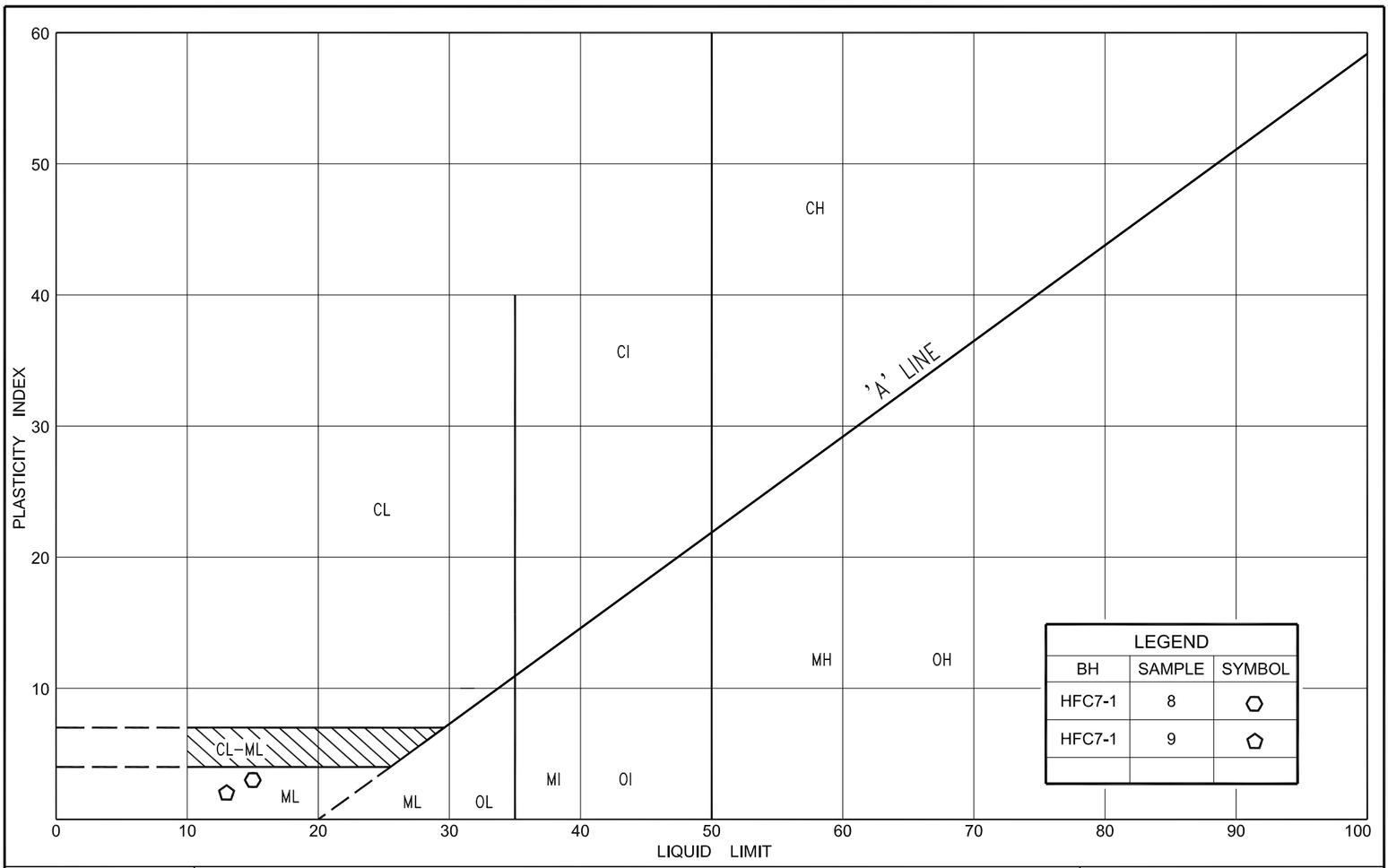
GRAIN SIZE DISTRIBUTION

SAND and SILT, trace to with gravel, trace to some clay
(TILL)

