January 2014

FOUNDATION INVESTIGATION AND DESIGN REPORT

CPR Structural Replacement, Site 30-080
Highway 11, Orillia, Ontario
GWP 2177-10-00

Submitted to:
Mr. Philip Loh, P.Eng.
Facca Inc.
2097 County Road 31
Lakeshore, Ontario
N0R 1R0

REPORT

Report Number: 13-1132-0078-1000-R02

Distribution:

4 Copies - Facca Inc.

2 Copies - Golder Associates Ltd.

Golder Associates

Table of Contents

PART A

FOUNDATION INVESTIGATION REPORT

CPR STRUCTURAL REPLACEMENT, SITE 30-080
HIGHWAY 11, ORILLIA, ONTARIO
GWP 2177-10-00

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Facca Inc. (Facca) to provide foundation engineering services for the replacement of the existing CPR structure (Site 30-080) on Highway 11 just north of the City of Orillia in the Township of Severn, Ontario as illustrated on the Key Plan, Figure 1.

This report presents the results of our current, limited investigation and the results of the previous subsurface investigations carried out at the site.

2.0 SOURCES OF INFORMATION

The following sources of information were reviewed during the preparation of this report and incorporated into the report, as appropriate:

- ""Foundation Investigation Report, CPR Overhead, Site 30-080, Replacement of Highway 11 CPR and Removal of Highway 11 CNR Structure in the Township of Severn, District: Toronto, Ontario, GWP No. 2177-10-00, Contract No. DB-2013-2019", Geocres No. 31D-558, dated May 1, 2013.
- "Geocres Report, Foundation Investigation for CPR Overhead Widening, Geocres No. 31D-254, January 1978.

3.0 SITE DESCRIPTION

3.1 General

The existing CPR Overhead Bridge (Site 30-080) is located approximately 900 metres south of Penley Road on Highway 11 just north of the City of Orillia in the Township of Severn, Ontario. The former CPR tracks were oriented generally in a northwest-southeast direction and were originally constructed in a cut approximately 9 metres deep with side slopes ranging from about 1.75 to 2.0 horizontal to 1 vertical. Currently, the railway has been decommissioned, the tracks removed, and the corridor is now a recreational trail. In general, the ground surface in the area ranges from about elevation 227 metres along the abandoned track/recreational trail to elevation 235.5 metres at the Highway 11 pavement surface. The slopes of the railway cut and the immediately adjacent terrain are grass covered and stands of trees and shrubs are present throughout the upper/higher ground.

3.2 Project Description

The work for this project will include the removal of the existing bridge structure, the installation of a box culvert for trail access, filling of the space between the new culvert and existing embankments and reinstatement of the highway in lieu of the existing bridge. It is understood that the length of the box culvert at Site 30-080 will be about 53 metres and its minimum interior width and height are to be 5 metres and 4.7 metres, respectively. Retained soil system (RSS) retaining walls will be constructed as wing walls for the new culvert.

4.0 INVESTIGATION PROCEDURES

4.1 Current Investigation

A limited supplementary subsurface investigation program was carried out to explore the subsurface conditions at locations other than those identified in the previous investigation report provided as part of the RFP. The investigation program consisted of four test pits excavated at the retaining walls and five test pits excavated in the area under the existing structure.

The test pits were excavated on September 17, 2013 using a rubber-tire backhoe supplied and operated by a local contractor. The subsurface conditions encountered in the test pits are summarized in Appendix A. Representative bulk samples of the major soil strata encountered were obtained, placed in sealed, labelled containers and brought to our laboratory for further examination. Groundwater conditions were observed during excavation of the test pits and these observations are also included in Appendix A.

The locations of the test pits were determined in the field by a member of our engineering staff and the ground surface elevations at the test pit locations were estimated based on the recent topographic survey of the site. The approximate locations of the test pits and the ground surface elevations at the test pit locations are summarized below. The approximate locations of the test pits are also shown on Drawing 1.

Test Pit	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Depth (m)
201	4945992.0	311362.5	227.0	1.9
202	4945972.5	311390.0	229.5	3.7
203	4945957.5	311405.5	226.5	2.5
204	4945941.0	3110398.5	227.0	1.4
205	4945968.5	311375.5	227.5	2.2
206	4945978.0	311364.5	228.0	2.5
207a	4945973.5	311383.0	229.0	2.0
207b	4945970.5	311382.0	227.5	2.0
208	4945963.0	311381.0	228.5	2.9

4.2 Previous Investigation by MTO

The results of the previous investigation carried out on behalf of the Ministry of Transportation were provided in the report entitled ""Foundation Investigation Report, CPR Overhead, Site 30-080, Replacement of Highway 11 CPR and Removal of Highway 11 CNR Structure in the Township of Severn, District: Toronto, Ontario, GWP No.

2177-10-00, Contract No. DB-2013-2019", Geocres No. 31D-558, dated May 1, 2013." and consisted of two boreholes (designated CPR-101, CPR-102) and Geocres No. 31D-254 two boreholes (1 (31D-254) and 2 (31D-254)) advanced in the vicinity of the bridge at the approximate locations shown on Drawing 1. The boreholes were advanced using continuous flight solid stem augers. Soil samples were collected using standard penetration test procedures. The Records of Boreholes and laboratory test data are provided in Appendix B. Groundwater conditions were observed in the open boreholes during and immediately following the drilling operations.

The locations of the boreholes were surveyed by others. The geodetic elevations of boreholes 1 (31D-254) and 2 (31D-254) were recorded in imperial units at the time of the previous investigation and converted to metric units for this report. The previous investigation boreholes are summarized below.

Borehole	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)
CPR-101	4945953.5	311401.0	226.4	10.8
CPR-102	4945989.0	311360.5	227.3	6.4
1 (31D-254)	4945903.5	311375.0	235.6	19.3
2 (31D-254)	4946002.0	311374.5	235.7	14.0

5.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

5.1 Regional Geology

The site is located within the Simcoe Lowlands physiographic region as described in The Physiography of Southern Ontario (Chapman and Putnam, 1984)[1]. The predominant overburden stratum consists of glaciolacustrine plain deposits comprised of sand, silt and clay. Limestone of the Simcoe Group, Bobcaygeon Formation typically underlies the overburden deposits.

The subsurface conditions encountered at the site are generally consistent with the reported regional geology.

5.2 Subsurface Conditions

The locations of the test pits and boreholes from the field investigations and ground surface elevations are shown on Drawing 1 and the profile on interpreted stratigraphic conditions contained in Appendix B. The detailed subsurface soil and groundwater conditions encountered in the test pits and boreholes and the results of in situ and laboratory testing are given on Table I in Appendix A and the Record of Borehole sheets contained in Appendix B. The stratigraphic boundaries shown on the borehole records and the interpreted stratigraphic sections are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions may vary between and beyond the borehole locations. Further, post-investigation construction work after the earliest boreholes (1 and 2) in 1977 and the like may have modified the subsurface conditions in some locations.

In general, the subsurface conditions encountered at the site consisted of topsoil and fill underlain by a deposit of clayey silt till, silt to clayey silt, sand and silty sand to sandy silt glacial till. At the Highway 11 approach embankment locations, asphalt is present at the road surface and is underlain by granular embankment fill, which in turn is underlain by a deposit of silt to clayey silt.

5.2.1 Pavement Structure

The pavement structure at boreholes 1 (31D-254) and 2 (31D-254) were noted to be 1.3 to 2.0 metres thick. There was no differentiation between asphalt and pavement granular base and subbase materials identified in the previous Record of Borehole Sheets. The pavement granular base and subbase materials had N[2] values, as determined in the standard penetration testing, of 13 to 44 blows per 0.3 metres.

[1] Chapman, L.J and Putnam, D.F., 1984. The Physiography of Southern Ontario, Ontario Geological Society, Special Volume 2, Third Edition. Accompanied by Map p. 2715, Scale 1:600,000.

[2] The SPT N value is defined as the number of blows required by a 63.5 kilogram hammer dropped from a height of 760 millimetres to drive a split spoon sampler a distance of 300 millimetres into the soil after having first penetrated 150 millimetres.

5.2.2 Topsoil

Layers of surficial topsoil 200 to 600 millimetres thick were encountered at the ground surface in test pits 201, 203 and 204. In test pit 208, the surficial sand fill was found to contain pockets of topsoil. Materials designated as topsoil in this report were classified solely based on visual and textural evidence. Testing of organic content or for other nutrients was not carried out. Therefore, the use of materials classified as topsoil cannot be relied upon for support and growth of landscaping vegetation.

5.2.3 Fill

Granular fill was encountered at the ground surface in boreholes CPR-101 and CPR-102. The granular fill was 1.4 and 0.9 metres thick, respectively. The granular fill had measured N values of 9 to 16 blows per 0.3 metres and water contents of 6 to 30 per cent.

