



May 2009

REPORT ON

FOUNDATION INVESTIGATION AND DESIGN REPORT TRICHORD OVERHEAD, VARIABLE MESSAGE, CANTILEVER, AND GROUND MOUNTED SIGNS HIGHWAY 7 TWINNING FROM HIGHWAY 417 TO CARLETON PLACE G.W.P. 252-99-00

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REPORT



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GEOTECHNICAL INVESTIGATION

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PART A

**FOUNDATION INVESTIGATION REPORT
TRICHORD OVERHEAD, VARIABLE MESSAGE,
CANTILEVER, AND GROUND MOUNTED SIGNS
HIGHWAY 7 TWINNING FROM HIGHWAY 417
TO CARLETON PLACE
G.W.P. 252-99-00**



1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by McCormick Rankin Corporation (MRC) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a foundation investigation associated with the twinning of Highway 7 from two to four lanes in the former West Carleton Township (which is now part of the City of Ottawa) and in Beckwith Township in Lanark County. The section of Highway 7 included in this assignment (W.P. 252-99-00) extends from 2.5 km west of Ashton Station Road to Carleton Place.

Foundation investigation services are required for the following components:

- Two new structural culverts at Lavallee Creek and the Willows Municipal Drain;
- High fill embankments for the new County Road 17 interchange; and,
- Various sign supports throughout the project.

This report addresses the foundation investigations for the sign supports.

The terms of reference for the original scope of work are outlined in the MTO's Request for Proposal (RFP) dated October 2005. The work was carried out in accordance with Golder's Quality Control Plan dated February, 2006. Scope changes relating to the Foundation investigations for the sign supports included:

1. The addition of a cantilever sign (per Golder Associates' proposal of September 26, 2007); and,
2. The addition of five variable message signs and three additional ground mounted signs (per Golder Associates' proposal of December 5, 2008).

In summary, the original scope of work and subsequent scope of work specify that Foundation investigation services are required for fourteen new signs, including one trichord overhead sign just east of Carleton Place, five variable message signs and seven ground mounted signs between Highway 417 and Carleton Place, and one cantilever sign at the Highway 417W-7W ramp.



2.0 SITE DESCRIPTION

Highway 7 is a two lane highway with ditches on either side. Portions of the highway west of the Highway 417 interchange have recently been twinned to form a four lane divided highway. A total of fourteen signs are proposed along Highway 7 as part of W.P. 252-99-00. One trichord overhead sign is to be located just east of Carleton Place, in the Township of Beckwith. Five variable message signs and seven ground mounted signs are to be located along Highway 7, between Highway 417 and Carleton Place. The first variable message sign, the trichord overhead sign and all of the ground mounted signs are to be located in the Township of Beckwith and the others, to the east, in the City of Ottawa. As well, one cantilever sign to be located on the Highway 7W-417W ramp in the City of Ottawa. The proposed sign locations are shown on Drawings 1 to 9 and are summarized in the following table. Note: The sign numbers used below are for the purposes of this report only.

Sign Type	Sign #	Sign Support Location
Trichord Overhead	1	Station 14+835, Beckwith Twp., Highway 7 WBL
	2	Station 15+980, Beckwith Twp., Highway 7 EBL
	3	Station 12+000, City of Ottawa, Highway 7 EBL
	4	Station 12+100, City of Ottawa, Highway 7 EBL
	5	Station 18+000, City of Ottawa, Highway 7 WBL
	6	Station 18+100, City of Ottawa, Highway 7 WBL
Variable Message	7	Station 11+890, City of Ottawa, 7W-417W Ramp
	8	Station 15+200, Beckwith Twp., Highway 7 EBL
	9	Station 15+952, Beckwith Twp., Highway 7 EBL
	10	Station 16+680, Beckwith Twp., Highway 7 WBL
	11	Station 16+952, Beckwith Twp., Highway 7 EBL
	12	Station 17+940, Beckwith Twp., Highway 7 WBL
Cantilever	13	Station 18+544, Beckwith Twp., Highway 7 EBL
	14	Station 18+940, Beckwith Twp., Highway 7 WBL
Ground Mounted		

The terrain over this area is generally flat to gently undulating. The ground surface elevation along Highway 7 generally rises from Carleton Place towards the existing Highway 417-7 interchange, varying from approximately Elevation 128 m to 136 m.



3.0 INVESTIGATION PROCEDURES

Subsurface investigations were carried out at the proposed sign locations in two phases, as follows:

- Eight boreholes (numbered 08-101 to 08-108, inclusive) were advanced between June 9 and 13, 2008, at the proposed trichord overhead, variable message, and cantilever sign locations.
- Seven boreholes (numbered 09-401 to 09-407, inclusive) were advanced between February 18 and 23, 2009, with one at each proposed ground mounted sign location.

The boreholes were advanced as close as practical to the proposed foundation locations shown on Drawings 1 to 9. The boreholes locations were determined in the field using a Trimble R8 GPS unit and the coordinates for the individual sign foundations provided by MRC, and are therefore expected to be within 1 metre of the proposed footing locations. Boreholes 08-101 and 08-102 could not be drilled at the proposed footing locations due to the presence of overhead wires, and were therefore advanced within 5 and 10 metres of the footing locations, respectively. Borehole 08-103 was slightly re-positioned approximately 5 metres away from the proposed foundation location due to the presence of a ditch and a fence. Borehole 08-108 was also re-positioned approximately 5 metres west of the proposed foundation location as this was in a median which was inaccessible. Finally, only one borehole was advanced at each ground mounted sign location. Where the sign requires three footings, the borehole was advanced at the location of the proposed centre footing. Where the sign requires only two footings, the borehole was advanced between the two proposed footings.

The boreholes were advanced using 108 mm inside diameter (I.D.) continuous flight hollow stem augers on both track and truck-mounted drill rigs, supplied and operated by Marathon Drilling Ltd. of Ottawa, Ontario.

The boreholes were advanced to depths ranging from 4.0 to 8.0 m (m) below the existing ground surface. Soil samples were obtained at intervals of 0.75 m of depth, using 50 mm outside diameter (O.D.) split-spoon samplers in accordance with Standard Penetration Test (SPT) procedures. Since bedrock was encountered within the investigation depth at Boreholes 08-104 to 08-107, and 09-404 to 09-407, inclusive, approximately 3.0 to 3.4 m of bedrock coring was carried out.

The water level in the open boreholes was observed throughout the drilling operations. Upon completion, the boreholes were backfilled with bentonite pellets, mixed with native soils, and the site conditions restored following completion of the work.

The field work was supervised throughout by members of our engineering and technical staff, who located the boreholes, directed the drilling, sampling, and in-situ testing operations, and logged the boreholes. The soil and bedrock samples were identified in the field, placed in appropriate containers, labelled, and transported to our Ottawa geotechnical laboratory. The samples then underwent further detailed visual examination and laboratory testing, including grain size distribution, water content, organic content, and Atterberg limit testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards as appropriate.

The borehole locations and ground surface elevations were determined by Golder personnel at the site using a Trimble R8 GPS unit. The borehole locations, including MTM NAD83 northing, and easting coordinates and ground surface elevations referenced to geodetic datum are summarized in the following table and are shown on Drawings 1 to 9.



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Trichord, Variable Message, and Cantilever Signs

Sign Number – Sign Support Location	Borehole No.	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)
1 - Hwy 7 WBL, Stn. 14+835	08-101	4999507.9	335002.0	128.3
	08-102	4999499.0	335003.4	129.6
2 - Hwy 7 EBL, Stn. 15+980	08-103	5000244.4	335875.2	127.8
3 - Hwy 7 EBL, Stn. 12+000	08-104	5005507.4	340557.2	135.2
4 - Hwy 7 EBL, Stn. 12+100	08-105	5005606.5	340561.4	135.6
5 - Hwy 7 WBL, Stn. 18+000	08-106	5009957.6	344184.2	133.9
6 - Hwy 7 WBL, Stn. 18+100	08-107	5010025.0	344258.5	134.5
7 - 7W/417W Ramp, Stn. 11+890	08-108	5014964.5	346162.9	134.4

Ground Mounted Signs

Sign Number – Sign Support Location	Borehole No.	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)
8 – Hwy 7 EBL, Stn. 15+200	09-401	4999733.1	335290.5	127.4
9 – Hwy 7 EBL, Stn. 15+952	09-402	5000233.4	335852.1	127.9
11 – Hwy 7 EBL, Stn. 16+952	09-403	5000879.4	336613.0	128.8
13 – Hwy 7 EBL, Stn. 18+544	09-404	5001925.5	337813.9	136.3
14 – Hwy 7 WBL, Stn. 18+940	09-405	5002235.4	338069.1	137.1
12 – Hwy 7 WBL, Stn. 17+940	09-406	5001578.1	337313.4	130.7
10 – Hwy 7 WBL, Stn. 16+680	09-407	5000762.1	336355.6	128.0



4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geological Conditions

The study area for this assignment lies within the physiographic region known as the Smith Falls Limestone Plain, as delineated in *The Physiography of Southern Ontario*¹ that lies within the major physiographic region of the Ottawa-St. Lawrence Lowland.

The Smiths Falls Limestone Plain is characterized by shallow overburden deposits overlying sedimentary bedrock consisting of limestones, dolostones, sandstones and shales. The shallow overburden soils are typically between 1 m and 3 m in thickness and are commonly comprised of sandy to gravelly till derived from the Precambrian Shield to the north, overlain by glaciofluvial sediments that consist of layered sands and gravels. In the vicinity of and north of Carleton Place, clay has been deposited within depressions in the bedrock that have been caused by faulting. Large areas of the plain are covered with peat and muck, due to poor drainage as a consequence of the relatively flat topography and shallow depth to bedrock.¹

4.2 Site Stratigraphy

The detailed subsurface soil, bedrock and groundwater conditions as encountered in the boreholes advanced during this investigation, together with the results of the laboratory tests carried out on selected soil samples, are given in Table 1, on the attached Record of Borehole and Record of Drillhole sheets, and on Figures 1 to 5. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

In general, the subsurface conditions consist of surficial layers of topsoil, peat or roadway fill (where present), overlying silty clay, sandy silt or sand (where present), underlain by silty sand till. The till is underlain by weathered shale, limestone, and/or dolostone bedrock.

A more detailed description of the subsurface conditions encountered in the boreholes put down for the present investigation at each sign location is provided in the following sections.

4.2.1 Fill

Approximately 0.5 to 1.5 m of roadway fill was encountered at ground surface and/or below the topsoil at Borehole 08-102, 08-107, 09-401, and 09-402, associated with the existing Highway 7. The fill consists of variable mixtures of sand, sand and gravel, silty sand, peat, and organic matter.

Approximately 5.8 m of embankment fill were encountered at ground surface at Borehole 08-108, associated with the existing highway 7W-417W ramp. The embankment fill material consists of about 0.5 m of crushed stone road base, overlying about 0.3 m of crushed stone road subbase, overlying about 5 m of layered silty sand and sandy silt. The SPT "N" values measured within the embankment fill range from 14 to 34 blows per 0.3 m of

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



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penetration, indicating that the fill has a compact to dense state of packing. The results on two grain size distribution tests on the embankment fill from Borehole 08-108 are shown on Figure 1.

No boulders or cobbles were encountered in the fill within these boreholes.

4.2.2 Topsoil / Peat

Approximately 100 to 400 mm of topsoil were encountered at ground surface at most of the sign locations (where no fill has been placed). About 100 mm of topsoil were also encountered beneath the existing highway embankment fill at Borehole 08-108.