FIG No.	DCC9-GS-1
HWY:	407E
W.P. No.	07-20016



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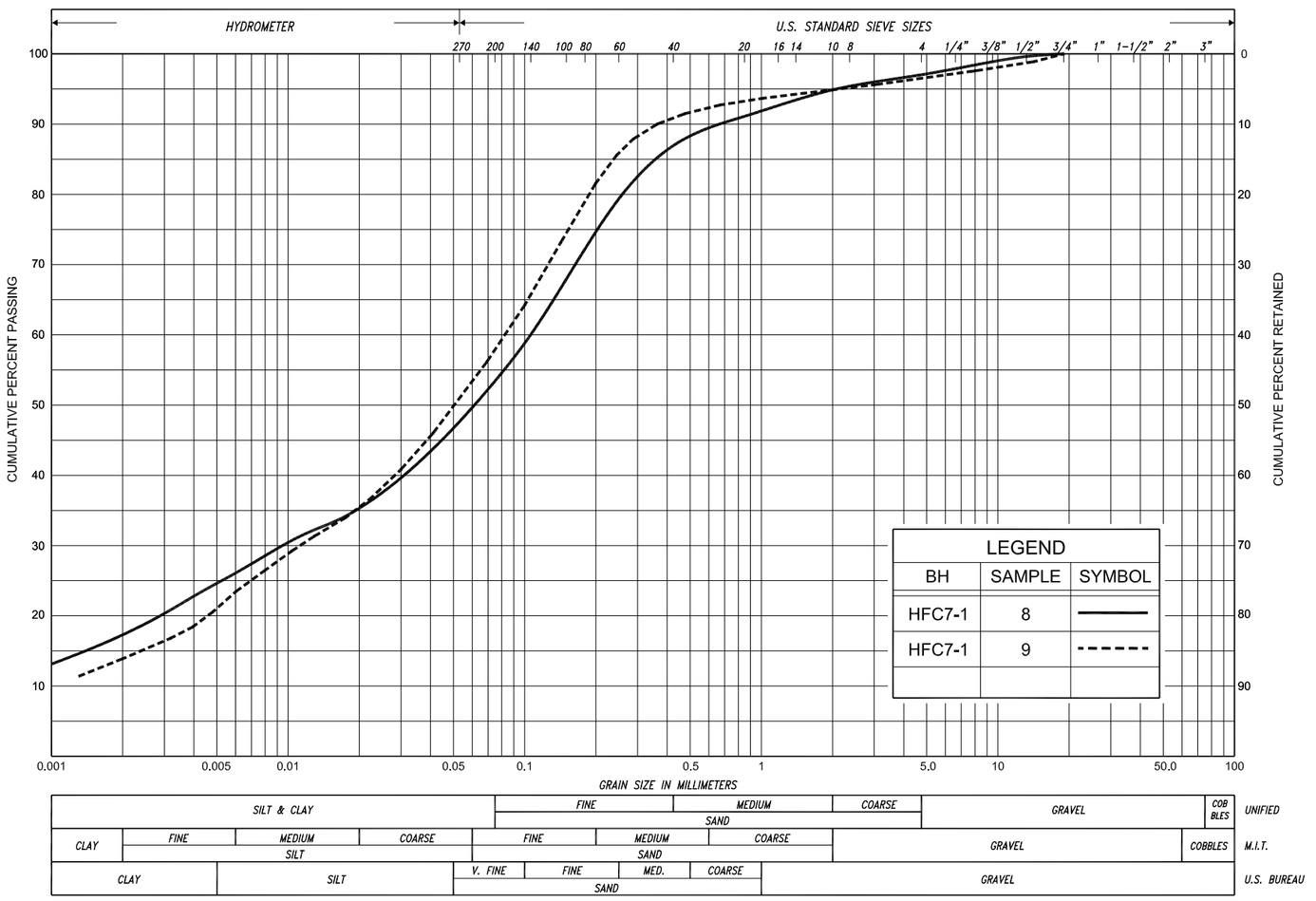
PLASTICITY CHART

SILTY SAND / SANDY SILT, some clay, trace gravel
(TILL)