Cohesive fill was encountered beneath the Highway 11 pavement structure in boreholes 1 (31D-254) and 2 (31D-254). The cohesive fill generally consisted of clayey silt with sand and contained some organics and boulders. The cohesive fill ranged from 4.8 to 6.6 metres thick. The fill had N values of 4 to greater than 100 blows per 0.3 metres. The cohesive fill had water contents of 4 to 15 per cent. Atterberg limits determination for a sample of the cohesive fill indicated a plastic limit of 11 per cent, liquid limit of 18 per cent and plasticity index of 7 per cent.

Layers of granular fill were encountered at the ground surface in test pits 202 and 206 to 208 and beneath the surficial topsoil in test pit 201. The granular fill generally consisted of sand, sand and gravel and silty sand with cobbles. Pieces of rebar and concrete were encountered in test pit 207a. The fill layers were about 0.6 to 1.3 metres thick at the test pit locations.

Layers of cohesive fill were encountered at the ground surface in test pit 205 and beneath the granular fill in test pits 206 to 208. Test pit 207a was terminated in the cohesive fill at a depth of 2.0 metres due to refusal on a concrete footing. Where fully penetrated, the cohesive fill ranged in thickness from 0.3 to 1.0 metres.

During the previous borehole investigations and current test pit explorations, the full lateral extent and/or character of the fill materials beneath the former railway tracks was not defined. Therefore, the fill materials may be highly variable in extent and composition and could include materials such as old railroad ties or other debris.

5.2.4 Sand

Sand layers were encountered beneath the topsoil in test pit 203 and beneath the fill in test pit 202. Test pit 202 was terminated in the sand after exploring the layer for about 2.4 metres. Where fully penetrated, the sand layer was 1.6 metres thick. The sand layer in test pit 202 was found to contain cobbles and boulders.

5.2.5 Clayey Silt Till

Beneath the fill, borehole CPR-101 encountered a layer of clayey silt glacial till. The clayey silt till was encountered at about elevation 225.0 metres and was explored for about 1.6 metres. The clayey silt had measured N values of 41 and 51 blows per 0.3 metres and water contents of 4 and 5 per cent.

A single Atterberg limits determination for a sample of the clayey silt till indicated a plastic limit of 21 per cent, liquid limit of 41 per cent and plasticity index of 20 per cent. These data are provided on Figure CPR-PC-1 in Appendix B and indicate a silty clay of intermediate plasticity. A grain size distribution curve for a sample of the clayey silt till is shown on Figure CPR-GS-1 in Appendix B.

5.2.6 Silt to Clayey Silt

Silt to clayey silt was encountered below the fill in boreholes 1 (31D-254) and 2 (31D-254) at elevations 227.7 and 228.8 metres, respectively. Both boreholes were terminated in the silt to clayey silt after exploring the layer for about 7.2 and 11.4 metres.

The N values in the silt to clayey silt ranged from 5 to greater than 100 blows per 0.3 metres. Samples of the silt to clayey silt had natural water contents of about 5 to 14 per cent. Atterberg limits determinations for six selected samples indicated plastic limits between 10 and 17 per cent, liquid limits between 15 and 34 per cent and plasticity indices between 2 and 17 per cent.

5.2.7 Sandy Silt Till

Sandy silt till was encountered beneath the surficial topsoil and fill in test pits 201, 204 to 206, 207b and 208 and beneath the sand in test pit 203. The till was encountered between about elevation 226.6 and 224.3 metres. All of the test pits were terminated in the till after exploring it for about 0.3 to 1.2 metres. Cobbles were encountered in the till during excavation of the test pits.

5.2.8 Silty Sand to Sand with Silt Till

Silty sand to sand with silt glacial till was encountered beneath the clayey silt till in borehole CPR-101 and beneath the fill in borehole CPR-102 at elevations 223.4 and 226.4 metres, respectively. Both boreholes were terminated in the silty sand to sand with silt till after exploring the layers for 5.5 to 7.8 metres.

The sandy silt to sand with silt till had N values from 16 to greater than 100 blows per 0.3 metres. The till had natural water contents of about 7 to 16 per cent with an average water content of about 9 per cent. Atterberg limits determinations carried out on two samples of the glacial till are shown on the Plasticity Chart, Figure CPR-PC-2 and indicated that the till is generally a silt of low plasticity. A grain size envelope for the till is provided on Figure CPR-GS-2 in Appendix B.

5.3 Groundwater Conditions

Details of the water levels observed in the open boreholes at the time of drilling are summarized on the Record of Boreholes contained in Appendix B. The water levels measured in the open boreholes upon completion of drilling are summarized in the table below.

Borehole	Ground Surface Elevation (m)	Depth to Water Level (m)	Groundwater Elevation (m)	Date
CPR-101	226.4	6.1	220.3	January 9, 2013
CPR-102	227.3	0.6	226.7	January 9, 2013
1 (31D-254)	235.6	8.8	226.8	September 21, 2013
2 (31D-254)	235.7	Not Observed	Not Observed	September 22, 2013

Groundwater seepage was observed in test pits 202, 203 and 208 at depths of about 1.2 to 2.7 metres or between about elevation 225.0 and 227.3 metres. Minor groundwater seepage was observed in test pits 201 at a depth of about 0.6 metres or about elevation 226.4 metres. Test pits 204 to 207b remained dry during excavation on September 17, 2013. A summary of groundwater seepage elevations is provided in the table below.

Test Pit	Ground Surface Elevation (m)	Encountered Water Level (m)
201	227.0	226.4
202	229.5	226.8
203	226.5	225.0
204	227.0	Dry
205	227.5	Dry
206	228.0	Dry
207a	229.0	Dry
207b	227.5	Dry
208	228.5	227.3

The groundwater levels are expected to fluctuate seasonally and are expected to rise during wet periods of the year.

6.0 CLOSURE

This report was prepared by Mr. Brett Thorner and reviewed by Dr. Storer J. Boone, P.Eng. Mr. Fintan J. Heffernan, P.Eng., Golder's Designated MTO Foundations Contact, conducted an independent quality control review of this report.

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED

Storer J. Boone, Ph. D., P.Eng.
Associate

ORIGINAL SIGNED

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

BT/SJB/FJH/cr

n:\active\2013\1132-geo\1132-0000\13-1132-0078 facca-db 2013-2019-hwy 11\ph 1000-fdns\rpts\r02-site 30-080\1311320078-1000-r02 jan 14 14 (final)- parts a&b fdns cpr overhead site 30-080 orillia.docx

PART B

FOUNDATION INVESTIGATION REPORT

CPR STRUCTURAL REPLACEMENT, SITE 30-080
HIGHWAY 11, ORILLIA, ONTARIO
GWP 2177-10-00

7.0 ENGINEERING RECOMMENDATIONS

7.1 General

This section of the report provides our foundation engineering design recommendations for the proposed box culvert replacement of the existing CPR overhead structure. These recommendations are based on our interpretation of the factual data obtained from the boreholes and test pits advanced during the current and previous subsurface investigations. The discussion and recommendations provided are intended to provide the designers with sufficient information to carry out the design of the work. Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project. The designers should satisfy themselves as to the sufficiency of the information provided.

The work for this project will include the removal and disposal of the existing overhead structure, the installation of a box culvert for trail access, filling of the space between the new culvert and existing embankments and reinstatement of the highway in lieu of the existing bridge. It is understood that the length of the box culvert will be about 53 metres and its minimum interior width and height are to be 5.0 metres and 4.7 metres, respectively. Retained soil system (RSS) retaining walls will be constructed as wing walls for the new culvert.

7.2 Foundation Design

7.2.1 Founding Elevation and Geotechnical Resistance

The new box culvert may be founded within dense to very dense silty sand to sandy silt till which exists in the railway cut at or below elevation 226 metres. Any existing topsoil or fill, as well as any loosened / disturbed materials should be subexcavated.

The culvert may be designed using a factored geotechnical resistance at Ultimate Limit States (ULS) of 450 kilopascals (kPa) and a geotechnical resistance at Serviceability Limit States (SLS) of 300 kPa (for 25 mm of settlement). These geotechnical resistances are for loads applied perpendicular to the surface of the footings and, where applicable, inclination of the load should be taken into account in accordance with Section 6.7.4 of the Canadian Highway Bridge Design Code (CHBDC 2006). The culvert should be designed to withstand the appropriate weight of fill and surcharge loadings. Camber in the culvert should not be necessary.