About 2.1 m of peat were encountered at ground surface at Borehole 08-106 and about 2.4 m of peat at Borehole 09-401 buried beneath peat fill. The SPT "N" values measured within the peat range from 'Weight of Hammer' to 4 blows per 0.3 m of penetration. The results of organic content testing conducted on one sample of the peat at Borehole 08-106 (Station 18+000) are given in the following table:

Borehole No.	Sample No.	Water Content (%)	Organic Content (%)
08-106	2	300%	64%

4.2.3 Clayey Silt and Silt

About 0.6 m of clayey silt were encountered below the topsoil at Borehole 09-404.

A 0.6 metre thick layer of silt is also present below the topsoil at Borehole 08-108 (buried beneath the embankment fill). One SPT "N" value of 21 blows per 0.3 m of penetration was measured within the silt, indicating a compact state of packing. The results of one grain size distribution test on the silt are shown on Figure 2.

4.2.4 Sandy Silt, Silty Sand, and Sand

A 0.8 m thick layer of sandy silt is present immediately below the topsoil at Borehole 08-104.

Approximately 0.8 m of silty sand was encountered below the topsoil at Borehole 09-406.

About 1.0 m of sand were encountered below the peat at Borehole 08-106. One SPT "N" value of 5 blows per 0.3 m of penetration was measured within the sand, indicating a loose state of packing. The results of one grain size distribution test from the sand are shown on Figure 3.

4.2.5 Silty Clay

Silty clay was encountered below the topsoil, fill material, clayey silt and silt (where encountered) at all of the sign locations, with the exception of Boreholes 08-104, 08-108, 09-404, and 09-405. The deposit varies greatly in thickness, from about 0.4 m thick at Borehole 08-107 to more than 6.5 m thick at Borehole 08-101. The thicker deposits exist at the west end of the project.



The upper portion of the silty clay at Boreholes 09-402 and 09-403, and the entire silty clay deposit at the remaining sign locations (at least to the depth investigated), with the exception of Borehole 08-106 below the sand and Borehole 09-401 below the peat, has been weathered to a grey brown crust. At Boreholes 09-402 and 09-403 the weathered crust varies up to about 3.4 m in thickness. In areas where the silty clay was not fully penetrated, the weathering was proven for thicknesses ranging up to about 6.6 m. The upper 0.9 m of weathered crust at Borehole 09-402 grades from a silty clay to a clayey silt. The SPT "N" values measured within the weathered silty clay deposit range from 3 to 15 blows per 0.3 m of penetration, indicating a very stiff consistency material.

Atterberg limit testing carried out on samples of the weathered crust measured liquid limits ranging from about 45 to 57 percent, and plasticity indices ranging from about 22 to 32 percent. These results suggest that the weathered crust has an intermediate to high plasticity. These results are summarized on Figure 4. The measured natural water contents in the deposit range from about 34 to 41 percent.

The silty clay at Boreholes 08-106 and 09-401, and below the depth of weathering at Boreholes 09-402 and 09-403, is grey in colour. The unweathered silty clay was not fully penetrated by the latter three boreholes but was proven for depths which vary from 5.9 to 6.1 m. The SPT "N" values measured within the unweathered silty clay range from 2 to 14 blows per 0.3 m of penetration. The results of one in-situ vane test in this material gave an undrained shear strength in excess of 96 kilopascals, indicating a very stiff consistency.

The results of Atterberg limit testing carried out on three samples of the grey silty clay gave plasticity index values ranging from 14 to 21 percent and liquid limit values of 30 to 48 percent, indicating low to intermediate plasticity (i.e., clayey silt to silty clay). These results are summarized on Figure 4. The measured water content of the grey silty clay ranges from approximately 22 to 44 percent which is generally lower than the measured liquid limit.

4.2.6 Silty Sand and Sandy Silt Till

Deposits of silty sand and sandy silt till are present below the silty clay, and/or silt (where present) at Boreholes 08-106, 08-107, 08-108, and 09-407. Based on the samples retrieved as well as the geological origin of this deposit and previous experience, the till is considered to consist of a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of silty sand and/or sandy silt with a trace of clay.

Where penetrated, the till deposit varied in thickness from 0.3 to 2.4 m. The results of two grain size distribution tests from the silty sand till are shown on Figure 5. The till was not fully penetrated at Borehole 08-108 but was proven for a thickness of 1.1 m before refusal was encountered.

SPT 'N' values for the till ranging from 6 to greater than 50 blows per 0.3 m of penetration indicate a loose to very dense state of packing, although the higher 'N' values could reflect the presence of cobbles and boulders, rather than the state of packing of the soil matrix. Refusal to sampler advancement was encountered within the glacial till at borehole 08-108, however the hole was advanced passed this depth by augering, thus further indicating the presence of cobbles and/or boulders.

The measured water contents of two samples of the silty sand till are approximately 8 percent.



4.2.7 Refusal and Bedrock

At Borehole 08-108, refusal to augering was encountered at a depth of 7.6 m below ground surface (i.e., elevation 126.8 m). The auger refusal could indicate the bedrock surface or the presence of boulders within the glacial till.

Bedrock was encountered beneath the fill and native soils, and was cored for about 3 m depth, at Boreholes 08-104 to 08-107, and 09-404 to 09-407, inclusive, at depths ranging from about 0.4 to 4.7 m below existing ground surface. At Boreholes 08-104, 09-404, and 09-405, inclusive, the upper 0.1 to 1.1 m of the bedrock was observed to be weathered and was penetrated by augering.

The following table summarizes the bedrock surface depth and elevation as encountered at the borehole locations.

Trichord, Variable Message, and Cantilever Signs

Sign Number – Sign Support Location	Borehole No.	Depth to Bedrock (m)	Bedrock Surface Elevation (m)
3 – Hwy 7 EBL, Stn. 12+000	08-104	0.8	134.4
4 – Hwy 7 EBL, Stn. 12+100	08-105	0.8	134.8
5 – Hwy 7 WBL, Stn. 18+000	08-106	4.7	129.2
6 – Hwy 7 WBL, Stn. 18+100	08-107	3.3	131.2

Ground Mounted Signs

Sign Number – Sign Support Location	Borehole No.	Depth to Bedrock (m)	Bedrock Surface Elevation (m)
13 – Hwy 7 EBL, Stn. 18+544	09-404	0.9	135.4
14 – Hwy 7 WBL, Stn. 18+940	09-405	0.4	136.7
12 – Hwy 7 WBL, Stn. 17+940	09-406	2.2	128.5
10 – Hwy 7 WBL, Stn. 16+680	09-407	2.9	125.1

The bedrock encountered in the boreholes consists of shale, limestone, sandy limestone, dolostone and/or dolomitic limestone. The bedrock is highly weathered (particularly near the top of the bedrock) to fresh and, at times, fractured. The fresh bedrock is medium strong to strong. The Rock Quality Designation (RQD) values ranged widely from 0 to 75 percent indicating a poor to fair quality rock. RQD values of 0 percent may indicate fractured bedrock. The discontinuities observed in the rock core were generally observed to be horizontal to sub-horizontal, associated with the bedding planes, however many vertical to sub-vertical jointing were observed in the fractured zones.



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4.2.8 Groundwater Conditions

The water levels were observed in the open boreholes during the drilling operations. The water level measurements are noted on the borehole records and are summarized in the following table:

Trichord, Variable Message, and Cantilever Signs

Sign Number – Sign Support Location	Borehole No.	Ground Surface Elevation (m)	Water Level Depth (m)	Water Level Elevation (m)
1 – Hwy 7 WBL, Stn. 14+835	08-101	128.3	5.9	122.4
	08-102	129.6	5.9	123.7
2 – Hwy 7 EBL, Stn. 15+980	08-103	127.8	Dry	-
3 – Hwy 7 EBL, Stn. 12+000	08-104	135.2	Unknown ¹	Unknown ¹
4 – Hwy 7 EBL, Stn. 12+100	08-105	135.6	Unknown ¹	Unknown ¹
5 – Hwy 7 WBL, Stn. 18+000	08-106	133.9	2.1	131.8
6 – Hwy 7 WBL, Stn. 18+100	08-107	134.5	Unknown ¹	Unknown ¹
7 – 7W/417W Ramp, Stn. 11+890	08-108	134.4	N/A	N/A

Note 1: Water was used for rock coring, therefore natural groundwater level is unknown.

Ground Mounted Signs

Sign Number – Sign Support Location	Borehole No.	Ground Surface Elevation (m)	Water Level Depth (m)	Water Level Elevation (m)
8 – Hwy 7 EBL, Stn. 15+200	09-401	127.4	0.6	126.8
9 – Hwy 7 EBL, Stn. 15+952	09-402	127.9	N/A	N/A
11 – Hwy 7 EBL, Stn. 16+952	09-403	128.8	Dry	-
13 – Hwy 7 EBL, Stn. 18+544	09-404	136.3	Unknown ¹	Unknown ¹
14 – Hwy 7 WBL, Stn. 18+940	09-405	137.1	0.6	136.5
12 – Hwy 7 WBL, Stn. 17+940	09-406	130.7	0.9	129.8
10 – Hwy 7 WBL, Stn. 16+680	09-407	128.0	Unknown ¹	Unknown ¹

Note 1: Water was used for rock coring, therefore natural groundwater level is unknown.

It should be noted that the groundwater levels at the site are expected to fluctuate seasonally, and are expected to rise during wet periods of the year.



5.0 CLOSURE

This report was prepared by Ms. Kim S. Lesage, EIT under the direction of the Project Manager, Mr. Michael I. Cunningham, P.Eng. This report was reviewed by Mr. Fintan J. Heffernan P.Eng., the designated MTO contact for this project.

Yours truly,

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GEOTECHNICAL INVESTIGATION

PART B

**FOUNDATION DESIGN REPORT
TRICHORD OVERHEAD, VARIABLE MESSAGE,
CANTILEVER, AND GROUND MOUNTED SIGNS
HIGHWAY 7 TWINNING FROM HIGHWAY 417
TO CARLETON PLACE
G.W.P. 252-99-00**



6.0 ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides foundation design recommendations for the proposed trichord overhead, variable message, cantilever, and ground mounted sign foundations associated with the twinning of Highway 7 from two to four lanes. The recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the subsurface investigation at this site. The interpretation and recommendations provided are intended only to provide the designers with sufficient information to assess the feasible alternatives and to design the proposed sign foundations. As such, where comments are made on construction they are provided in order to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods, scheduling and the like.

The design recommendations for the trichord overhead, variable message, and cantilever sign foundations are provided separately from those for ground mounted sign foundations. A comparison of the foundation alternatives for all sign types is provided in Table 2.

6.2 Trichord Overhead, Variable Message, and Cantilever Sign Foundations

Caisson foundations for the different sign types should be designed in accordance with the following sections and structural standard drawings contained in MTO's Sign Support Manual:

- **Trichord Overhead Sign:** Tri-Chord Static Sign Supports, Section 4, and Standard Drawings SS118-3, SS118-4, and/or SS118-5;
- **Variable Message Sign (on static sign support structures):** Cantilever Static Sign Supports, Section 3, and Standard Drawings SS118-3, SS118-4, and SS118-5; and,
- **Cantilever Sign:** Cantilever Static Sign Supports, Section 3, and Standard Drawing SS118-3 SS118-4, and/or SS118-5.

The standard sign foundation designs presented on the Standard Drawings were developed based on the minimum soil conditions given below; where weaker soils are encountered, a site-specific design is required.