FIG No.	HFC7-PC-1
HWY:	407E
W.P. No.	07-20016

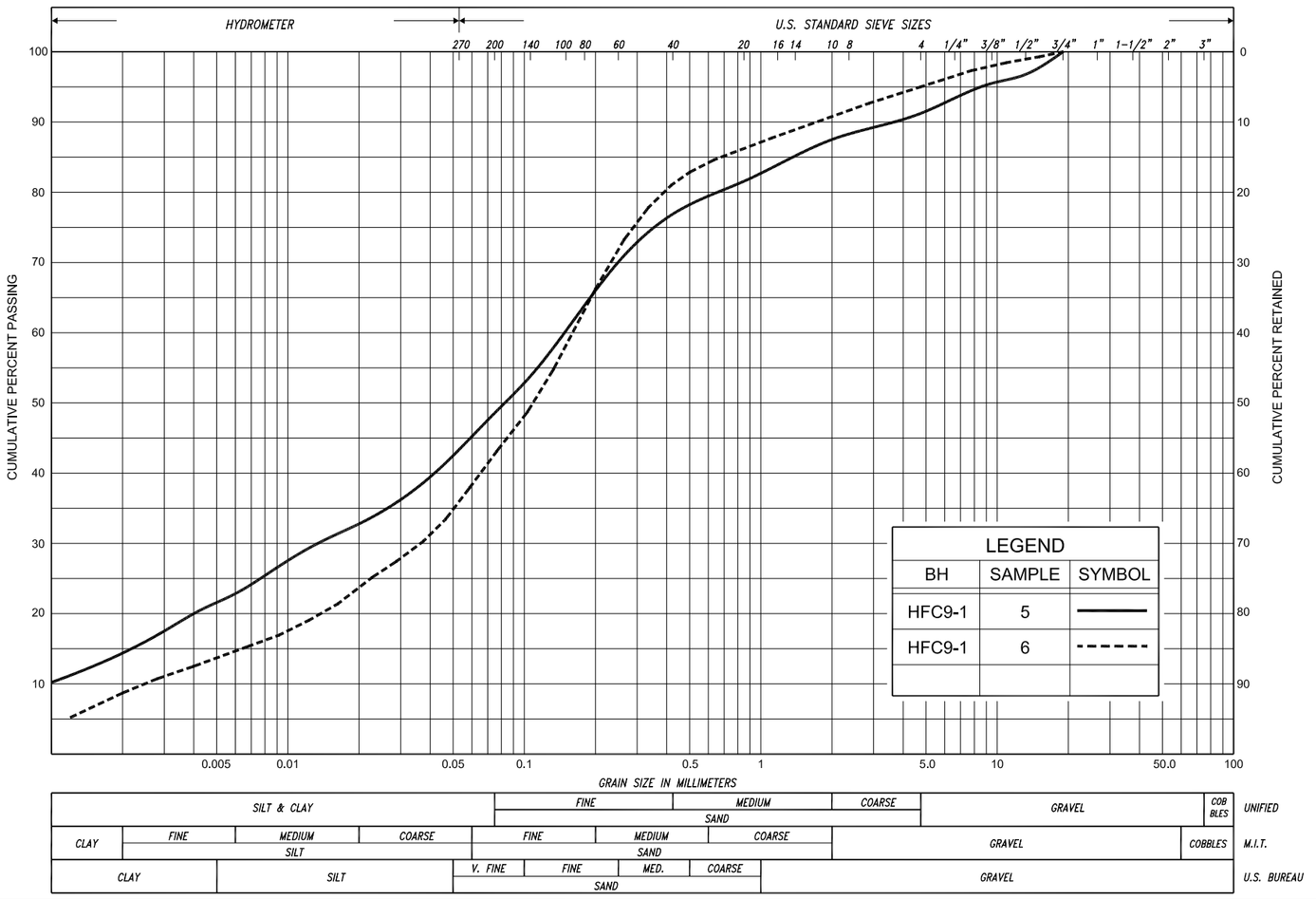


Ontario
Peto MacCallum Ltd. CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SILTY SAND / SANDY SILT, some clay, trace gravel
(TILL)

FIG No.	HFC7-GS-1
HWY:	407E
W.P. No.	07-20016



Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SILTY SAND, trace to some clay, trace gravel
(TILL)