The founding soils are susceptible to disturbance and potential loosening/softening. Granular bedding, consisting of SP 110S13 Granular A or Granular B Type II (minimum 200 millimetres thick), should be provided over the founding soils immediately after inspection by the geotechnical engineer. Alternatively, a concrete working slab (100 millimetre thick concrete slab with a compressive strength of 20 megapascals) could be provided.

7.2.2 Resistance to Lateral Loads

Resistance to lateral forces / sliding resistance between the concrete box culvert and the subgrade should be calculated in accordance with Section 6.7.5 of the CHBDC. For a concrete base slab constructed on a granular bedding material or granular levelling pad, the coefficient of friction, tan δ, can be taken as 0.7. If pre-cast box culvert sections are to be used, the coefficient of friction, tan δ, can be taken as 0.7.

7.3 Seismic Considerations

7.3.1 Site Coefficient

The soil profile at this site has been classified as Type I based on the CHBDC. Based on Table 4.4 of the CHBDC, a Site Coefficient "S" (ground motion amplification factor) of 1.0 should be used in seismic design, if required.

7.3.2 Seismic Analysis Coefficient

The potential for seismic (earthquake) loading must also be considered for the design of retaining walls in accordance with Section 4.6 of the CHBDC. Based on Table A3.1.1 of the CHBDC, the site is located in Seismic Performance Zone 1. In accordance with Section 4.4.5.1 of the CHBDC, seismic analysis is not required for structures located in Seismic Performance Zone 1.

7.4 Retaining Walls

It is understood that retained soil system (RSS) walls will be constructed adjacent to the ends of the culvert to maintain the footprint of the new embankment fill within the existing MTO right-of-way. The RSS walls may be founded at or below elevation 226 metres in the dense to very dense silty sand to sandy silt till, except for the RSS wall in the northeast quadrant (borehole CPR-101 and test pit 203) which should be founded at or below elevation 225 metres in the hard clayey silt or dense sandy silt till, using the geotechnical resistances provided in Section 7.2.1. All softened/loosened materials should be removed from within the footprint of the RSS walls and the area brought to grade with compacted Granular A or Granular B Type II. Typically, RSS walls have a front facing supported on a strip footing placed at shallow depth below the ground surface in front of the wall mass. As the RSS structure is a proprietary system, it is the responsibility of the wall designer to ensure that the internal stability of the wall is adequate. The granular embankment fill above the walls should be trimmed to an overall inclination of 2 horizontal to 1 vertical or flatter. Embankment/wall systems constructed in this matter should have an adequate factor of safety for global stability.

7.5 Lateral Earth Pressures for Design

The lateral earth pressures acting on the culvert walls and any associated wing walls/retaining walls will depend on the type and method of placement of the backfill materials, the nature of the soils behind the backfill, the magnitude of surcharge, including construction loadings, the freedom of lateral movement of the structure and the drainage conditions behind the walls. As discussed above, design for seismic (earthquake) loadings is not anticipated to be required for this structure.

The following recommendations are made concerning the design of the box culvert walls and associated retaining walls. These design 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.

- Select free-draining granular fill meeting the specifications of SP 110S13 (Aggregates) Granular A or Granular B Type II but containing less than 5 percent passing the No. 200 sieve size should be used as backfill behind the box culvert walls and retaining walls. Compaction (including type of equipment, target densities, etc.) should be carried out in accordance with OPSS 501 (Compacting). Longitudinal 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) and 3121.150 (Walls, Retaining, Backfill).
- A minimum compaction surcharge of 12 kPa should be included in the lateral earth pressures for the structural design of the walls, in accordance with CHBDC Section 6.9.3 and Figure 6.6. Other surcharge loadings should be accounted for in the design, as required.
- For restrained structures, the granular fill should be placed in a zone with width equal to at least 1.6 metres behind the back of the walls (in accordance with Figure C6.20(a) of the Commentary to the CHBDC).

  For unrestrained structures, granular fill should be placed within the wedge shaped zone defined by a line drawn at no steeper than 1.5 horizontal to 1 vertical extending up and back from the rear face of the base of the footing (in accordance with Figure C6.20(b) of the Commentary to the CHBDC).
- For restrained or unrestrained structures, the pressures are based on the proposed embankment fill materials and the existing overburden soils and the following parameters (unfactored) may be used assuming the use of granular or earth fill:

	Granular "A"	Granular "B" Type II	Earth Fill
Soil unit weight:	22 kN/m^3	21 kN/m^3	21 kN/m^3
Coefficients of static lateral earth pressure:			
Active, K_a	0.27	0.27	0.33
At Rest, K_o	0.43	0.43	0.50

7.6 Subgrade Preparation and Embankment Construction

Embankment fills are required over and adjacent to the new culvert structure to fill the gap between the existing ground surface near the recreational trail and the existing Highway 11 road surface. All topsoil, softened/loosened materials and/or fill materials should be stripped from the proposed embankment footprint and the subgrade should be graded to drain to local sump locations or drainage ditches outside of the embankment footprint.

The subgrade should be proofrolled under the direction of the geotechnical engineer prior to fill placement to identify any loose/softened areas requiring subexcavation or additional compaction. Embankment fill should consist of Granular B Type II placed and compacted in accordance with OPSS 501 (Compacting) and 206S03 (Earth Excavation and Grading). If groundwater conditions are such that the base of the excavations is wet, proofrolling should not be undertaken and the first 0.5 metres of new Granular B Type II should be spread in relatively thin lifts using only the compaction effort impacted by the spreading equipment. The fill should be benched into the existing cut slopes consistent with OPSD 208.010 (Benching of Earth Slopes).

Following construction of the new embankment, the side slopes should be trimmed to a final inclination of 2 horizontal to 1 vertical or flatter. In accordance with MTO standard practice, a minimum 2 metre wide bench should be provided at mid-height in areas where the fill is greater than 8 metres. Following completion of filling and trimming, the slopes should be appropriately vegetated. The embankment fill will be founded on the native glacial till and the factor of safety of the slopes will be in excess of 1.3.

Settlements of the completed embankments are expected to be less than 25 millimetres and the settlement will be mainly occurring during filling/construction.

7.7 Construction Considerations

Temporary subexcavation for the construction of the box culvert and retaining wall foundations are expected to extend through the existing topsoil, fill and compact to very dense silty sand to sandy silt till deposit. Cobbles and boulders should be expected in the till. Also, pieces of rebar and concrete were encountered when excavating the test pits in the embankment fill by the north pier.

The excavations will also extend below the long term groundwater level, which was typically at about elevation 226.7 metres in the boreholes closest to the recreational trail. The recent test pits did not indicate that groundwater would be problematic and can likely be handled by pumping from properly constructed and filtered sumps in the base of the excavation outside the embankment footprint, as required.

All open cut excavations should be carried out in accordance with the guidelines outlined in the current Ontario Occupational Health and Safety Act (OHSA) for Construction Activities. The existing fill materials would be classified as Type 3 soils and the silty sand to sandy silt till would be classified as Type 1 soil. Temporary excavations should be made with side slopes inclined no steeper than 1 horizontal to 1 vertical.

8.0 CLOSURE

This report was prepared by Mr. Brett Thorner, P.Eng. and reviewed by Dr. Storer J. Boone, P.Eng. Mr. Fintan J. Heffernan, P.Eng., Golder's Designated MTO Foundations Contact, conducted an independent quality control review of this report.