- **Case 1 (Cohesionless Soils):** Sand with a friction angle of 28 degrees surrounding the upper two-thirds of the portion of the caisson foundation below the frost depth, and sand with a friction angle of 30 degrees surrounding the lower third of the portion of the caisson below the design frost depth.
- **Case 2 (Cohesive Soils):** Soft clay with an undrained shear strength of 25 kPa surrounding the upper two-thirds of the portion of the caisson foundation below the frost depth, and soft clay with an undrained shear strength of 50 kPa surrounding the lower third of the portion of the caisson below the design frost depth.

In the standard trichord overhead, variable message on static sign support structures, and cantilever sign footing design (class 1 and 2 only), the caissons are extended 5 m below the design frost depth, unless bedrock is encountered within this depth; for sign foundation design, the frost depth in the Ottawa area may be taken as



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1.8 m. The typical caisson founding level would therefore be 6.8 m below the ground surface, except where bedrock is encountered within this depth, as is the case for four of the five variable message sign supports.

Where caisson foundations are considered, it is recommended that MTO's Special Provision SP903S01 be included in the Contract Documents for the construction of caisson piles.

The following table summarizes the depth to bedrock and the bedrock surface elevation in the boreholes at each of the proposed sign support locations where bedrock was encountered within 6.8 m depth, as determined by bedrock coring:

Borehole No.	Sign Number – Sign Support Location	Sign Type	Depth to Refusal /Bedrock (m)	Bedrock Surface Elevation (m)
08-104	3 – Hwy 7 EBL, Stn. 12+000	Variable Message	0.8	134.4
08-105	4 – Hwy 7 EBL, Stn. 12+100	Variable Message	0.8	134.8
08-106	5 – Hwy 7 WBL, Stn. 18+000	Variable Message	4.7	129.2
08-107	6 – Hwy 7 WBL, Stn. 18+100	Variable Message	3.3	131.2

Using the standard design approach, a nominal socket into the rock will be required for sign 5 (Hwy 7 WBL, Stn. 18+000) and sign 6 (Hwy 7 WBL, Stn. 18+100) supports, where the depth to bedrock is approximately 4.7 and 3.3 m below ground surface, respectively.

The depth to bedrock at variable message sign 3 (Hwy 7 EBL, Stn. 12+000) and sign 4 (Hwy 7 EBL, Stn. 12+100) is very shallow, at approximately 0.8 m depth relative to the ground surface at the sign support locations. The foundations for these sign supports could therefore consist of either a caisson embedded into the bedrock, or a spread footing or caisson anchored/dowelled to the surface of the bedrock. However, a footing anchored to the bedrock with dowels is recommended as the more economic option. Recommendations pertaining to these foundation alternatives are provided in Sections 6.2.2 and 6.2.3.

At signs 1 and 2, where the depth to bedrock is greater than 6.8 m, the foundation for the sign support should be designed as a caisson in soil, as discussed in Section 6.2.1.

It is understood that the cantilever sign (sign 7) will be a Class 3 sign and the foundations will extend 6 m (and not 5 m) below frost level, giving a foundation depth of 7.8 m. The borehole at that sign location (Borehole 08-108) encountered refusal at 7.6 m depth, which may indicate bedrock or may indicate boulders in the glacial till. That refusal level is apparently slightly above the design founding level (depending on what the actual ground surface level will be at the sign location). If that refusal indicates bedrock, then the standard design approach could require that a shallow socket be provided. Three options could therefore be considered:

- 1) Raise the design ground level (if needed) to make the founding level above the measured refusal/bedrock level.
- 2) Provide a shallow socket, in accordance with the standard design.



- 3) Carry out a site specific design in accordance with the recommendations given in Section 6.2.1 and the parameters given in Table 3, to evaluate whether the foundation can instead be designed as a caisson in soil.

A summary of the recommended foundation systems for these signs is provided on Table 2.

6.2.1 Caisson Foundations in Soil

The supports for trichord overhead sign 1 and variable message sign 2 may be designed as caisson foundations within soil. Based on the results from Borehole 08-101, 08-102, and 08-103 (at signs 1 and 2), the weathered silty clay soils at these locations have an undrained shear strength of approximately 75 kPa or more, which exceeds the minimum criteria on which the standard sign foundation is based.

The support for cantilever sign 7 can also potentially be designed as a caisson foundation in soil, if the grading would result in a founding level above elevation 126.8 m (the refusal depth in Borehole 09-108). The results from the borehole indicate that the embankment fill, silt, and till soils have a friction angle of approximately 30 degrees or more, which exceeds the minimum criteria on which the standard sign foundations are based.

The standard foundation design may be checked using the following equations to calculate the unfactored passive lateral earth pressure, P_p (kPa), distributed along the depth of the caisson foundation; this earth pressure distribution is triangular with depth:

$$P_p = K_p \gamma d \quad \text{Above the groundwater table; and,}$$

$$P_p = K_p \gamma d_w + K_p \gamma' (d - d_w) \quad \text{Below the groundwater table.}$$

Where:

- K_p Is the passive earth pressure coefficient, as given in Table 3;
- γ Is the bulk unit weight (kN/m^3), as given in Table 3;
- γ' Is the effective unit weight below the groundwater level (kN/m^3);
- d Is the depth below the ground surface (m); and,
- d_w Is the depth to the groundwater level (m), as given in Table 3.

The stratigraphy and design parameters for the subsurface conditions encountered in the boreholes at the sign locations are given in Table 3 following the text of this report.

The unfactored lateral resistance should be calculated assuming an equivalent pile width equal to three times the caisson diameter. A resistance factor of 0.5 should be applied to the unfactored lateral resistance to obtain the factored lateral geotechnical resistance at Ultimate Limit States (ULS).

Where an undrained shear strength, c_u , is provided for a cohesive soil layer in Table 3, the capacity of the caisson should be checked to determine whether the drained or undrained case will govern. In this case, the lateral resistance for the length of the caisson within the cohesive soil should be calculated assuming an unfactored passive lateral pressure distribution varying from $2 c_u$ at the surface to $9 c_u$ at and below a depth



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equivalent to three pile diameters, acting over the actual width of the caisson. A resistance factor of 0.5 should be applied to this calculated lateral resistance in order to obtain the factored lateral geotechnical resistance at ULS.

For both the drained and undrained cases, the passive resistance in front of the caisson within the upper 1.8 m below ground surface should be neglected in the design of the foundations to account for frost action.

For cantilever sign 7, if the grading would result in a founding level below elevation 126.8 m, then the above methodology can also be used to check whether a shallow socket can be avoided and that sign support designed as a caisson in soil.

6.2.2 Caisson Foundations Socketed into Rock

The supports for variable message signs 3 to 6, inclusive, may be designed as caisson foundations socketed into rock. Sign 7 may also require a shallow rock socket.

In accordance with Standard Drawing SS118-3 of MTO's Sign Support Manual (Standard Drawing SS118-3, dated April 2007), where bedrock is encountered at a depth, y (in m), of less than 5 m below the bottom of the frost layer, the required depth of the foundation below the frost layer can be reduced to:

$$y + (5 \text{ m} - y)/2$$

Notes:

1 – Note 8 in the General Notes of Standard Drawing SS118-3 indicates that this methodology for reducing the socket depth can only be used with approval from MTO. Furthermore, this is a note to the designer and should be deleted for the drawing included in the contract package.

2 – Note 9 in the General Notes of Standard Drawing SS118-3 does not apply and should be deleted for the drawing included in the contract package.

For signs 3 and 4, the depth to the surface of the bedrock is less than the frost depth of 1.8 m. Based on the above, the caissons at these locations would be socketed up to 2.5 m into the limestone bedrock. However, due to the high bedrock elevations, it is instead recommended to install dowels and anchor the footings to the bedrock.

For signs 5 and 6, the depth to bedrock is less than 5 m below the design frost depth. The depth of rock socket required can be determined based on the equation above. However it is recommended that a site-specific design be carried out for these locations (using the soil parameters given in Table 3) to determine whether a rock socket is indeed required (and to what depth) or whether the overburden soils can provide the required lateral resistance. It is not recommended to use dowels to anchor to bedrock, because the bedrock elevation is deep, which could make drilling of the anchor holes and the placement of dowels difficult. The foundation system should however be selected by the structural designers based on the structural requirements of the project.

The need for a shallow socket at sign 7 (where refusal was encountered slightly above the design founding level) should similarly be evaluated using a site-specific design.



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Where a bedrock socket is required, the unfactored passive lateral resistance of the rock mass may be taken as 1 MPa (to take account of fracturing in the upper portion of the rock mass, based on the lower RQD values in some of the boreholes). A resistance factor of 0.5 should be applied in order to obtain the factored lateral geotechnical resistance at ULS. From a design/analysis perspective, that lateral resistance would be assumed to act against the projected vertical planar area of the rock face against the side of the sign support.

From a geotechnical perspective, the rock sockets could have a diameter less than 1200 millimetres (the standard caisson diameter) however the actual size should be decided by the structural designers.

It is noted that the (fresh and intact) bedrock at the site is strong. Coring or churn drilling will, therefore, be necessary to advance the socket into the bedrock.

6.2.3 Foundations Anchored to Rock

It is considered that the option of a footing or caisson anchored to the rock is likely the more practical/economic option for signs 3 and 4.

Where anchoring of caissons or spread footings is adopted, it is recommended that MTO's Special Provision SP902S01 be included in the Contract Documents, requiring inspection and approval of the foundation area by the Quality Verification Engineer prior to footing construction, to ensure that all loose and/or highly fractured rock has been removed from the foundation areas. The horizontal resistance of the dowels is dependent on the strength of the bedrock, grout and steel. The dowels may be designed based on an unfactored passive lateral resistance for the rock mass of 1 MPa. A resistance factor of 0.5 should be applied in order to obtain the factored lateral geotechnical resistance at ULS. The rock dowels should have a minimum embedded length within the bedrock of 1 m, and the structural strength of the dowel and the compressive strength of the grout should not be exceeded.

For uplift of the dowels, a factored value of 700 kPa may be assumed for the cement grout-to-rock bond stress for ULS design. The actual bond stress along the rock-grout interface may vary from the design value given and it should, therefore, be verified in the field by pull-out testing; in this case, a Special Provision will have to be included in the Contract Documents to cover this testing. It should be noted that it is important that the annular space be compatible with the dowel size; typically, an annular space of about 6 mm to 10 mm (1/4 in. to 3/8 in.) is appropriate for use with deformed bar and cement grout.

A sample Non-Standard Special Provision (NSSP) which addresses the supply, installation and testing of rock dowels is included in Appendix A.

6.3 Ground Mounted Sign Foundations

Foundations for ground mounted signs should be designed in accordance with the following standard design methods contained in MTO's Sign Support Manual:

- Steel Column Sign Supports, Section 5, and Standard Drawing SS118-30.



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In the standard ground mounted sign footing design, the footing depth is determined based on the sign area and number of columns (Section 5.4.3 of MTO's Sign Support Manual) with no particular requirements in regards to the supporting soil. The standard footing depths range between 1.6 and 2.8 metres.

The following table summarizes the proposed footing depth, and the depth to intact/fresh bedrock and the bedrock surface elevation in the boreholes at each of the proposed ground mounted sign support locations where bedrock was encountered, as determined by bedrock coring and inferred from auger refusal:

Borehole No.	Sign Number – Sign Support Location	Proposed Footing Depth (m)	Depth to Refusal/ Fresh Bedrock (m)	Fresh Bedrock Surface Elevation (m)
09-404	13 – Hwy 7 EBL, Stn. 18+544	2.0	1.5 ¹	134.8
09-405	14 – Hwy 7 WBL, Stn. 18+940	2.5	1.5 ¹	135.6
09-406	12 – Hwy 7 WBL, Stn. 17+940	2.5	2.2	128.5
09-407	10 – Hwy 7 WBL, Stn. 16+680	1.9	2.9	125.1

Note 1: Weathered bedrock exists above that level which was penetrated by augering.