FIG No.	HFC9-GS-1
HWY:	407E
W.P. No.	07-20016

APPENDIX C

RECORD OF BOREHOLE SHEETS FROM PREVIOUS INVESTIGATIONS

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM24-3 1 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 726.8 E 357 483.9 Townline Road | ORIGINATED BY ES
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.05.29 - 2008.05.29 | CHECKED BY MEF

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 + 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 (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
223.1											
0.0	**TOPSOIL:** (100mm)						223				
0.1	Clayey **SILT**, with sand, trace gravel, mixed with topsoil Stiff to Very Stiff Brown Moist (TILL)		1	AS							
			1	SS	10		222				
			2	SS	18		221				
			3	SS	24						5 28 45 22
220.1							220				
3.0	Sandy **SILT**, trace gravel, occasional cobble, occasional oxide staining Dense to Very Dense Brown Moist (TILL)		4	SS	41						
			5	SS	76		219				
	Augers grinding at 5.3 to 5.6m						218				
216.9	Augers grinding at 6.2 to 6.5m						217				
6.2	Silty **SAND**, some clay, trace gravel Very Dense to Dense Grey Moist (TILL)		6	SS	88						
			7	SS	74		216				6 47 28 19
			8	SS	36		215				
213.1							214				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity — (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM24-3 2 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 726.8 E 357 483.9 Townline Road | ORIGINATED BY ES
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.05.29 - 2008.05.29 | CHECKED BY MEF

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 + 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 (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
10.0	Clayey **SILT**, with sand, trace gravel Hard to Very Stiff Grey Moist (TILL)						213				
			9	SS	33		212				
			10	SS	27		211				2 37 39 22
210.0							210				
13.1	Silty **CLAY**, trace sand, trace to occasional gravel Hard to Very Stiff Grey Moist (TILL)		11	SS	34	▽	209				
			12	SS	24		208				0 7 33 60
							207				
206.0			13	SS	38		206				
17.1	Silty **SAND**, some clay, some gravel Dense to Very Dense Grey Moist (TILL)										
			14	SS	66		205				10 47 32 11
							204				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity — (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM24-3 3 OF 3 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 726.8 E 357 483.9 Townline Road ORIGINATED BY ES
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2008.05.29 - 2008.05.29 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page								
	Silty **SAND**, some clay, some gravel Dense Grey Moist (TILL)		15	SS	46		203		
201.8							202		
21.3 / 201.3	**SAND**, fine grained Compact Grey		16	SS	27				
21.8	Moist						201		
	SAND and **SILT**, trace gravel, trace clay Very Dense Grey Moist (TILL)		17	SS	100/ .075		200		
			18	SS	186		199		4 50 39 7
197.1			19	SS	100/ .100		198		
26.0	END OF BOREHOLE AT 26.0m. BOREHOLE OPEN AND WATER LEVEL AT 14.3m UPON COMPLETION. BOREHOLE SEALED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.								

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 (%) 20 40 60

ONTMT4S 0510.GPJ 12/1/08

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM24-4 1 OF 3 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 604.9 E 357 526.3 Townline Road ORIGINATED BY WB
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2008.05.28 - 2008.05.28 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
224.6									
0.0 / 224.1	**TOPSOIL**, trace clay, trace gravel Brown Moist		1	AS					
0.5	Clayey **SILT**, with sand, trace gravel Very Stiff to Hard Brown to Grey Moist (TILL)		1	SS	22		224		
			2	SS	29		223		
			3	SS	30		222		0 44 39 17
			4	SS	37		221		
			5	SS	26		220		
			6	SS	70		219		7 40 39 14
			7	SS	52		218		
			8	SS	50		217		3 41 36 20
							216		
							215		

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 (%) 20 40 60

Continued Next Page

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM24-4 2 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 604.9 E 357 526.3 Townline Road | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.05.28 - 2008.05.28 | CHECKED BY MEF