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED

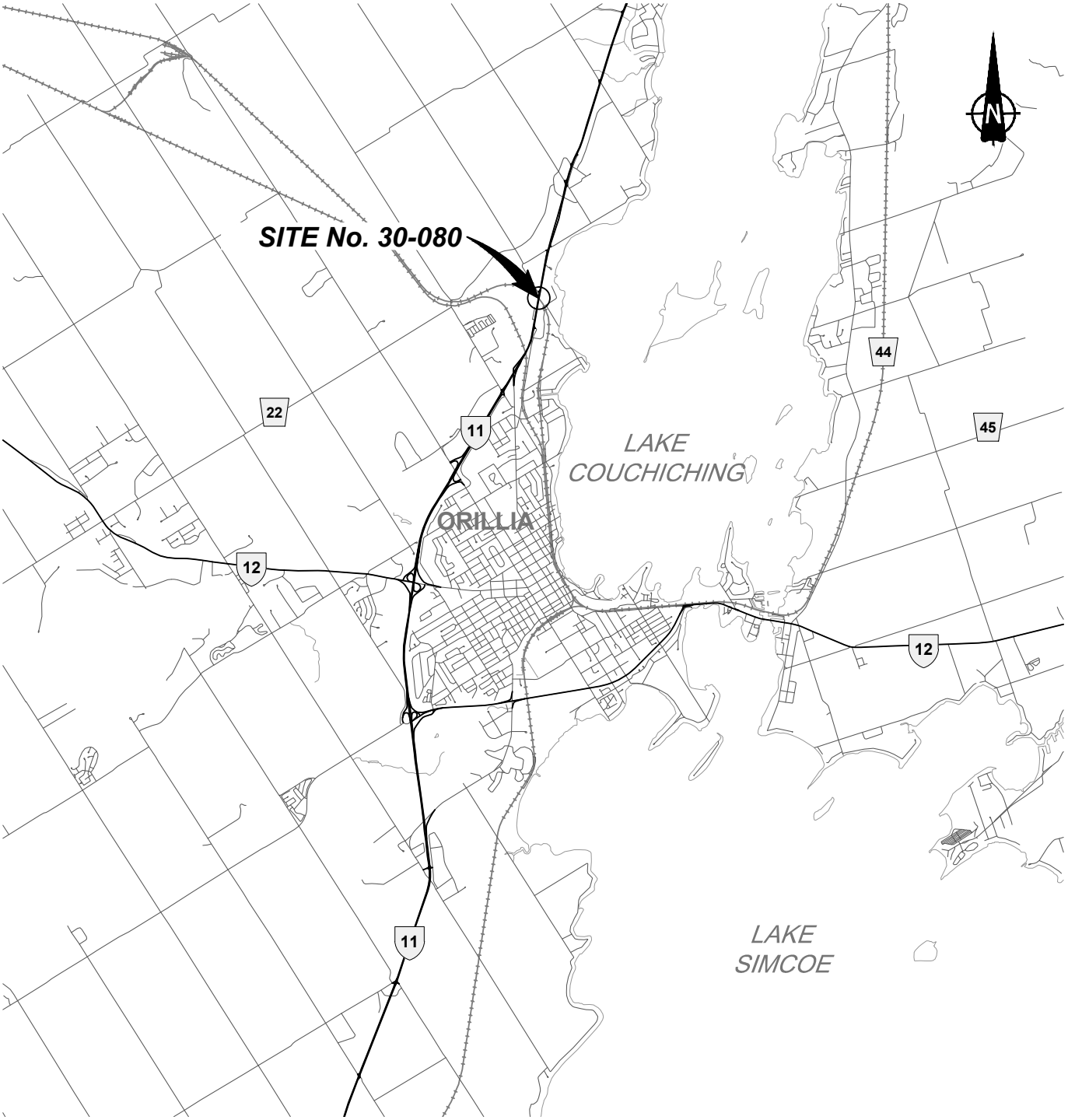
Storer J. Boone, Ph. D., P.Eng.
Associate

ORIGINAL SIGNED

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

BT/SJB/FJH/cr

n:\active\2013\1132-geo\1132-0000\13-1132-0078 facca-db 2013-2019-hwy 11\ph 1000-fdns\rpts\r02-site 30-080\1311320078-1000-r02 jan 14 14 (final)- parts a&b fdns cpr overhead site 30-080 orillia.docx



SCALE
0 2000 4000m
1:100,000

REFERENCE

PLAN BASED ON CANMAP STREETFILES V.2008.5.

NOTES

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

PROJECT

SITE 30-080 CPR STRUCTURAL REPLACEMENT
HIGHWAY 11, ORILLIA, ON
GWP 2177-10-00

TITLE

KEY PLAN

Golder Associates
LONDON, ONTARIO

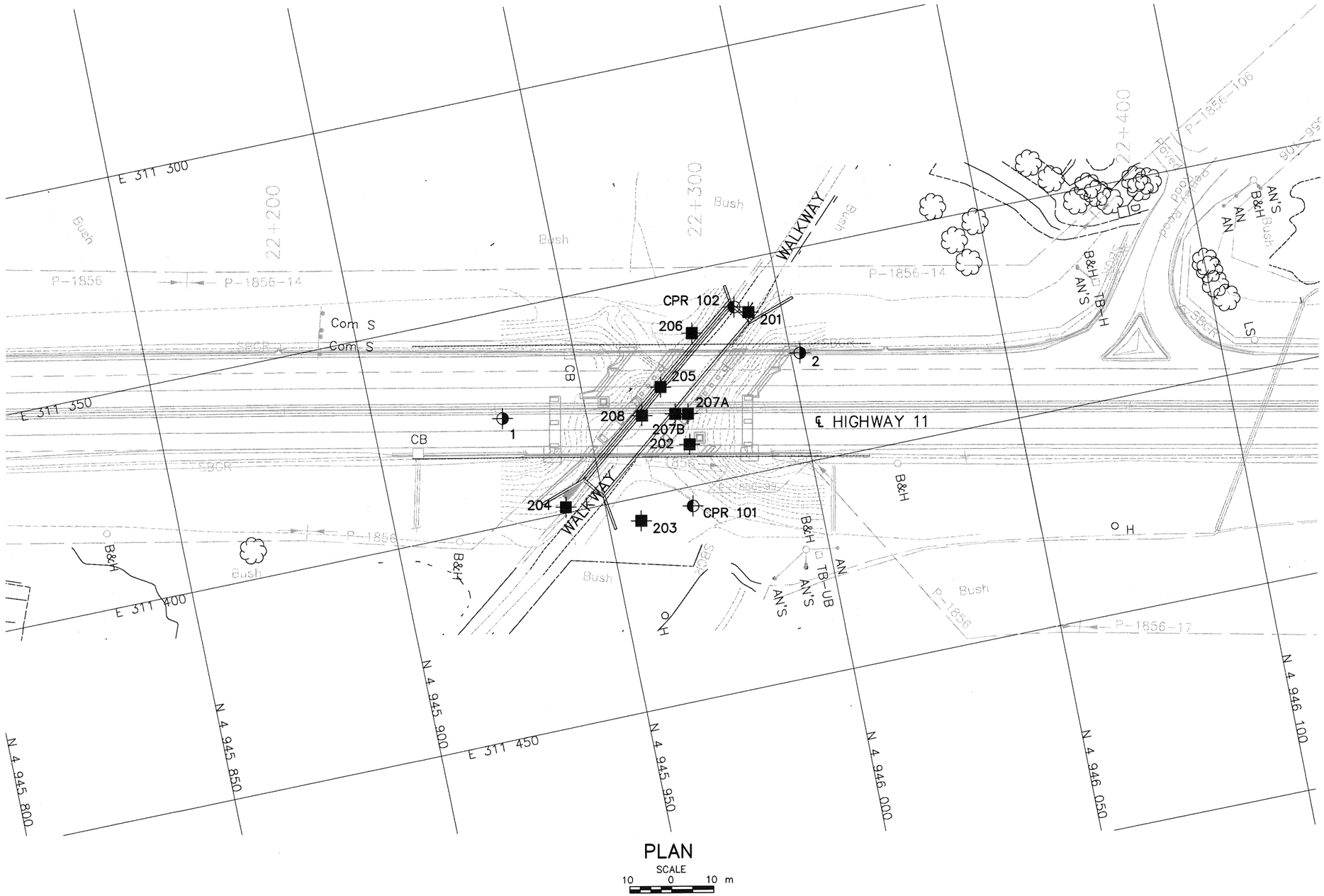
PROJECT No.		13-1132-0078	FILE No.	1311320078-1000-F02001
			SCALE	AS SHOWN REV. 0
CADD	LMK	Sept. 26/13		
CHECK				

FIGURE 1

Drawing file: 1311320078-1000-F02001.dwg Oct 22, 2013 - 5:29pm

MINISTRY OF TRANSPORTATION, ONTARIO

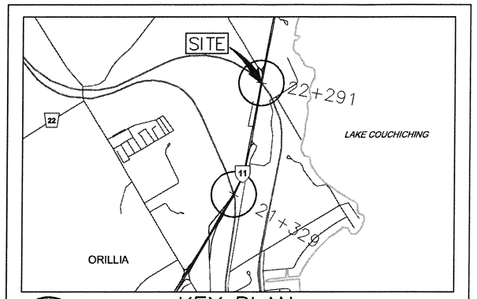
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.



PLAN
SCALE
10 0 10 m

CONT No.	
WP No. 2177-10-00	
CPR STRUCTURAL REPLACEMENT HIGHWAY 11 IMPROVEMENTS BOREHOLE LOCATIONS	SHEET

Golder Associates Ltd.
LONDON, ONTARIO, CANADA



KEY PLAN
SCALE IN KILOMETRES
0 2 4

LEGEND

- Test Pit – Current Investigation
- Borehole (Geocres 31D-558)
- Borehole (Geocres 31D-254)

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
201	227.0	4 945 992.2	311 362.5
202	229.5	4 945 972.5	311 390.2
203	226.5	4 945 957.7	311 405.5
204	227.0	4 945 940.8	311 398.6
205	227.5	4 945 968.5	311 375.5
206	228.0	4 945 978.2	311 364.6
207A	229.0	4 945 973.5	311 383.0
207B	227.5	4 945 970.6	311 382.4
208	228.5	4 945 962.8	311 381.2
(Geocres 31D-558)			
CPR-101	226.4	4 945 953.7	311 401.1
CPR-102	227.3	4 945 989.1	311 360.6
(Geocres 31D-254)			
1	235.6	4 945 903.3	311 375.0
2	235.7	4 946 002.2	311 374.4

NOTES

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

Elevations have been interpolated from existing contour data.