Footings for ground mounted signs are constructed by placing steel columns within concrete filled holes. The depth to (fresh/intact) bedrock at ground mounted signs 10 (Hwy 7 WBL, Stn. 16+680), 12 (Hwy 7 WBL, Stn. 17+940), 13 (Hwy 7 EBL, Stn. 18+544), and 14 (Hwy 7 WBL, Stn. 18+940) ranges from about 1.5 to 2.9 m relative to the ground surface at the sign support locations. Based on these bedrock depths and the proposed footing depths, the foundations for signs 12, 13, and 14 could be within the bedrock. For these three signs, it will be required to drill holes into the bedrock, to reach the proposed footing depths. It is noted that the bedrock at the site is medium strong to strong. Coring or churn drilling could, therefore, be necessary to advance holes into the bedrock. Consideration could instead be given to the use of foundations anchored to the rock. Recommendations for rock anchors were provided in Section 6.2.3. The foundation system should be selected by the structural designers based on the structural requirements of the project. However, foundations socketed into the bedrock are probably the preferred option.

Signs 8, 9, 10, and 11 will be founded within the overburden soils. No unusual problems are anticipated in drilling in the overburden for these signs. A site-specific design is not required at the location of signs 9, 11, and 12. Sign 8 (Hwy 7 EBL, Stn. 15+200) will be founded in peat fill and natural peat, which is not a suitable founding soil. Two alternatives could therefore be considered:

- 1 – The peat could be subexcavated and replaced with compacted engineered fill.
- 2 – A site specific design be carried out.

For Option 1, the peat deposit should be removed from the footing locations and replaced with compacted engineered fill, as shown on Figure 6. It is recommended that the peat be removed from the area extending laterally from the sign support (in all directions) by a distance equal to the foundation depth. The peat should be replaced with Granular B Type II, placed in maximum 300 mm thick lifts, and compacted to at least 95% of its standard Proctor maximum dry density.



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For Option 2, parameters are provided in Table 3 for carrying out a site specific design. It is possible that a caisson diameter larger than the typical 0.45 metres may be required. Note: Parameters below 6.1 m depth cannot be provided since the borehole terminated at that depth.

The selection of the preferred foundation system, between Options 1 and 2, should be made by the structural designers based on the structural requirements.

A summary of the foundation design options for each of the ground mounted signs is provided on Table 2. Should site specific designs be carried out (using the methods described previously in Section 6.2.1), parameters are provided in Table 3.

6.4 Construction Considerations

It is recommended that an NSSP be included in the Contract Documents to warn the Contractor of the following items that are expected to affect the installation of the sign foundations:

- **Control of overburden soils and groundwater:** The overburden soils at the sign locations include water-bearing peat, sand, sandy silt, and silty sand till. These soils should be expected to be unstable below the groundwater level. Cohesionless soil under these conditions are subjected to unbalanced hydrostatic pressures and thus will slough, cave-in and boil. "Perched" groundwater may also be encountered at the base of cohesionless fill materials, atop the underlying, less permeable clayey silt or till deposit. Wet cohesionless soils should be expected to run or flow into the caisson holes during or after drilling for the foundations. Therefore, temporary or permanent caisson liners are recommended to minimize ground loss during drilling and concrete placement.
- **Bedrock strength:** Some of the sign foundations will require sockets to be formed within the bedrock. Where not weathered, the bedrock at the site includes medium strong to strong shale, limestone, sandy limestone, dolostone and/or dolomitic limestone. It should be anticipated that it will be necessary to use rock coring or churn drilling techniques to advance the caisson holes into the medium strong to strong bedrock, that wear of the drill bits will be high, and that the rate of progress in forming the socket will be slow.
- **Cobbles and boulders:** Cobbles and boulders have been encountered within the till deposit. Appropriate equipment and procedures will be required to penetrate these obstructions during excavation for foundation construction.

Sample NSSPs to address these requirements are included in Appendix A.

As described previously, a sample NSSP is also included in regards to the requirements for the supply, installation and testing of rock dowels which may be required for the foundation of signs 3, and 4.



7.0 CLOSURE

This report was prepared by Mrs. Kim S. Lesage, EIT under the direction of the Project Manager, Mr. Michael I. Cunningham, P.Eng. This report was reviewed by Mr. Fintan J. Heffernan P.Eng., the designated MTO contact for this project.

Yours truly,

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Table 1: Summary of Water Content and Atterberg Limit Determination

Borehole No.	Sample No.	Depth (m)	Water Content (%)	Atterberg Limits			
				W _L	W _P	LI	PI
08-101	3	2.29-2.90	34	52	26	0.3	27
08-101	7	5.34-5.95	36	47	24	0.5	23
08-102	3	1.52-2.13	40	51	26	0.6	25
08-102	8	5.34-5.95	38	48	24	0.6	24
08-103	3	1.52-2.13	39	57	25	0.4	32
08-103	6	4.57-5.18	34	45	23	0.5	22
08-106	2	1.52-2.13	300	-	-	-	-
08-106	4	3.05-3.66	22	30	17	0.4	14
08-107	2	1.52-2.13	8	N/A	N/A	N/A	N/A
08-108	8B	6.10-6.71	8	N/A	N/A	N/A	N/A
08-401	5	3.81-4.42	44	N/A	N/A	N/A	N/A
08-401	6	4.57-5.18	39	N/A	N/A	N/A	N/A
08-401	7	5.49-6.10	32	48	28	0.2	21
08-402	4	2.29-2.90	37	N/A	N/A	N/A	N/A
08-402	6	3.81-4.42	40	N/A	N/A	N/A	N/A
08-402	8	5.49-6.10	35	46	25	0.5	21
08-403	3	2.29-2.90	41	54	23	0.6	31
08-403	5	3.81-4.42	33	N/A	N/A	N/A	N/A
08-403	7	5.34-5.95	33	N/A	N/A	N/A	N/A



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Table 2 : Comparison of Foundation Alternatives

Sign #	Sign Type	Caisson Foundation in Soil	Caisson Foundation in Soil with Rock Socket	Caisson Foundation in Soil with Rock Dowels	Spread Footings on Rock with Rock Dowels
1	Trichord Overhead	Preferred Alternative	N/A	N/A	N/A
2	Variable Message	Preferred Alternative	N/A	N/A	N/A
3	Variable Message	N/A – Rock too shallow	Feasible, but not economic	Feasible, but not economic	Preferred Alternative
4	Variable Message	N/A – Rock too shallow	Feasible, but not economic	Feasible, but not economic	Preferred Alternative
5	Variable Message	N/A – Rock too shallow	Preferred Alternative	Feasible, but not preferred	Not practical due to depth to bedrock surface
6	Variable Message	N/A – Rock too shallow	Preferred Alternative	Feasible, but not preferred	Not practical due to depth to bedrock surface
7	Cantilever	Preferred Alternative – If grade is raised or if acceptable by site-specific design	Preferred option if grade not raised or caisson in soil not feasible based on a site-specific design	Probably not feasible due to depth to bedrock surface	Not feasible due to depth to bedrock surface
8	Ground Mounted	Preferred Alternative ¹	N/A	N/A	N/A
9	Ground Mounted	Preferred Alternative ¹	N/A	N/A	N/A



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Sign #	Sign Type	Caisson Foundation in Soil	Caisson Foundation in Soil with Rock Socket	Caisson Foundation in Soil with Rock Dowels	Spread Footings on Rock with Rock Dowels
10	Ground Mounted	Preferred Alternative ¹ , provided foundations less than 2.9 metres deep	N/A	N/A	N/A
11	Ground Mounted	Preferred Alternative ¹	N/A	N/A	N/A
12	Ground Mounted	N/A – Rock too shallow	Preferred Alternative ¹	Feasible, but not economic	Feasible, but probably not preferred
13	Ground Mounted	N/A – Rock too shallow	Preferred Alternative ¹	Feasible, but not economic	Feasible, but probably not preferred
14	Ground Mounted	N/A – Rock too shallow	Preferred Alternative ¹	Feasible, but not economic	Feasible, but probably not preferred

¹ Ground mounted sign supports on steel columns

N/A – Not an applicable/appropriate design option



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Table 3: Design Parameters

Sign Number – Sign Support Location	Sign Type	Borehole No.	Stratum	Depth ¹ (m)	Elevation (m)	Groundwater Elevation (m)	Design Parameters ^{2,3}			
							c _u	Φ'	γ	K _p
1-Hwy 7 WBL, Stn. 14+835	Trichord Overhead	08-101	Topsoil	0.0 – 0.2	128.3 – 128.1	122.4	75	30	18	8
			Silty clay (Weathered Crust)	0.2 – 6.7	128.1 – 121.6					
1-Hwy 7 WBL, Stn. 14+835	Trichord Overhead	08-102	Fill	0.0 – 1.5	129.6 – 128.1	123.7	–	30	18.5	8.5
			Silty clay (Weathered Crust)	1.5 – 6.7	128.1 – 122.9					
2-Hwy 7 EBL, Stn. 15+980	Variable Message	08-103	Topsoil	0.0 – 0.1	127.8 – 127.7	Dry	75	30	18	8
			Silty clay (Weathered Crust)	0.1 – 6.7	127.7 – 121.1					
3-Hwy 7 EBL, Stn. 12+000	Variable Message	08-104	Sandy silt	0.0 – 0.8	135.2 – 134.4	–	–	30	20	10
			Weathered Shale (Bedrock)	0.8 – 0.9	134.4 – 134.7					
			Limestone (Bedrock)	Below 0.9	Below 134.7					
4-Hwy 7 EBL, Stn. 12+100	Variable Message	08-105	Topsoil	0.0 – 0.2	135.6 – 135.4	–	75	30	18	8
			Silty Clay (Weathered Crust)	0.2 – 0.8	135.4 – 134.8					
			Limestone (Bedrock)	Below 0.8	Below 134.8					
5-Hwy 7 WBL, Stn. 18+000	Variable Message	08-106	Peat	0.0 – 2.1	133.9 – 131.8	131.8	–	–	10	–
			Sand	2.1 – 3.1	131.8 – 130.9					
			Silty clay	3.1 – 4.4	130.9 – 129.5					
			Silty sand Till	4.4 – 4.7	129.5 – 129.2					
			Limestone (Bedrock)	Below 4.7	Below 129.2					
6-Hwy 7 WBL, Stn. 18+100	Variable Message	08-107	Fill	0.0 – 0.5	134.5 – 134.0	–	–	28	20	10
			Silty clay (Weathered Crust)	0.5 – 0.9	134.0 – 133.6					
			Silty sand Till	0.9 – 3.3	133.6 – 131.2					
			Limestone (Bedrock)	Below 3.3	Below 131.2					