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 + 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 (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page														
	Clayey **SILT**, with sand, trace gravel Hard Grey Moist (TILL)														
			9	SS	35		214		○						
							213								
			10	SS	35		212		○						
211.5															
13.1	Silty **CLAY**, some sand, trace gravel Hard Grey Moist (TILL)														
			11	SS	49		211		○						
							210								
			12	SS	47		209		⊢●						2 24 34 40
208.4															
16.2	Clayey **SILT**, some sand, trace gravel Hard Grey Moist (TILL)														
			13	SS	75		208		○						
							207								
			14	SS	54		206		○						
205.4															
19.2	Silty **SAND**, some clay, trace gravel Very Dense Grey Moist (TILL)						205								

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM24-4 3 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 604.9 E 357 526.3 Townline Road | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.05.28 - 2008.05.28 | CHECKED BY MEF

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 + 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 (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page														
	Silty **SAND**, some clay, trace gravel Very Dense Grey Moist (TILL)		15	SS	52/ .150		204								2 54 33 11
			16	SS	100/ .075		203								
201.6							202								
23.0	END OF BOREHOLE AT 23.0m. WATER LEVEL AT 12.8m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen.		17	SS	100/ .100										

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
2008.06.26	10.9	213.7
2008.06.26	decomissioned	

+³, ×³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 12/1/08

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM27-1 1 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 863.8 E 359 069.1 Langmaid Drive | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY SLL
DATUM Geodetic | DATE 2008.04.02 - 2009.04.07 | CHECKED BY MEF

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 + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
208.9											
0.0	**SAND**, fine grained, trace gravel and organics Compact Dark Brown Moist to Wet (FILL)		1	GS							
208.2 0.7	Silty **SAND**, trace gravel, occasional cobble and boulder Compact to Very Dense Brown to Grey Moist to Wet (TILL)		2	SS	14		208	○			
			3	SS	28		207	○			
			4	SS	25			○			3 49 34 14
	Some Clay		5	SS	31		206	○			
			6	SS	46		205	○			
			7	SS	34		204	○			
	Some gravel and clay						203	○			
			8	SS	35		202	○			14 46 27 13
							201	○			
			9	SS	22		200	○			
							199				

Continued Next Page

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM27-1 2 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 863.8 E 359 069.1 Langmaid Drive | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY SLL
DATUM Geodetic | DATE 2008.04.02 - 2009.04.07 | CHECKED BY MEF

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 + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **SAND**, trace gravel Very Dense Brown to Grey Moist to Wet (TILL)		10	SS	100/ .275		198	○			
	Some clay, trace of gravel		11	SS	100/ .225		197	○			6 49 31 14
			12	SS	100/ .175		196				
			13	SS	100/ .150		195	○			
			14	SS	100/ .150		194	○			
							193				
							192	○			
			15	SS	19		191	○			
							190				
							189				

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM27-1 3 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 863.8 E 359 069.1 Langmaid Drive | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY SLL
DATUM Geodetic | DATE 2008.04.02 - 2009.04.07 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100; 40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										4 45 32 19
	Silty **SAND**, some clay, trace gravel Very Dense Brown to Grey Moist to Wet (TILL)		16	SS	100/ .175		188				
			17	SS	100/ .075		187				
185.9			18	SS	100/ .100		186				
23.0	END OF BOREHOLE AT 23.0m. WATER LEVEL AT 4.6m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.04.08 4.6 204.3 2009.04.30 10.6 198.3										

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

$\oplus$ (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 7/23/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM27-2 1 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 780.3 E 359 106.1 Langmaid Drive | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2009.03.31 - 2009.04.02 | CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100; 40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
208.9											
0.0	**SAND**, fine grained, trace gravel and organics Compact Dark Brown Moist to Wet (FILL)		1	SS							
208.3											
0.6	Silty **SAND**, some clay, trace gravel, occasional cobble and boulder Dense to Very Dense Brown Moist to Wet (TILL)		2	SS	33		208				
			3	SS			207				
			4	SS	32		206				
			5	SS	54		205				2 48 36 14
			6	SS	60		204				
			7	SS	42		203				
			8	SS	89		202				
			9	SS	100/ 250		201				5 55 29 10
							200				
							199				