REFERENCE

Base plans provided in digital format by Facca.

NO.	DATE	BY	REVISION

Geocres No.

HWY. 11		PROJECT NO. 13-1132-0078	DIST.
SUBM'D. BT	CHKD.	DATE: Oct. 21/13	SITE: 30-080
DRAWN: LMK/WDF	CHKD.	APPD.	DWG. 1

PLOT DATE: January 15, 2014
FILENAME: \\golder.gds\gal\London\active\2013\1132-Geo\13-1132-0078 FACCA-BB 2013-2019-HWY 11\Drafting\PRODUCTION\AutoCAD Files\131320078-100-902001.dwg

APPENDIX A

Record of Test Pits, Current Investigation

APPENDIX A - TABLE I

RECORDS OF TEST PITS

CPR Structural Replacement (Site No. 30-080)
Highway 11, Orillia, Ontario
GWP 2177-10-00

TEST PIT	GROUND SURFACE ELEVATION (m)	DEPTH (m)	STRATIGRAPHY	REMARKS
201	227.0	0.00 to 0.20	Brown sandy **TOPSOIL**	Minor seepage at 0.55 metres. depth
		0.20 to 0.80	Brown and grey fine to medium sand, some silt (**FILL**)	Practical refusal at 1.90 metres.
		0.80 to 1.90	Grey **SANDY SILT**, some gravel, trace clay with cobbles (**TILL**)	
202	229.5	0.00 to 1.30	Brown fine to medium sand, some silt, some gravel with cobbles and boulders (**FILL**)	Major seepage at 2.7 metres depth.
		1.30 to 3.70	Brown fine to medium **SAND**, trace silt with clayey silt pockets	
203	226.5	0.00 to 0.60	Brown sandy **TOPSOIL**, some gravel	Major seepage at 1.5 metres depth.
		0.60 to 2.20	Brown fine to medium **SAND**, trace silt	
		2.20 to 2.50	Brown **SANDY SILT**, some gravel, trace clay with cobbles (**TILL**)	Practical refusal at 2.50 metres.
204	227.0	0.00 to 0.40	Brown sandy **TOPSOIL**, trace gravel with rootlets	Test pit remained dry.
		0.40 to 1.40	Brown **SANDY SILT**, some gravel, trace clay with cobbles and boulders (**TILL**)	Practical refusal at 1.40 metres.
205	227.5	0.00 to 0.90	Brown clayey silt, some sand, gravel with cobbles (**FILL**)	Test pit remained dry.
		0.90 to 2.20	Grey **SANDY SILT**, some gravel, trace clay with cobbles (**TILL**)	Practical refusal at 2.20 metres.

RECORDS OF TEST PITS

TEST PIT	GROUND SURFACE ELEVATION (m)	DEPTH (m)	STRATIGRAPHY	REMARKS
206	228.0	0.00 to 0.50	Brown fine to medium sand, some silt, topsoil, trace gravel with cobbles (**FILL**)	Test pit remained dry.
		0.50 to 1.30	Brown clayey silt, some sand, trace gravel (**FILL**)	Practical refusal at 2.50 metres.
		1.30 to 2.50	Grey **SANDY SILT**, some gravel, trace clay with cobbles (**TILL**)	
207a	229.0	0.00 to 0.80	Brown fine to medium sand, some silt, gravel with cobbles, rebar and concrete pieces (**FILL**)	Test pit remained dry.
		0.80 to 2.00	Brown clayey silt, some sand, trace gravel with cobbles (**FILL**)	Practical refusal at 2.00 metres (may have hit concrete footing of north pier).
207b	227.5	0.00 to 0.07	Brown sand and gravel, trace silt (**FILL**)	Test pit remained dry.
		0.07 to 0.16	Black sand and gravel (**FILL**)	Practical refusal at 2.00 metres.
		0.16 to 1.20	Brown silty sand (**FILL**)	
		1.20 to 1.50	Brown clayey silt, some sand, trace gravel with cobbles (**FILL**)	
		1.50 to 2.00	Grey **SANDY SILT**, some gravel, trace clay with cobbles (**TILL**)	
208	228.5	0.00 to 0.90	Brown fine to medium sand, trace silt, gravel with topsoil pockets (**FILL**)	Major seepage at 1.2 to 1.6 metres depth.
		0.90 to 1.90	Brown silt to clayey silt, some sand, gravel with cobbles (**FILL**)	Practical refusal at 2.90 metres.
		1.90 to 2.90	Grey **SANDY SILT**, some gravel, trace clay with cobbles (**TILL**)	

NOTES:
1. Test pits excavated September 17, 2013.
2. For test pit locations, see Drawing 1.
3. Table to be read in conjunction with accompanying report.

Prepared By: BT
Checked By: SJB

APPENDIX B

Record of Boreholes and Laboratory Test Data (MTO Investigation, 2013, Geocres No. 31D-558)

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No CPR-101 1 of 1 METRIC

G.W.P. 2177-10-00 **LOCATION** Coords: 4 945 953.7 N; 311 401.1 E **ORIGINATED BY** F.P.

DIST Central **HWY** 11 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers **COMPILED BY** B.R.

DATUM Geodetic **DATE** January 09, 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 (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
226.4	Ground Surface										
0.0	Gravelly sand, trace silt Compact Dark brown Moist		1	SS	10		226		○		
	Sand, trace silt Loose Brown Moist (FILL)		2	SS	9	▽*			○		
225.0							225				
1.4	Clayey silt trace sand, trace gravel Hard Grey Moist (TILL)		3	SS	41				○		2 7 53 38
223.4			4	SS	51		224		○		
3.0	Silty sand to Sand with silt trace to some clay trace to some gravel Dense to very dense Brown Moist to wet (TILL)		5	SS	34		223		○		
			6	SS	104/20cm				○		
			7	SS	52		222		○		15 49 24 12
	with gravel, trace clay		8	SS	81		221		○		
			9	SS	61	▼*	220		○		
			10	SS	101		219		○		18 52 22 8
			11	SS	123		218		○		8 47 33 12
215.6			12	SS	100/18cm		217		○		
10.8	End of borehole						216				

* 2013 01 09

▽ Water level observed during drilling

▼ Water level measured after drilling

Borehole open upon completion of drilling.

ON MTO_VER3 NEW LOGO 12KF069A.GPJ ON_MOT.GDT 5/1/2013 3:51:57 PM

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No CPR-102 1 of 1 METRIC

G.W.P. 2177-10-00 **LOCATION** Coords: 4 945 989.1 N; 311 360.6 E **ORIGINATED BY** F.P.

DIST Central **HWY** 11 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers **COMPILED BY** B.R.

DATUM Geodetic **DATE** January 09, 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 (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
227.3	Ground Surface										
0.0	Gravelly sand, trace silt Compact Dark brown Moist to wet		1	SS	10	▼*	227		○		
226.4	(FILL)										
0.9	Silty sand to Sand with silt some clay trace to some gravel Compact to Brown very dense Moist to wet (TILL)		2	SS	16		226		○		
			3	SS	74				○		13 41 33 13
			4	SS	117/23cm		225				
			5	SS	110/23cm		224		○		18 38 32 12
			6	SS	101				○		
			7	SS	122		223		○H		8 55 22 15
							222				
220.9			8	SS	119		221		○		
6.4	End of borehole										

* 2013 01 09

▽ Water level observed during drilling

▼ Water level measured after drilling

Borehole open upon completion of drilling.