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Sign Number – Sign Support Location	Sign Type	Borehole No.	Stratum	Depth ¹ (m)	Elevation (m)	Groundwater Elevation (m)	Design Parameters ^{2,3}				
							c _u	ϕ'	γ	γ'	K _p
7-W/417W Ramp Stn. 11+890	Cantilever	08-108	Fill	0.0 – 5.8	134.4 – 128.6	–	–	30	20	10	3.0
			Topsoil	5.8 – 5.9	128.6 – 128.5						
			Silt	5.9 – 6.5	128.5 – 127.9	–	30	20	10	3.0	
			Silty sand Till	6.5 – 7.6	127.9 – 126.8	–	32	22	12	3.3	
8-Hwy 7 EBL, Stn. 15+200	Ground Mounted	09-401	Fill	0.0 – 1.4	127.4 – 126.0	126.8	–	–	10	–	–
			Peat	1.4 – 3.8	126.0 – 123.6		–	–	10	–	–
			Silty Clay	3.8 – 6.1	123.6 – 121.3		50	30	18	8	3.0
9-Hwy 7 EBL, Stn. 15+952	Ground Mounted	09-402	Fill	0.0 – 0.6	127.9 – 127.3	–	–	28	20	10	2.8
			Silty Clay to Clayey Silt	0.6 – 1.5	127.3 – 126.4		75	30	18	8	3.0
			Silty Clay (Weathered Crust)	1.5 – 3.7	126.4 – 124.2		75	30	18	8	3.0
			Sity Clay	3.7 – 6.1	124.2 – 121.8		75	30	18	8	3.0
11-Hwy 7 EBL, Stn. 16+952	Ground Mounted	09-403	Topsoil	0.0 – 0.3	128.8 – 128.5	Dry	75	30	18	8	3.0
			Silty Clay (Weathered Crust)	0.3 – 3.7	128.5 – 125.1		75	30	18	8	3.0
			Silty Clay	3.7 – 5.9	125.1 – 122.9						
13-Hwy 7 EBL, Stn. 18+544	Ground Mounted	09-404	Topsoil	0.0 – 0.3	136.3 – 136.0	–					
			Clayey Silt	0.3 – 0.9	136.0 – 135.4		75	30	18	8	3.0
			Weathered Shale (Bedrock)	0.9 – 1.5	135.4 – 134.8		–	40	25	15	4.6
			Sandy Limestone (Bedrock)	1.5 – 4.5	134.8 – 131.8						
14-Hwy 7 WBL, Stn. 18+940	Ground Mounted	09-405	Topsoil	0.0 – 0.4	137.1 – 136.7	136.5	–	40	25	15	4.6
			Weathered Shale (Bedrock)	0.4 – 1.5	136.7 – 135.6						
			Dolostone (Bedrock)	1.5 – 3.1	135.6 – 134.1						
			Dolomitic Limestone (Bedrock)	3.1 – 4.7	134.1 – 132.4						
12-Hwy 7 WBL, Stn. 17+940	Ground Mounted	09-406	Topsoil	0.0 – 0.3	130.7 – 130.4	129.8					
			Silty Sand	0.3 – 1.1	130.4 – 129.6		–	28	20	10	2.8
			Silty Clay (Weathered Crust)	1.1 – 2.2	129.6 – 128.5		75	30	18	8	3.0
			Dolostone (Bedrock)	2.2 – 5.3	128.5 – 125.4						



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Sign Number – Sign Support Location	Sign Type	Borehole No.	Stratum	Depth ¹ (m)	Elevation (m)	Groundwater Elevation (m)	Design Parameters ^{2,3}			
							c_u	ϕ'	γ	K_p
10-Hwy 7 WBL, Strn. 16+680	Ground Mounted	09-407	Topsoil	0.0 – 0.3	128.0 – 127.8	-				
			Silty Clay (Weathered Crust)	0.3 – 2.4	127.8 – 125.6		75	30	18	8
			Sandy Silt Till	2.4 – 2.9	125.6 – 125.1		-	32	22	12
			Dolostone (Bedrock)	2.9 – 6.1	125.1 – 121.9					3.3

NOTES:

1. Depths are given for the borehole location; the ground surface elevation at the borehole location should be compared to the ground surface elevation at the actual sign support location, and the depths of the soil strata and depth to bedrock adjusted accordingly.

2. Design parameters: c_u Is undrained shear strength (kPa);

ϕ' Is effective friction angle (degrees);

γ Is bulk unit weight (kN/m³);

γ' Is effective unit weight below the groundwater level (kN/m³); and,

K_p Is passive earth pressure coefficient.

3. Although the passive resistance in the upper 1.8 m is neglected to account for frost action, c_u , ϕ' and K_p parameters are given in the event that the ground surface elevation varies significantly between the borehole and sign support locations.

4. No strength was assigned to the topsoil and peat.

LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE		III. SOIL DESCRIPTION	
AS	Auger sample	(a)	Cohesionless Soils
BS	Block sample		
CS	Chunk sample		
DO	Drive open	Density Index	N
DS	Denison type sample	(Relative Density)	Blows/300 mm
FS	Foil sample		Or Blows/ft.
RC	Rock core	Very loose	0 to 4
SC	Soil core	Loose	4 to 10
ST	Slotted tube	Compact	10 to 30
TO	Thin-walled, open	Dense	30 to 50
TP	Thin-walled, piston	Very dense	over 50
WS	Wash sample	(b)	Cohesive Soils
DT	Dual Tube sample	Consistency	C _u or S _u
II. PENETRATION RESISTANCE			
Standard Penetration Resistance (SPT), N:			
The number of blows by a 63.5 kg. (140 lb.)			
hammer dropped 760 mm (30 in.) required			
to drive a 50 mm (2 in.) drive open			
Sampler for a distance of 300 mm (12 in.)			
DD- Diamond Drilling			
Dynamic Penetration Resistance; N_d:			
The number of blows by a 63.5 kg (140 lb.)			
hammer dropped 760 mm (30 in.) to drive			
Uncased a 50 mm (2 in.) diameter, 60° cone			
attached to "A" size drill rods for a distance			
of 300 mm (12 in.).			
PH:	Sampler advanced by hydraulic pressure	Very soft	Kpa 0 to 12 Psf 0 to 250
PM:	Sampler advanced by manual pressure	Soft	12 to 25 250 to 500
WH:	Sampler advanced by static weight of hammer	Firm	25 to 50 500 to 1,000
WR:	Sampler advanced by weight of sampler and rod	Stiff	50 to 100 1,000 to 2,000
		Very stiff	100 to 200 2,000 to 4,000
		Hard	Over 200 Over 4,000
Peizo-Cone Penetration Test (CPT):			
An electronic cone penetrometer with			
a 60° conical tip and a projected end area			
of 10 cm ² pushed through ground			
at a penetration rate of 2 cm/s. Measurements			
of tip resistance (Q _t), porewater pressure			
(PWP) and friction along a sleeve are recorded			
Electronically at 25 mm penetration intervals.			
		IV. SOIL TESTS	
		w	water content
		w _p	plastic limited
		w _l	liquid limit
		C	consolidaiton (oedometer) test
		CHEM	chemical analysis (refer to text)
		CID	consolidated isotropically drained triaxial test ¹
		CIU	consolidated isotropically undrained triaxial test
			with porewater pressure measurement ¹
		D _R	relative density (specific gravity, G _s)
		DS	direct shear test
		M	sieve analysis for particle size
		MH	combined sieve and hydrometer (H) analysis
		MPC	modified Proctor compaction test
		SPC	standard Proctor compaction test
		OC	organic content test
		SO ₄	concentration of water-soluble sulphates
		UC	unconfined compression test
		UU	unconsolidated undrained triaxial test
		V	field vane test (LV-laboratory vane test)
		γ	unit weight

Note:

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

LIST OF SYMBOLS

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

I. GENERAL

π	= 3.1416
$\ln x$	natural logarithm of x
$\log_{10} x$ or $\log x$	logarithm of x to base 10
g	Acceleration due to gravity
t	time
F	factor of safety
V	volume
W	weight

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight*)
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = p_s/p_w$) formerly (G_s)
e	void ratio
n	porosity
S	degree of saturation
*	Density symbol is p . Unit weight symbol is γ where $\gamma = pg$ (i.e. mass density x acceleration due to gravity)

(a) Index Properties (cont'd.)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (overconsolidated range)
C_s	swelling index
C_a	coefficient of secondary consolidation
m_v	coefficient of volume change
c_v	coefficient of consolidation
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation pressure
OCR	Overconsolidation ratio = σ'_p/σ'_{vo}

(d) Shear Strength

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

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

2. Shear strength = (Compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of weathering

Faintly Weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock texture and structure are preserved.

BEDDING THICKNESS

<u>Description</u>	<u>Bedding Plane Spacing</u>
Very thickly bedded	>2 m
Thickly bedded	0.6 m to 2m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	<6 mm

JOINT OR FOLIATION SPACING

<u>Description</u>	<u>Spacing</u>
Very wide	>3 m
Wide	1 – 3 m
Moderately close	0.3 – 1 m
Close	50 – 300 mm
Very close	<50 mm

GRAIN SIZE

<u>Term</u>	<u>Size*</u>
Very Coarse Grained	>60 mm
Coarse Grained	2 – 60 mm
Medium Grained	60 microns - 2mm
Fine Grained	2 – 60 microns
Very Fine Grained	<2 microns

Note: *Grains >60 microns diameter are visible to the naked eye.

O:\Templates\Rock Description Terminology

CORE CONDITION

Total Core Recovery

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varies from 0% for completely broken core 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to (W.R.T.) Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviated description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

B –	Bedding	Ca-	Calcite
FO-	Foliation/Schistosity	P-	Polished
CL -	Cleavage	S-	Slickensided
SH -	Shear Plane/Zone	SM-	Smooth
VN-	Vein	R-	Ridged/Rough
F -	Fault	ST-	Stepped
CO-	Contact	PL-	Planar
J -	Joint	FL-	Flexured
FR-	Fracture	UE-	Uneven
MF -	Mechanical	W-	Wavy
A-	Angular	C-	Curved
BP-	Bedding Plane	H-	Hackly
BL-	Blast Induced	SL-	Sludge Coated
ll	Parallel To	TCA-	To Core Axis
	Perpendicular To	STR-	Stress Induced

PROJECT 06-1120-014-4000		RECORD OF BOREHOLE No 08-101		1 OF 1	METRIC
W.P. 252-99-00	LOCATION N 4999507.9; E 335002.0	ORIGINATED BY D.G.			
DIST _____ HWY 7	BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem	COMPILED BY J.M.			
DATUM Geodetic	DATE June 9, 2008	CHECKED BY K.S.L.			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED						
128.3	GROUND SURFACE							20 40 60 80 100	25 50 75						
0.0	Silty sand with organic matter (TOPSOIL)														
0.2	Black SILTY CLAY (Weathered Crust) Very stiff Grey-brown Moist to wet														
			1	SS	9										
			2	SS	9										
			3	SS	15										
			4	SS	12										
			5	SS	7										
			6	SS	5										
			7	SS	4										
			8	SS	5										
121.6	End of Borehole														
6.7	Note: Water level in open borehole at 5.9 m depth (Elev. 122.4 m) upon completion of drilling														

+ 3, X 3

Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

PROJECT 06-1120-014-4000		RECORD OF BOREHOLE No 08-102		1 OF 1	METRIC
W.P. 252-99-00		LOCATION N 4999499.0; E 335003.4		ORIGINATED BY D.G.	
DIST HWY 7		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.	
DATUM Geodetic		DATE June 9, 2008		CHECKED BY K.S.L.	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED		W _p	W	W _L		
129.6	GROUND SURFACE													
0.0	Medium sand, some crushed stone (FILL)		1	GRAB										
129.3	Brown													
0.3	Moist													
128.8	Sand and gravel (FILL)													
	Brown													
	Moist													
0.8	Silty sand with organic matter (TOPSOIL FILL)		2	SS	12									
	Black													
	Moist													
128.1	Silty sand (FILL)													
	Grey													
	Moist													
1.5	SILTY CLAY (Weathered Crust)		3	SS	9									
	Very stiff													
	Grey-brown													
	Moist to wet													
			4	SS	8									
			5	SS	10									
			6	SS	11									
			7	SS	9									
			8	SS	5									
			9	SS	8									
122.9	End of Borehole													
6.7	Note: Water level in open borehole at 5.9 m depth (Elev. 123.7 m) upon completion of drilling													