Continued Next Page

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

$\oplus$ (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 7/23/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM27-2 2 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 780.3 E 359 106.1 Langmaid Drive | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2009.03.31 - 2009.04.02 | CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **SAND**, some clay, trace gravel, occasional cobble obstacle Very Dense Brown Moist to Wet (TILL)										
			10	SS	75		198				
			11	SS	100/ .150		197				
			12	SS	100/ .150		196				
194.3							195				
14.6	**SAND**, some silt and clay, trace gravel Compact Brown Moist						194				
193.2			13	SS	29						4 80 16 (SI+CL)
15.7	Sandy **SILT**, some clay, trace gravel Very Dense Brown to Greyish Brown Moist (TILL)						193				
			14	SS	100/ .075		192				
191.2											
17.7	Clayey **SILT**, sandy Hard Brown (TILL)						191				
			15	SS	100/ .075		190				1 18 66 15
189.7											
19.2	**SILT**, some sand, some clay, trace gravel Dense Brown Moist to Wet						189				

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+ 3 , × 3 : Numbers refer to Sensitivity (20 / 15 ⊕ 5 / 10) (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM27-2 3 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 780.3 E 359 106.1 Langmaid Drive | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2009.03.31 - 2009.04.02 | CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILT, some sand, some clay, trace gravel Dense Brown Moist to Wet		16	SS	47						
187.9											
21.0	**SILT** and **SAND**, trace clay, trace gravel, clayey silt layers Very Dense Greyish Brown Moist to Wet (TILL)		17	SS	100/ .100		188				
			18	SS	100/ .075		187				1 41 50 8
			19	SS	100/ .050		186				
184.5							185				
24.4	END OF BOREHOLE AT 24.4m. BOREHOLE OPEN AND WATER LEVEL AT 4.5m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.										

ONTMT4S 0510.GPJ 7/23/09

+ 3 , × 3 : Numbers refer to Sensitivity (20 / 15 ⊕ 5 / 10) (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM28-1 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 682.7 E 359 283.6 Conc. 6 Road | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY SLL
DATUM Geodetic | DATE 2009.04.13 - 2009.04.13 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
211.7											
0.0	**SAND** and **GRAVEL**, trace organics material Brown Moist (FILL)		1	GS							
211.0							211				
0.7	Silty **SAND**, some clay, occasional cobbles and boulders Dense to Very Dense Brown to Grey Moist (TILL)		2	SS	38						
			3	SS	58		210				
			4	SS	45		209				0 54 33 13
			5	SS	100/ .250						
							208				
			6	SS	100/ .300		207				
							206				
205.9											
5.8	Silty **CLAY**, with sand, trace gravel Hard Grey (TILL)(CL)		7	SS	100/ .225		205				4 52 28 16
			8	SS	100/ .150		204				
							203				
			9	SS	100/ .150		202				
201.8											

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+ ^{3}, × ^{3}: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 7/27/09

Ministry of Transportation
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THURBER

RECORD OF BOREHOLE No CM28-1 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 682.7 E 359 283.6 Conc. 6 Road | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY SLL
DATUM Geodetic | DATE 2009.04.13 - 2009.04.13 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
9.9	Sandy **SILT**, some clay, trace gravel Very Dense Grey Moist (TILL)		10	SS	100/ .200		201				
			11	SS	100/ .150		200				5 34 44 17
							199				
			12	SS	100/ .125		198				
							197				
196.4											
15.3	END OF BOREHOLE AT 15.3m. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen.		13	SS	100/ .050						

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
2009.04.13	2.4	209.3
2009.04.30	3.7	208.0
2009.07.21	2.7	209.0

+ ^{3}, × ^{3}: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 7/21/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM28-2 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 708.4 E 359 390.0 Conc. 6 Road | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY SLL
DATUM Geodetic | DATE 2009.04.09 - 2009.04.09 | CHECKED BY MEF