7 , 5 × Numbers refer to Sensitivity

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

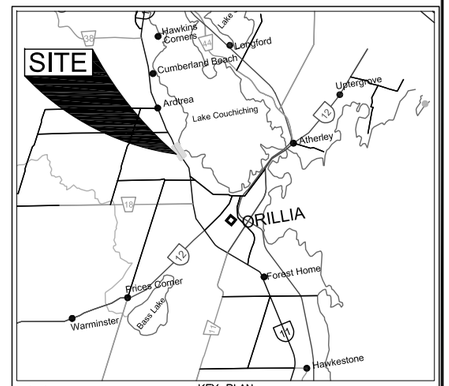
CONT No 2013-XXX

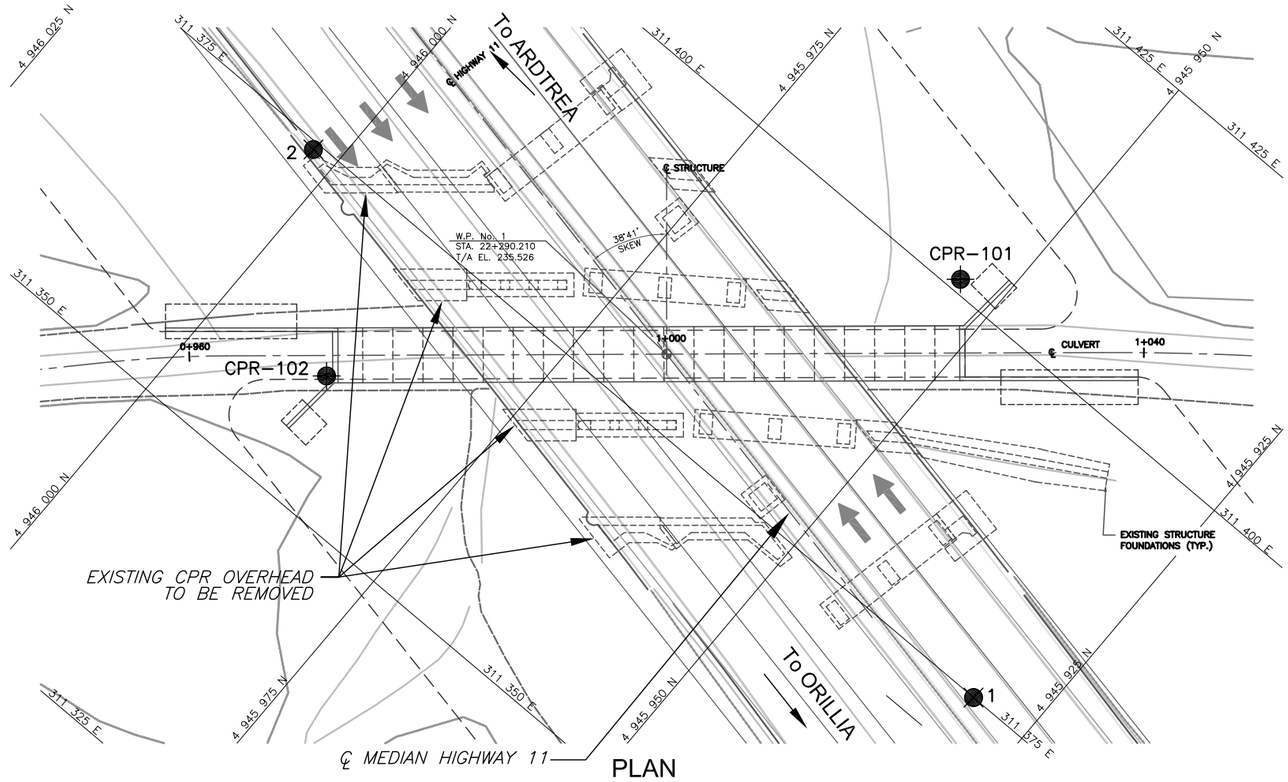
WP No 2177-10-00

CPR OVERHEAD REPLACEMENT CULVERT
HIGHWAY 11 STA 22+290.2
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS

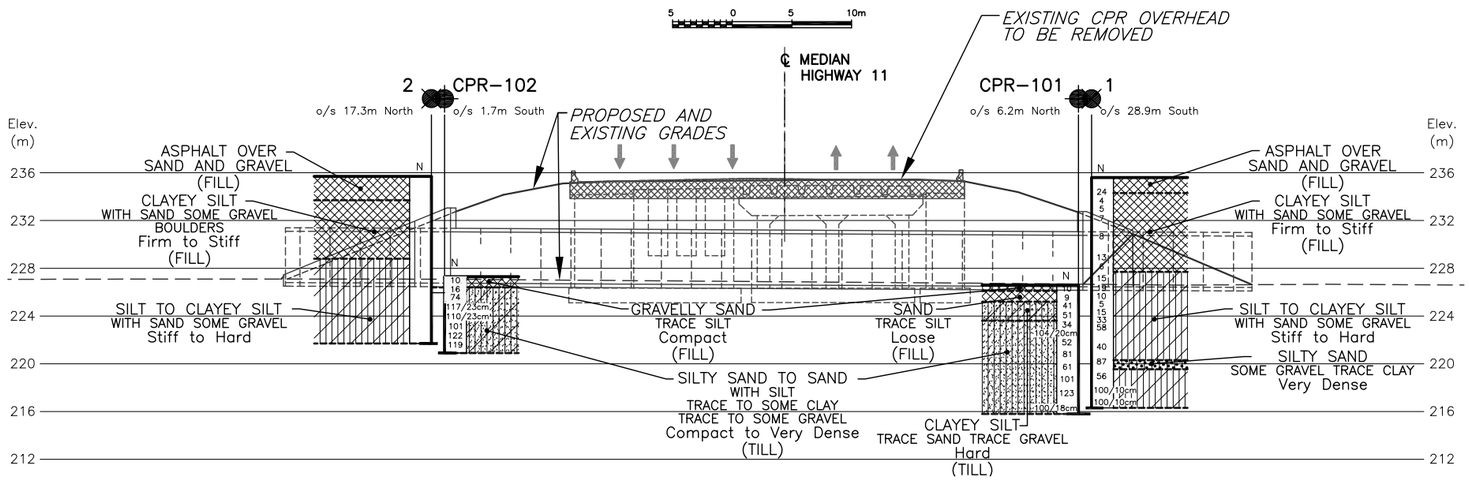




PLAN

SCALE

5 0 5 10m



PROFILE ALONG ℄ BOX CULVERT (PROPOSED)

SCALE

5 0 5 10m

NOTES:

1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE LOGS.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
3. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.

LEGEND	
	Borehole
	Previous Borehole from Geocres Report
N	Blows/0.3m (Std. Pen Test, 475 J/blow)
CONE	Blows/0.3m (60 Cone, 475 J/blow)
	WL at time of investigation Jan. 2013
*	Water level not established
	Head ARTESIAN WATER Encountered
	PIEZOMETER

BH No	ELEVATION	NORTHINGS	EASTINGS
CPR-101	226.4	4 945 953.7	311 401.1
CPR-102	227.3	4 945 989.1	311 360.6
GEOCRES REPORT BOREHOLES			
1	235.6	4 945 930.3	311 375.0
2	235.7	4 946 002.2	311 374.4

REGISTERED PROFESSIONAL ENGINEER B. R. GRAY MAY 01, 2013 PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER C M P Nascimento May 1, 2013 PROVINCE OF ONTARIO

Reference AECOM Drawings:
60282808-ST-CULVERT_30-080_GA_Precast-Alt3&4.dwg dated Jan. 2013
and B-189-11-120933.dwg

– NOTE –
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS		
DATE	BY	DESCRIPTION

Geocres No. 31D-558

HWY No	11			DIST	North Bay
SUBM'D	NA	CHECKED	BR	DATE	MAY 01, 2013
DRAWN	NA	CHECKED	BRG	APPROVED	CN
				SITE	30-080/1/2
				DWG	CPR-1

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1

W P 162-75-04 LOCATION Co-ords N 16,226,079; E 1,021,542 ORIGINATED BY JM

DIST 5 HWY 11 BOREHOLE TYPE Continuous Flight Auger (MVM) COMPILED BY JM

DATUM Geodetic DATE September 21, 1977 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
773.0	Ground Level							
0.0	Asphalt, Sand, Gravel							
768.8	(Fill Material)		1	SS	24		770	58 38 (4)
4.2	Fill Material		2	SS	4			
	Clayey Silt with Sand,		3	SS	5			
	Some Gravel		4	SS	7			11 43 36 10
	Black Organic		5	SS	8		760	
	Firm to Stiff		6	SS	13			
			7	SS	6		750	14 38 33 15
747.0			8	SS	15			
26.0			9	SS	19	▽		
			10	SS	10			
	Silt to Clayey Silt with Sand, Gravel		11	SS	5		740	
			12	SS	15			27 38 26 9
			13	SS	33			
			14	SS	58			
			15	SS	40		730	
	Silty Sand							
	Some Gravel, Trace of Clay		16	SS	87			
							720	
	Stiff to Hard		17	SS	56			
			18	SS	100/ 4"			
709.7			19	SS	100/ 4"		710	8 45 32 15
63.3	End of Borehole							