MISS. MTO 06-1120-014-4000 GPJ ON MOT GDT 5/7/09

PROJECT <u>06-1120-014-4000</u>		RECORD OF BOREHOLE No 08-103		1 OF 1	METRIC
W.P. <u>252-99-00</u>	LOCATION <u>N 5000244.4; E 335875.2</u>	ORIGINATED BY <u>H.E.C.</u>			
DIST <u></u> HWY <u>7</u>	BOREHOLE TYPE <u>Power Auger 108mm I.D. Hollow Stem</u>	COMPILED BY <u>J.M.</u>			
DATUM <u>Geodetic</u>	DATE <u>June 10, 2008</u>	CHECKED BY <u>K.S.L.</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								<div><div>○ UNCONFINED</div><div>● QUICK TRIAXIAL</div></div>	<div><div>+ FIELD VANE</div><div>× REMOULDED</div></div>	<div><div>W_p</div><div>W</div><div>W_L</div></div>				

127.8	GROUND SURFACE													
0.0	Silty sand with organic matter (TOPSOIL)													
0.1	Black SILTY CLAY, trace shells (Weathered Crust) Very stiff Grey-brown Moist													
			1	SS	13		127							
			2	SS	11		126							
			3	SS	13		125							
			4	SS	9		124							
			5	SS	8		123							
			6	SS	7		122							
			7	SS	9									
			8	SS	9									
121.1	End of Borehole													
6.7	Note: Borehole dry upon completion of drilling													

MISS MTO 06-1120-014-4000 GPJ ON MOT GDT 5/7/09

PROJECT 06-1120-014-4000			RECORD OF BOREHOLE No 08-104			1 OF 1			METRIC		
W.P. 252-99-00			LOCATION N 5005507.4; E 340557.2			ORIGINATED BY D.G.					
DIST _____ HWY 7			BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem			COMPILED BY J.M.					
DATUM Geodetic			DATE June 12, 2008			CHECKED BY K.S.L.					

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W		
135.2	GROUND SURFACE															
0.0	TOPSOIL Sandy SILT, trace gravel, occasional cobble Grey-brown Moist to wet															
134.4	Shale (BEDROCK) Weathered Brown Moist to wet		1	SS	>50											
0.9	Limestone (BEDROCK) Slightly weathered to fresh and fractured Medium bedded Grey Strong		2	NQ RC	REC 100%											
			3	NQ RC	REC 100%											
	- Strong, thinly bedded, greenish grey Dolomite layer from 1.2m to 1.9m depth		4	NQ RC	REC 100%											
	Bedrock cored between 0.9 m and 4.0 m depth. For bedrock coring details refer to Record of Drillhole 08-104.		5	NQ RC	REC 100%											
131.2	End of Borehole															
4.0																

MISS MTO 06-1120-014-4000.GPJ ON MOT GDT 5/7/09

PROJECT: 06-1120-014-4000

RECORD OF DRILLHOLE: 08-104

SHEET 1 OF 1

LOCATION: N 5005507.4; E 340557.2

DRILLING DATE: 6/12/2008

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: --

DRILL RIG: CME 850

DRILLING CONTRACTOR: Marathon Drilling Co. Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH	COLOUR & RETURN	FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED												DIAMETER POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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DEPTH SCALE

1 : 50



LOGGED: H.E.C.

CHECKED: K.S.L.

MIS-RCK 001 06-1120-014-4000 (ROCK) GPJ GAL-MISS.GDT 5/9/09 JM

PROJECT 06-1120-014-4000		RECORD OF BOREHOLE No 08-105		1 OF 1	METRIC
W.P. 252-99-00		LOCATION N 5005606.5; E 340561.4		ORIGINATED BY D.G.	
DIST HWY 7		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.	
DATUM Geodetic		DATE June 11, 2008		CHECKED BY K.S.L.	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x REMOULDED					WATER CONTENT (%) w _p w w _L				
135.6	GROUND SURFACE						20	40	60	80	100	25	50	75			
0.0	Sandy silt with organic matter (TOPSOIL)																
135.4	Dark grey Moist		1	GRAB													
0.2	SILTY CLAY (Weathered Crust)																
134.8	Grey-brown Moist																
0.8	Limestone (BEDROCK)		2	HQ RC	REC 100%											RQD 0%	
	Highly weathered																
	Medium bedded		3	HQ RC	REC 100%											RQD 0%	
	Grey																
	Strong																
133.1	Limestone (BEDROCK)																
2.5	Fractured		4	HQ RC	REC 100%											RQD 0%	
	Faintly weathered to fresh																
	Thinly to medium bedded																
	Grey																
	Strong																
	Bedrock cored between 0.8 m and 4.2 m depth. For bedrock coring details refer to Record of Drillhole 08-105.		5	HQ RC	REC 100%											RQD 0%	
131.4																	
-4.2	End of Borehole																

MISS_MTO 06-1120-014-4000 GPJ ON MOT GDT 5/7/09

PROJECT: 06-1120-014-4000

RECORD OF DRILLHOLE: 08-105

SHEET 1 OF 1

LOCATION: N 5005606.5; E 340561.4

DRILLING DATE: 6/11/2008

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 850

DRILLING CONTRACTOR: Marathon Drilling Co, Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	FLUSH % RETURN	COLOUR % RETURN	FR/FX-FRACTURE F-FAULT		SM-SMOOTH	FL-FLEXURED	BC-BROKEN CORE		DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
									CL-CLEAVAGE	J-JOINT	R-ROUGH	UE-UNEVEN	MB-MECH. BREAK			
									SH-SHEAR	P-POLISHED	ST-STEPPED	W-WAVY	B-BEDDING			
									VN-VEIN	S-SLICKENSIDED	PL-PLANAR	C-CURVED				
RECOVERY		R.Q.D. %	FRACT INDEX PER 0.3	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec										
TOTAL CORE %	SOLID CORE %			DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	10 ⁶	10 ⁵									
10 ⁴	10 ³	10 ²	10 ¹	10 ⁰		10 ⁶	10 ⁵									
1	Power Auger HQ Core	Continued from Record of Borehole 08-105		134.80 0.00												
		Limestone (BEDROCK) Highly weathered Medium bedded Grey Strong		1												
2				2												
			Limestone (BEDROCK) Fractured Faintly weathered to fresh Thinly to medium bedded Grey Strong	133.10 2.50	3											
3		4														
4		End of Drillhole		131.40 4.20												
5																
6																
7																
8																
9																
10																

DEPTH SCALE

1 : 50



LOGGED: D.G.

CHECKED: K.S.L.

MIS-RCK 001 06-1120-014-4000 (ROCK) GPJ GAL-MISS GDT 5/9/09 JM

PROJECT 06-1120-014-4000			RECORD OF BOREHOLE No 08-106			1 OF 1			METRIC																
W.P. 252-99-00			LOCATION N 5009957.6; E 344184.2			ORIGINATED BY D.G.																			
DIST _____ HWY 7			BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem			COMPILED BY J.M.																			
DATUM Geodetic			DATE June 12, 2008			CHECKED BY K.S.L.																			
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																				
133.9	GROUND SURFACE																								
0.0	PEAT Black Moist																								
			1	SS	1																				
			2	SS	3																				
131.8																									
2.1	SAND, trace silt Loose Grey Wet		3	SS	5																				
130.9																									
3.1	SILTY CLAY Very stiff Grey Wet		4	SS	13																				
			5	SS	8																				
129.5																									
4.4	Silty SAND, some gravel, trace clay (TILL) Grey Wet		6	SS	>50																				
129.2																									
4.7	Limestone (BEDROCK) Fractured Medium bedded Grey Strong		7	NQ RC	REC 100%																				
			8	NQ RC	REC 100%																				
			9	NQ RC	REC 100%																				
128.0																									
5.9	Limestone (BEDROCK) Fresh Thinly to medium bedded Grey Strong		10	NQ RC	REC 100%																				
	Bedrock cored between 4.7 m and 8.0 m depth. For bedrock coring details refer to Record of Drillhole 08-106.		11	NQ RC	REC 100%																				
126.0																									
8.0	End of Borehole																								
	Note: Water level in open borehole at 2.1 m depth (Elev. 131.8 m) upon completion of drilling																								

MISS_MTO 06-1120-014-4000 GPJ ON MOT GDT 5/7/09

PROJECT: 06-1120-014-4000

RECORD OF DRILLHOLE: 08-106

SHEET 1 OF 1

LOCATION: N 5009957.6; E 344184.2

DRILLING DATE: 6/12/2008

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 850

DRILLING CONTRACTOR: Marathon Drilling Co. Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH	COLOUR % RETURN	FR/FX-FRACTURE F-FAULT				SM-SMOOTH				FL-FLEXURED				BC-BROKEN CORE				DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION				
									CL-CLEAVAGE				J-JOINT				R-ROUGH				UE-UNEVEN						MB-MECH. BREAK			
									SH-SHEAR				P-POLISHED				ST-STEPPED				W-WAVY						B-BEDDING			
									VN-VEIN				S-SLICKENSIDED				PL-PLANAR				C-CURVED									
						RECOVERY		R.Q.D. %		FRACT INDEX PER 0.3		DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K _f cm/sec																
						TOTAL CORE %		SOLID CORE %						DIP w.r.t CORE AXIS		TYPE AND SURFACE DESCRIPTION		10 ⁻⁶		10 ⁻⁵		10 ⁻⁴		10 ⁻³						
						88888		88888		88888		88888		88888																
5	Rotary Drill NG Core	Continued from Record of Borehole 08-106		129.20																										
		Limestone (BEDROCK) Fractured Medium bedded Grey Strong		4.70	1																									
					2																									
6			Limestone (BEDROCK) Fresh Thinly to medium bedded Grey Strong		128.00	3																								
					5.00	4																								
7					5																									
8		End of Drillhole		125.00																										
				8.00																										
9																														
10																														
11																														
12																														
13																														
14																														

DEPTH SCALE

1 : 50



LOGGED: D.G.

CHECKED: K.S.L.