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 (40 80 120 160 200) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
211.3											
0.0	**ASPHALT**, (75mm)										
0.1	**SAND**, some gravel, trace rootlets Compact Brown		1	GS			211				
210.6	Moist										
0.7	(FILL)										
	Clayey **SILT**, trace to some sand, trace gravel, trace rootlets, topsoil stained Very Stiff to Hard Brown		2	SS	15				o		
			3	SS	35		210		o		
209.1											
2.2	Silty **SAND**, some clay, trace gravel, with silty sand seams Dense to Very Dense Brown to Grey Moist to Wet (TILL)		4	SS	100/ .200		209		o		
			5	SS	49		208		o		5 50 27 18
			6	SS	60	▽	207		o		
			7	SS	40		206		o		
			8	SS	100/ .200		205		o		5 57 27 11
	with silty clay pockets						204				
			9	SS	100/ .100		203		o		
201.4							202				

Continued Next Page

+ 3 , × 3 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 7/21/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM28-2 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 708.4 E 359 390.0 Conc. 6 Road | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY SLL
DATUM Geodetic | DATE 2009.04.09 - 2009.04.09 | CHECKED BY MEF

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 (40 80 120 160 200) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
9.9	**SAND** and **SILT**, trace gravel and clay Very Dense Grey Wet (TILL)		10	SS	100/ .150		201		o		3 50 42 5
			11	SS	100/ .075		200		o		
			12	SS	100/ .050		199				
							198				
196.4							197				
14.9	Clayey **SILT**, some sand, trace gravel Hard Grey (TILL)		13	SS	100/ .050				o		
196.0											
15.3	END OF BOREHOLE AT 15.3m. BOREHOLE OPEN AND WATER LEVEL AT 5.2m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.15m AND COLD PATCH ASPHALT TO SURFACE.										

+ 3 , × 3 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 7/21/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM29d-1 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 979.3 E 359 905.2 Enfield Road | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2009.03.20 - 2009.03.20 | CHECKED BY LT

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 (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
198.6											
0.0	**SAND**, fine grained, trace gravel Compact Brown Moist to Wet (FILL)		1	AS			198				
197.2			2	SS	29						
1.4	Sandy **SILT**, trace gravel, trace wood fibers and organics Compact Dark Greyish Wet (FILL)		3	SS	16		197				
196.5											
2.1	Silty **SAND**, some clay, some gravel Dense to Compact Greyish Brown Saturated		4	SS	33		196				
			5	SS	19		195				20 44 23 13
194.3											
4.3	Silty **CLAY**, trace to some sand, trace gravel Firm to Very Stiff Greyish Brown (CL)		6	SS	14		194				
			7	SS	15		193				0 3 54 43
							192				
			8	SS	19		191				
							190				
			9	SS	23		189				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity — (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 8/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM29d-1 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 979.3 E 359 905.2 Enfield Road | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2009.03.20 - 2009.03.20 | CHECKED BY LT

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 (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
188.2											
10.4	Silty **CLAY**, trace to some sand, trace gravel Firm to Very Stiff Brown (CL)						188				
	SILT, some sand, some clay, with silty clay layers Compact to Loose Greyish Brown Saturated		10	SS	12		187				
185.3											
13.3	Sandy **SILT**, trace gravel, occasional cobble Very Dense Greyish Brown Saturated (TILL)		11	SS	4		186				0 11 68 21
			12	SS	100		185				
184.0											
14.6	Silty **CLAY**, sandy, trace gravel Very Stiff Greyish Brown (TILL)						184				
			13	SS	23		183				2 29 33 36
182.8											
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE BACKFILLED WITH BENTONITE AND CUTTINGS TO SURFACE.										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity — (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 8/14/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM29d-2 1 OF 3 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 869 965.2 E 359 898.5 Enfield Road ORIGINATED BY LH
HWY 407 BOREHOLE TYPE Solid Stem Augers & Wash Boring COMPILED BY SN
DATUM Geodetic DATE 2009.03.25 - 2009.03.27 CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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
198.3								20 40 60 80 100 / 40 80 120 160 200	20 40 60		
0.0	**SAND**, trace gravel Loose to Compact Dark Brown Moist to Wet (FILL)		1	SS	8		198				
	Mixed with clayey silt layers, trace organics		2	SS	18		197				
196.0			3	SS	12		196				
2.3	Silty **SAND**, some gravel, trace clay Compact to Dense Brown Wet to Saturated		4	SS	20						
194.0			5	SS	31		195				10 48 37 5
4.3	Silty **CLAY**, some sand, trace gravel Stiff to Very Stiff Greyish Brown (CL)		6	SS	24		194				
	Sand seams, fissures filled with sand and gravel		7	SS	14		192				
			8	SS	19		191				1 11 40 48
	Gravelly sand layers Silt seams		9	SS	25		189				