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE

PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L

WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ

PML Note:
Fill symbol added from 4.2 to 26.0 ft. depth

$\bullet^3$, $\times^5$: Numbers refer to Sensitivity

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

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2

W P 162-75-04 LOCATION Co-ords N 16,226,315; E 1,021,540 ORIGINATED BY JM

DIST 5 HWY 11 BOREHOLE TYPE Continuous Flight Auger (MVN) COMPILED BY JM

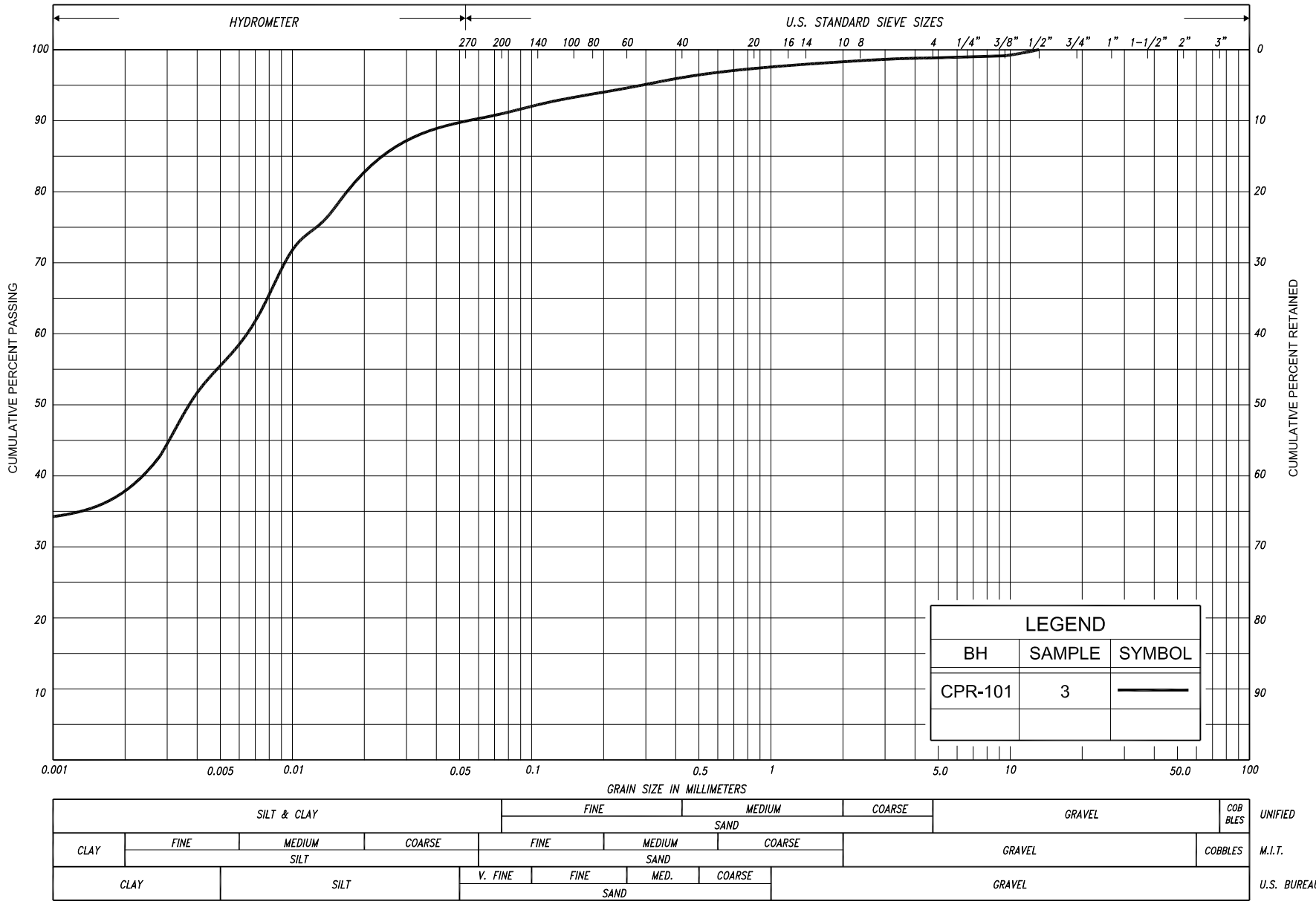
DATUM Geodetic DATE September 22, 1977 CHECKED BY [illegible]

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 (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
773.2	Ground Level										
0.0	Asphalt, Sand, Gravel (Fill Material)		1	SS	44		770		○		39 53 (8)
766.7			2	SS	13						
6.5	Fill Material		3	SS	19				○		2 93 (5)
	Clayey Silt With Sand, Boulders Some Gravel		4	SS	5						
			5	SS	102/ 11"		760				
			6	SS	7						
750.7	Firm to Stiff		7	SS	11						15 41 32 12
22.5			8	SS	13		750				
	Silt to Clayey Silt With Sand, Gravel		9	SS	18						
			10	SS	24				○		30 41 22 7
			11	SS	34						
	Stiff to Hard						740				
			12	SS	16				○		37 33 21 9
			13	SS	100/ 2"						
727.2			14	SS	100/ 3"		730		○		23 49 18 10
46.0	End of Borehole										

Note: Water Level Not Observed

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

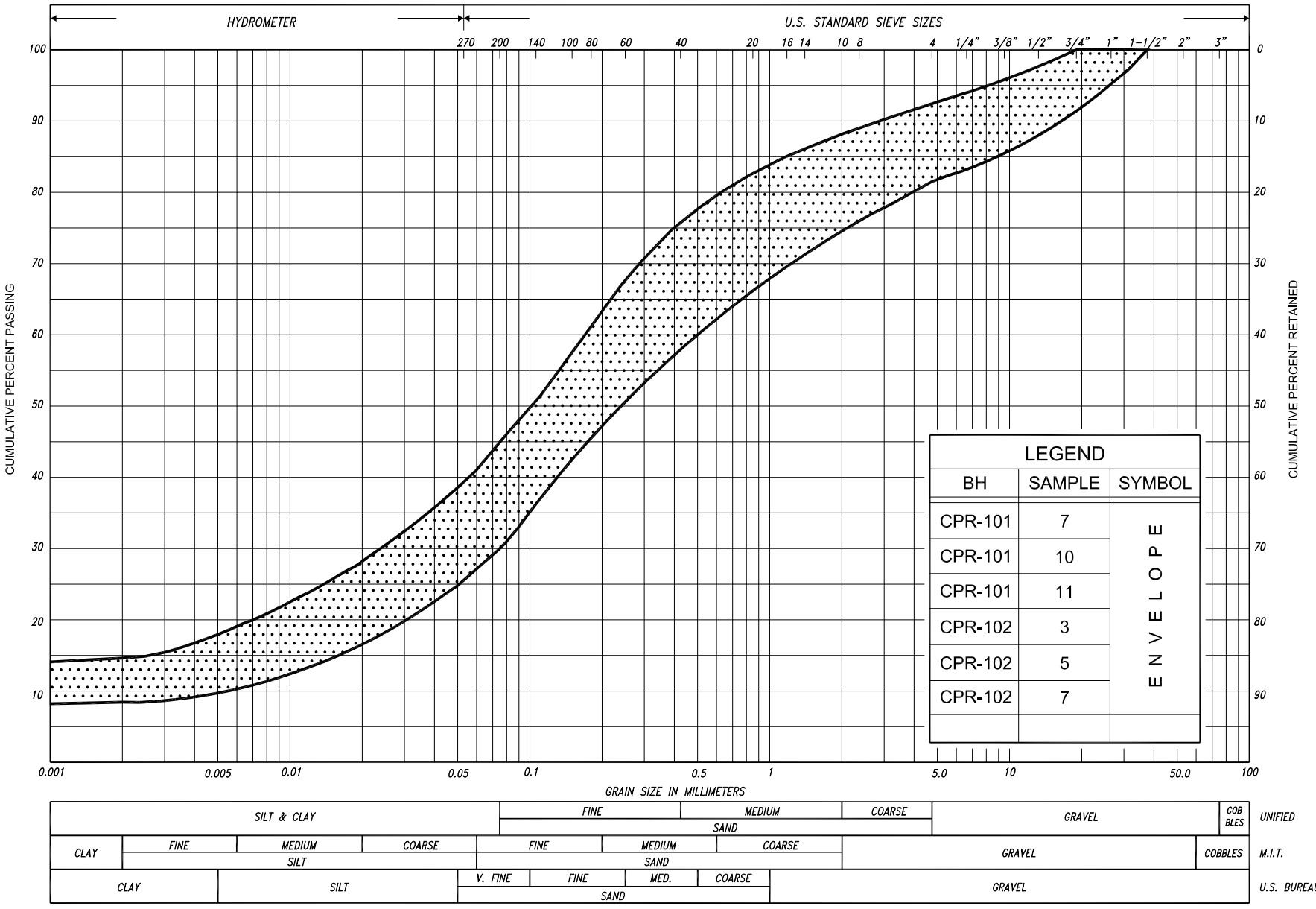


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT, trace sand, trace gravel
(TILL)