MIS-RCK 001 06-1120-014-4000 (ROCK) GPJ GAL-MISS GDT 5/9/09 JM

PROJECT <u>06-1120-014-4000</u>		RECORD OF BOREHOLE No 08-107		1 OF 1	METRIC
W.P. <u>252-99-00</u>		LOCATION <u>N 5010025.0; E 344258.5</u>		ORIGINATED BY <u>D.G.</u>	
DIST <u> </u> HWY <u>7</u>		BOREHOLE TYPE <u>Power Auger 108mm I.D. Hollow Stem</u>		COMPILED BY <u>J.M.</u>	
DATUM <u>Geodetic</u>		DATE <u>June 12, 2008</u>		CHECKED BY <u>K.S.L.</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)						
								20 40 60 80 100			w _p w w _L						
						○ UNCONFINED + FIELD VANE											
						● QUICK TRIAXIAL × REMOULDED											
134.5	GROUND SURFACE																
0.0	Sand and gravel (FILL) Brown																
134.0																	
0.5	SILTY CLAY (Weathered Crust) Grey-brown Moist																
133.6																	
0.9	Silty SAND, some gravel, trace clay, with cobbles and boulders (TILL) Loose to dense Grey brown Moist		1	SS	6												
			2	SS	23											17 43 30 10	
			3	SS	42												
131.2			4	SS	>50												
3.3	Limestone (BEDROCK) Fresh Thinly to medium bedded Grey Strong Bedrock cored between 3.3 m and 6.4 m depth. For bedrock coring details refer to Record of Drillhole 08-107.		5	NQ RC	REC 100%											RQD 75%	
			6	NQ RC	REC 100%											RQD 69%	
			7	NQ RC	REC 100%											RQD 43%	
128.1																	
6.4	End of Borehole																

MISS_MTO 06-1120-014-4000.GPJ ON MOT GDT 5/7/09

PROJECT: 06-1120-014-4000

RECORD OF DRILLHOLE: 08-107

SHEET 1 OF 1

LOCATION: N 5010025.0; E 344258.5

DRILLING DATE: 6/12/2008

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 850

DRILLING CONTRACTOR: Marathon Drilling Co. Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.		RUN NO	PENETRATION RATE (m/min)	FLUSH	COLOUR % RETURN	FR/FX-FRACTURE F-FAULT CL-CLEAVAGE J-JOINT SH-SHEAR P-POLISHED VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED				SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR C-CURVED				FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED				BC-BROKEN CORE MB-MECH. BREAK B-BEDDING				DIAMETER POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
				DEPTH (m)	RECOVERY					R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA	HYDRAULIC CONDUCTIVITY K, cm/sec																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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DEPTH SCALE

1 : 50



LOGGED: D.G.


CHECKED: K.S.L.

MIS-RCK 001 06-1120-014-4000 (ROCK) GPJ GAL-MISS GDT 5/9/09 JM

PROJECT 06-1120-014-4000		RECORD OF BOREHOLE No 08-108		1 OF 1	METRIC
W.P. 252-99-00		LOCATION N 5014964.5; E 346162.9		ORIGINATED BY H.E.C.	
DIST _____ HWY 7		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.	
DATUM Geodetic		DATE June 13, 2008		CHECKED BY K.S.L.	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						
134.4	GROUND SURFACE						20 40 60 80 100									
0.0	Crushed limestone (BASE) Grey															
133.9	Crushed limestone (SUBBASE) Grey						134									
0.5	Moist															
133.6	Layered sandy silt and silty sand, trace gravel (FILL) Compact to dense Brown to grey Moist to wet		1	SS	34											
0.8							133									
			2	SS	14										0 57 39 4	
			3	SS	22		132									
			4	SS	28		131									
			5	SS	30		130									
			6	SS	28										0 61 35 4	
							129									
128.6			7	SS	27											
5.9	Silty sand, trace organic matter (TOPSOIL) Compact Black Wet														1 6 81 12	
127.9	SILT, some clay, trace sand Compact Brown Wet		8	SS	21		128								21 46 27 6	
6.5	Silty SAND, some gravel with cobbles (TILL) Grey Wet		9	SS	>50											
126.8							127									
7.6	End of Borehole Auger Refusal															

MISS_MTO 06-1120-014-4000 GFI ON MOT GDT 5/7/09

PROJECT 06-1120-014-4000		RECORD OF BOREHOLE No 09-401		1 OF 1		METRIC													
W.P. 252-99-00		LOCATION N 4999733.0; E 335290.5		ORIGINATED BY P.A.H.															
DIST _____ HWY 7		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.															
DATUM Geodetic		DATE Feb. 19, 2009		CHECKED BY K.S.L.															
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED			WATER CONTENT (%) w _p w w _L			γ kN/m ³			GR SA SI CL		
127.4 0.0	GROUND SURFACE Peat, some gravel (FILL) Dark brown to black Wet					▽	127												
			1	SS	4														
126.0 1.4	PEAT Dark brown Wet							126											
			2	SS	4														
		3	SS	WH			125												
		4	SS	WH		124													
123.6 3.8	SILTY CLAY Very stiff Grey Wet																		
		5	SS	2															
		6	SS	4															
		7	SS	14			122												
121.3 6.1	End of Borehole Note: Water level in open borehole at 0.6 m depth (Elev. 126.8 m) upon completion of drilling																		

MISS_MTO 06-1120-014-4000.GPJ ON MOT.GDT 5/7/09

PROJECT <u>06-1120-014-4000</u>			RECORD OF BOREHOLE No 09-402			1 OF 1			METRIC		
W.P. <u>252-99-00</u>			LOCATION <u>N 5000233.0; E 335852.1</u>			ORIGINATED BY <u>P.A.H.</u>					
DIST <u> </u> HWY <u>7</u>			BOREHOLE TYPE <u>Power Auger 108mm I.D. Hollow Stem</u>			COMPILED BY <u>J.M.</u>					
DATUM <u>Geodetic</u>			DATE <u>Feb. 20, 2009</u>			CHECKED BY <u>K.S.L.</u>					

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED		WATER CONTENT (%) w _p w w _L				
127.9	GROUND SURFACE													
0.0	Silty sand, trace gravel, organic matter and clay (FILL) Brown Frozen		1	A.S.										
127.3														
0.6	SILTY CLAY to CLAYEY SILT, trace shells Grey-brown Very moist		2	SS	6									
126.4														
1.5	SILTY CLAY (Weathered Crust) Very stiff Grey-brown Wet		3	SS	12									
			4	SS	12									
			5	SS	9									
124.2														
3.7	SILTY CLAY Very stiff Dark grey Wet		6	SS	7									
			7	SS	8									
			8	SS	7									
121.8														
6.1	End of Borehole													

MISS_MTO 06-1120-014-4000.GPJ ON MOT.GDT 5/7/09

PROJECT 06-1120-014-4000		RECORD OF BOREHOLE No 09-403		1 OF 1		METRIC							
W.P. 252-99-00		LOCATION N 5000879.0; E 336613.0		ORIGINATED BY P.A.H.									
DIST _____ HWY 7		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.									
DATUM Geodetic		DATE Feb. 20, 2009		CHECKED BY K.S.L.									
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
128.8	GROUND SURFACE												
0.0	TOPSOIL												
128.5	Dark brown												
0.3	SILTY CLAY (Weathered Crust)												
	Very stiff												
	Grey-brown												
	Wet												
			1	SS	9								
			2	SS	12								
			3	SS	9								
			4	SS	5								
125.1													
3.7	SILTY CLAY, some black organic mottling												
	Very stiff												
	Dark grey												
	Wet												
			5	SS	5								
			6	SS	5								
			7	SS	9								
122.9													
5.9	End of Borehole												
	Note: Borehole dry upon completion of drilling												

MISS_MTO 06-1120-014-4000.GPJ ON_MOT GDT 5/7/09

PROJECT 06-1120-014-4000			RECORD OF BOREHOLE No 09-404			1 OF 1			METRIC							
W.P. 252-99-00			LOCATION N 5001925.0; E 337813.9			ORIGINATED BY P.A.H.										
DIST HWY 7			BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem			COMPILED BY J.M.										
DATUM Geodetic			DATE Feb. 23, 2009			CHECKED BY K.S.L.										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED								
136.3	GROUND SURFACE															
0.0	TOPSOIL															
136.0																
0.3	CLAYEY SILT Light brown Moist		1	A.S.												
135.4																
0.9	Shale (BEDROCK) Completely to highly weathered Olive-grey		2	SS	33											
134.8																
1.5	Sandy Limestone (BEDROCK) Slightly weathered Thinly bedded Grey Strong		3	NQ RC	REC 96%											RQD 22%
133.3																
3.0	Sandy Limestone (BEDROCK) Fresh Thinly bedded Grey Medium strong to strong Bedrock cored between 1.5 m and 4.5 m depth. For bedrock coring details refer to Record of Drillhole 09-404.		4	NQ RC	REC 100%											RQD 40%
131.8																
4.5	End of Borehole															

MISS MTO 06-1120-014-4000 GPJ ON MOT GDT 5/7/09

PROJECT <u>06-1120-014-4000</u>		RECORD OF BOREHOLE No 09-405		1 OF 1	METRIC
W.P. <u>252-99-00</u>	LOCATION <u>N 5002235.0; E 338069.1</u>	ORIGINATED BY <u>P.A.H.</u>			
DIST <u>HWY 7</u>	BOREHOLE TYPE <u>Power Auger 108mm I.D. Hollow Stem</u>	COMPILED BY <u>J.M.</u>			
DATUM <u>Geodetic</u>	DATE <u>Feb. 18, 2009</u>	CHECKED BY <u>K.S.L.</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED						W _p W W _L		
137.1	GROUND SURFACE						20 40 60 80 100									
0.0	Organic silty clay, trace gravel (TOPSOIL)		1	A.S.			137									
136.7	Dark brown Moist															
0.4	Shale (BEDROCK) Completely to moderately weathered Grey-brown		2	SS	80		136									
135.6																
1.5	Dolostone (BEDROCK) Slightly weathered Thinly bedded Dark grey Medium strong to strong		3	NQ RC	REC 91%		135							RQD 0%		
			4	NQ RC	REC 95%										RQD 0%	
			5	NQ RC	REC 87%									RQD 0%		
134.1	Dolomitic Limestone (BEDROCK) Fresh Laminated to thinly bedded Light grey and olive-grey Medium strong to strong						134									
3.1	Bedrock cored between 1.5 m and 4.7 m depth. For bedrock coring details refer to Record of Drillhole 09-405.		6	NQ RC	REC 100%		133							RQD 62%		
132.4																
4.7	End of Borehole															
	Note: Water level in open borehole at 0.6 m depth (Elev. 136.5 m) upon completion of drilling															

MISS_MTO 06-1120-014-4000 GPJ ON_MOT GDT 5/7/09

PROJECT: 06-1120-014-4000

RECORD OF DRILLHOLE: 09-405

SHEET 1 OF 1

LOCATION: N 5002235.0; E 338069.1

DRILLING DATE: Feb, 18, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Marathon Drilling Co. Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH	COLOUR % RETURN	FR/FX-FRACTURE F-FAULT CL-CLEAVAGE J-JOINT SH-SHEAR P-POLISHED VN-VEIN S-SLICKENSIDED PL-PLANAR	SM-SMOOTH R-ROUGH ST-STEPPED C-CURVED	FL-FLEXURED UE-UNEVEN W-WAVY	BC-BROKEN CORE MB-MECH. BREAK B-BEDDING	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Record of Borehole 09-405		135.00										
2		Dolostone (BEDROCK) Slightly weathered Thinly bedded Dark grey Medium strong to strong		1.50										
3														
4														
5														
6														
7														
8														
9														
10														
11														
		End of Drillhole		132.40 4.70										

DEPTH SCALE

1 : 50



LOGGED: P.A.H.

CHECKED: K.S.L.