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

ONTMT4S 0510.GPJ 8/17/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM29d-2 2 OF 3 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 869 965.2 E 359 898.5 Enfield Road ORIGINATED BY LH
HWY 407 BOREHOLE TYPE Solid Stem Augers & Wash Boring COMPILED BY SN
DATUM Geodetic DATE 2009.03.25 - 2009.03.27 CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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
	Continued From Previous Page							20 40 60 80 100 / 40 80 120 160 200	20 40 60		
187.9	Silty **CLAY**, trace sand, trace gravel Stiff to Very Stiff Greyish Brown (CL)						188				
10.4	Sandy **SILT**, some clay, trace gravel Compact to Dense Greyish Brown Saturated		10	SS	15		187				
185.2			11	SS	43		186				1 26 56 17
13.1	Sandy **SILT**, trace gravel, occasional cobble Very Dense Greyish Brown Saturated (TILL)		12	SS	70		185				
183.7							184				
14.6	Silty **CLAY**, sandy, trace gravel Hard to Stiff Greyish Brown (TILL)(CL)		13	SS	55		183				
			14	SS	28		182				6 34 31 29
			15	SS	27		180				
							179				

Continued Next Page

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

ONTMT4S 0510.GPJ 8/14/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM29d-2 3 OF 3 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 869 965.2 E 359 898.5 Enfield Road ORIGINATED BY LH

HWY 407 BOREHOLE TYPE Solid Stem Augers & Wash Boring COMPILED BY SN

DATUM Geodetic DATE 2009.03.25 - 2009.03.27 CHECKED BY LT

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 (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty CLAY, sandy, trace gravel Stiff to Very Stiff Greyish Brown (TILL)(CL)		16	SS	14		178		o		
							177				
			17	SS	20				o		
175.4							176				
22.9	Silty CLAY, trace to some sand Very Stiff to Stiff Grey		18	SS	18		175		o		
	with silty sand seams		19	SS	13		174		o		
173.3											
25.0	ARTESIAN CONDITION ENCOUNTERED AFTER EXTENDING CASING TO 25.9m. AFTER 45min, WATER IN CASING AT 0.74m ABOVE GROUND SURFACE. ARTESIAN CONDITION SEALED AND BOREHOLE BACKFILLED TO SURFACE WITH BENTONITE USING REVERSE AUGER ROTATION.										

+ ³ , × ³ : Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 8/14/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CCM-03 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 442.0 E 356 038.8 | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.12.18 - 2008.12.18 | CHECKED BY MEF

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 + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
237.1											
0.0	**TOPSOIL**, mixed with clay Very Soft Brown		1	SS	2		237				
236.5											
0.6	Silty **CLAY**, sandy, trace gravel, occasional sandy silt inclusions, occasional cobbles or boulders Very Stiff to Hard Brown (TILL)(CL)		2	SS	24		236				
			3	SS	49		235				7 39 31 23
			4	SS	100		234				
			5	SS	100/ 0.275	▼					5 29 30 36
233.0							233				
4.1	**SAND** and **SILT**, some clay, trace gravel, occasional silty sand inclusions Very dense Greyish Brown Damp (TILL)		6	SS	100/ 0.200		232				
			7	SS	100/ 0.125		231				
							230				
			8	SS	100/ 0.150		229				6 46 30 18
			9	SS	100/ 0.100		228				

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+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CCM-03 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 442.0 E 356 038.8 | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.12.18 - 2008.12.18 | CHECKED BY MEF

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 + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND and **SILT**, some clay, trace gravel, occasional silty sand layers Very dense Greyish Brown Damp (TILL)		10	SS	100/ 0.100		227				
224.8							226				
12.3	END OF BOREHOLE AT 12.3m. Piezometer installation consists of 25mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.02.10 3.4 233.7		11	SS	100/ 0.100		225				

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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