FIG No.	CPR-GS-1
HWY:	11
W.P. No.	2177-10-00

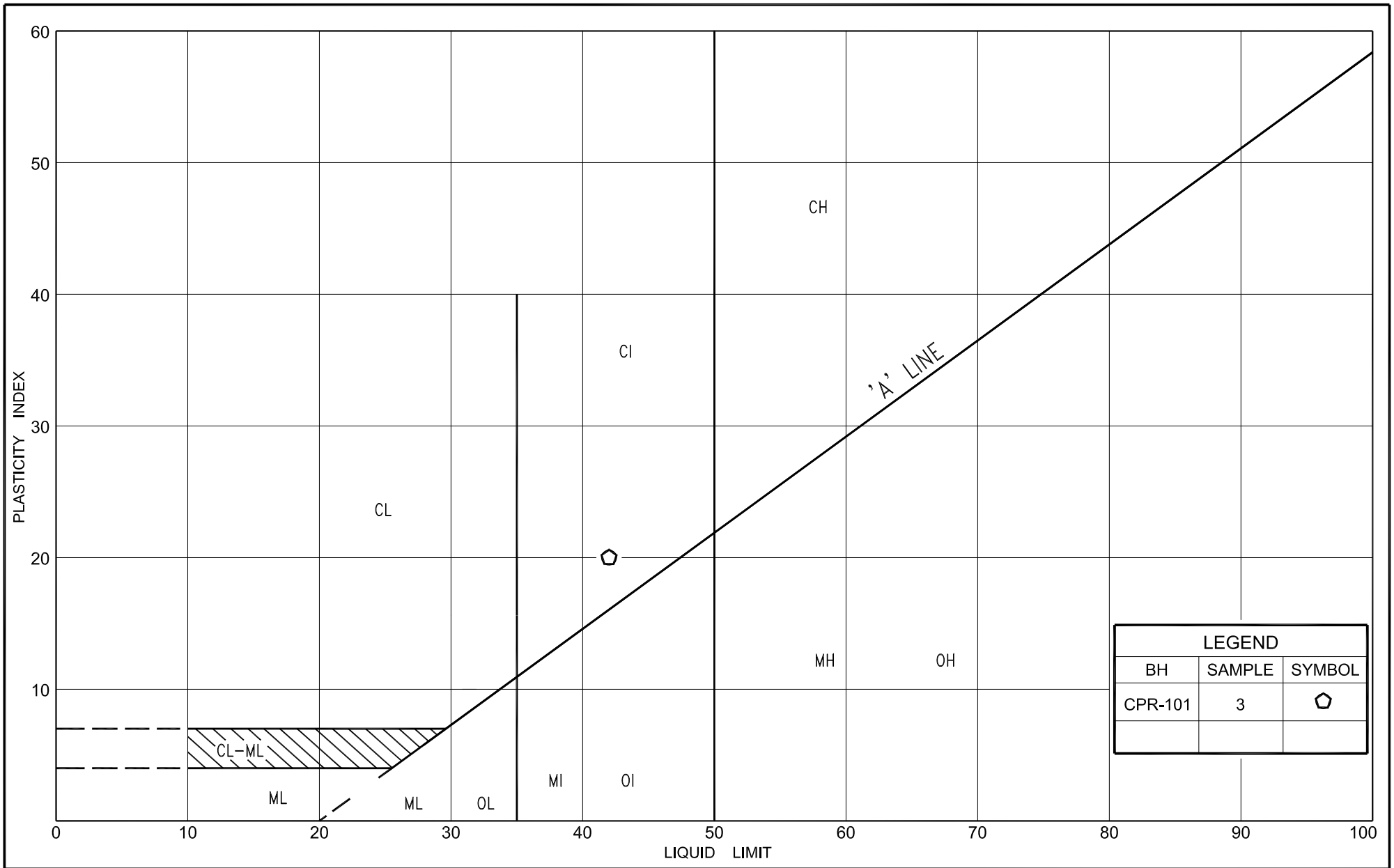


Ontario

GRAIN SIZE DISTRIBUTION

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

FIG No.	CPR-GS-2
HWY:	11
W.P. No.	2177-10-00

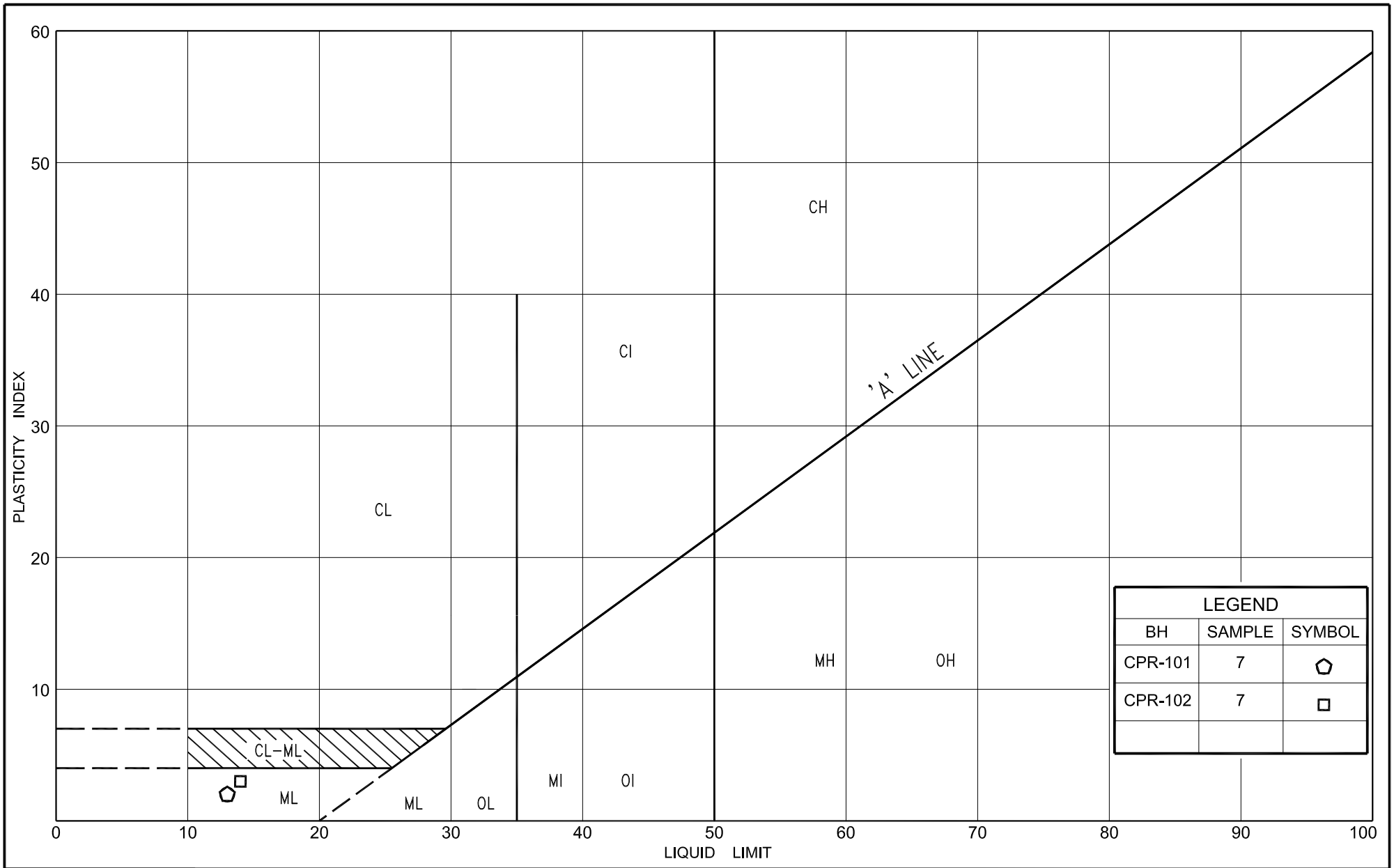


Ontario

PLASTICITY CHART

CLAYEY SILT, trace sand, trace gravel
(TILL)

FIG No.	CPR-PC-1
HWY:	11
W.P. No.	2177-10-00



Ontario

PLASTICITY CHART

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

FIG No.	CPR-PC-2
HWY:	11
W.P. No.	2177-10-00

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

Africa	+ 27 11 254 4800
Asia	+ 852 2562 3658
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ltd.
309 Exeter Road, Unit #1
London, Ontario, N6L 1C1
Canada
T: +1 (519) 652 0099

Golder Associates