MIS-RCK 001 06-1120-014-4000 (ROCK) GPJ GAL-MISS GDT 5/9/09 JM

PROJECT <u>06-1120-014-4000</u>		RECORD OF BOREHOLE No 09-406		1 OF 1	METRIC
W.P. <u>252-99-00</u>		LOCATION <u>N 5001578.0; E 337313.4</u>		ORIGINATED BY <u>P.A.H.</u>	
DIST <u> </u> HWY <u>7</u>		BOREHOLE TYPE <u>Power Auger 108mm I.D. Hollow Stem</u>		COMPILED BY <u>J.M.</u>	
DATUM <u>Geodetic</u>		DATE <u>Feb. 18, 2009</u>		CHECKED BY <u>K.S.L.</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE					w _p w w _L				
								● QUICK TRIAXIAL × REMOULDED									
130.7	GROUND SURFACE																
0.0	TOPSOIL																
130.4																	
0.3	Silty SAND, trace clay and gravel Loose Brown Wet																
129.6																	
1.1	SILTY CLAY (Weathered Crust) Very stiff Grey-brown Wet		1	SS	5												
			2	SS	3												
128.5																	
2.2	Dolostone (BEDROCK) Fresh Thinly bedded Light grey with dark grey partings Medium strong to strong Bedrock cored between 2.2 m and 5.3 m depth. For bedrock coring details refer to Record of Drillhole 09-406.		3	NQ RC	REC 97%										RQD 14%		
			4	NQ RC	REC 100%										RQD 33%		
			5	NQ RC	REC 100%										RQD 31%		
125.4																	
5.3	End of Borehole Note: Water level in open borehole at 0.9 m depth (Elev. 129.8 m) upon completion of drilling																

MISS_MTO 06-1120-014-4000.GPJ ON MOT GDT 5/7/09

PROJECT		RECORD OF BOREHOLE		No 09-407		1 OF 1		METRIC						
W.P.		LOCATION		N 5000762.0; E 336355.6		ORIGINATED BY		P.A.H.						
DIST		HWY		BOREHOLE TYPE		COMPILED BY		J.M.						
DATUM		Geodetic		DATE		Feb. 19, 2009		CHECKED BY						
K.S.L.														
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED						
128.0	GROUND SURFACE													
0.0	TOPSOIL													
127.8														
0.3	SILTY CLAY (Weathered Crust) Very stiff Grey-brown Very moist		1	SS	9									
			2	SS	9									
125.6														
2.4	Sandy SILT, some gravel (TILL) Compact Grey-brown Wet		3	SS	12									
125.1														
2.9	Dolostone (BEDROCK) Fresh Laminated to thinly bedded Grey Medium strong to strong Bedrock cored between 2.9 m and 6.1 m depth. For bedrock coring details refer to Record of Drillhole 09-407.		4	NQ RC	REC 98%									RQD 69%
			5	NQ RC	REC 100%									RQD 70%
121.9														
6.1	End of Borehole													

MISS_MTO 06-1120-014-4000.GPJ ON MOT GDT 5/7/09

PROJECT: 06-1120-014-4000

RECORD OF DRILLHOLE: 09-407

SHEET 1 OF 1

LOCATION: N 5000762.0; E 336355.6

DRILLING DATE: Feb. 19, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Marathon Drilling Co. Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	FLUSH % RETURN	COLOUR	FR/FX-FRACTURE F-FAULT				SM-SMOOTH		FL-FLEXURED		BC-BROKEN CORE		DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
									CL-CLEAVAGE		J-JOINT		R-ROUGH		UE-UNEVEN		MB-MECH. BREAK			
									SH-SHEAR		P-POLISHED		ST-STEPPED		W-WAVY		B-BEDDING			
									VN-VEIN		S-SLICKENSIDED		PL-PLANAR		C-CURVED					
		Continued from Record of Borehole 09-407		125.10																
3		Dolostone (BEDROCK) Fresh Laminated to thinly bedded Grey Medium strong to strong		2.00																
4																				
5																				
6																				
		End of Drillhole		121.00																
7																				
8																				
9																				
10																				
11																				
12																				

DEPTH SCALE

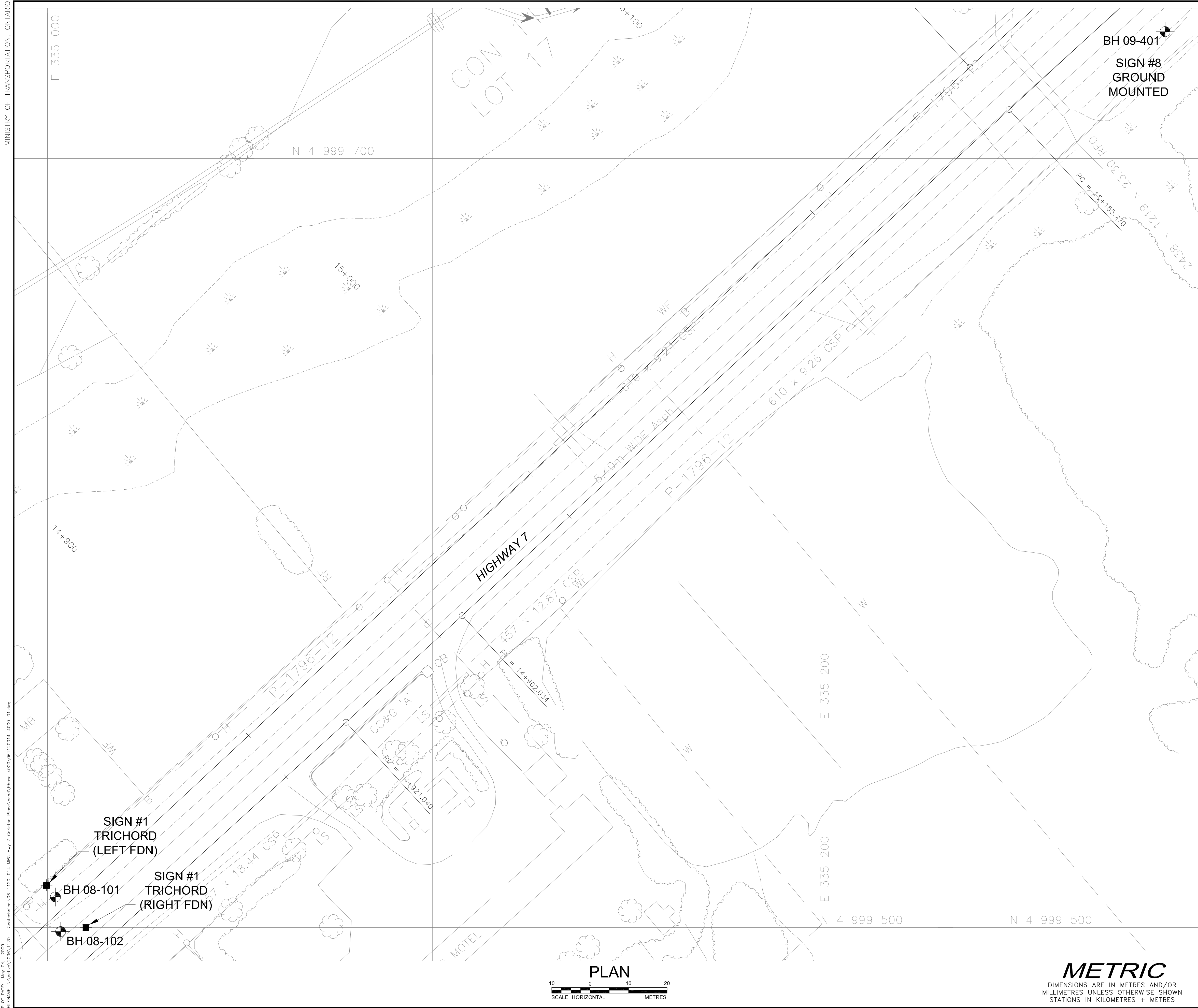
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LOGGED: P.A.H.

CHECKED: K.S.L.

MIS-RCK 001 06-1120-014-4000 (ROCK) GPJ GAL-MISS GDT 5/9/09 JM



PLT DATE: May 04, 2009
FILENAME: N:\Active\2008\1120 - Geotechnical\06-1120-014 MRC Hwy 7 Corridor\Plan\Coord\Phase 4000\06112014-4000-01.dwg

CONT No. -
WP No. 252-99-00

HIGHWAY 7

HIGHWAY 417 TO CARLETON PLACE

BOREHOLE LOCATIONS

SHEET
1

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA

KEY PLAN

SCALE 5 0 5 KM

LEGEND

Borehole - Current Golder Associates Ltd. Investigation

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
08-101	128.3	4999507.9	335002.0
08-102	129.6	4999499.0	335003.4
09-401	127.4	4999733.0	335290.5

REFERENCE

Base plan supplied by the McCormick Rankin Corporation

NOTES

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

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.

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NO.	DATE	BY	REVISION
Geocres No. 31F-171			
HWY. 7		PROJECT NO.06-1120-014	DIST.
SUBM'D. K.L.	CHKD. M.I.C.	DATE: AUGUST 2008	SITE:
DRAWN: J.M.	CHKD. F.J.H.	APPD.	DWG. 1

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



PLAN

10 0 10 20

SCALE HORIZONTAL METRES

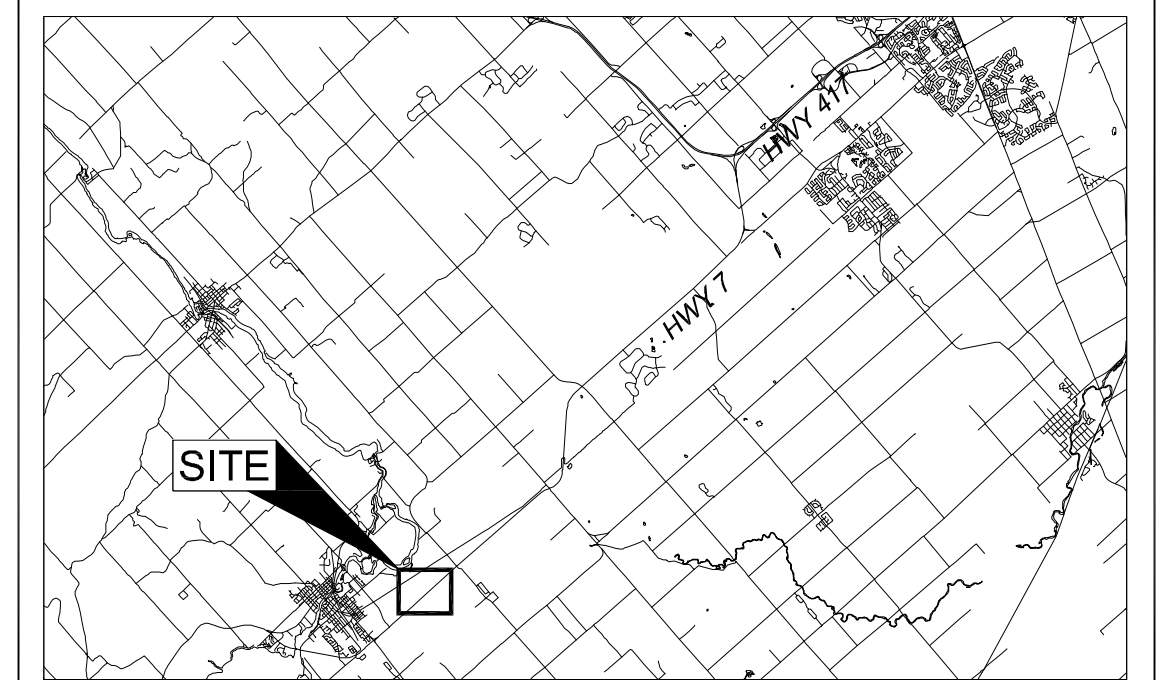
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN
STATIONS IN KILOMETRES + METRES

SHEET

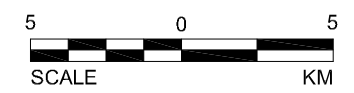
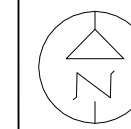
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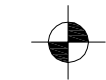
Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



KEY PLAN



LEGEND



Borehole – Current Golder Associates Ltd.
Investigation

[illegible]

REFERENCE

Base plan supplied by the McCormick Rankin Corporation

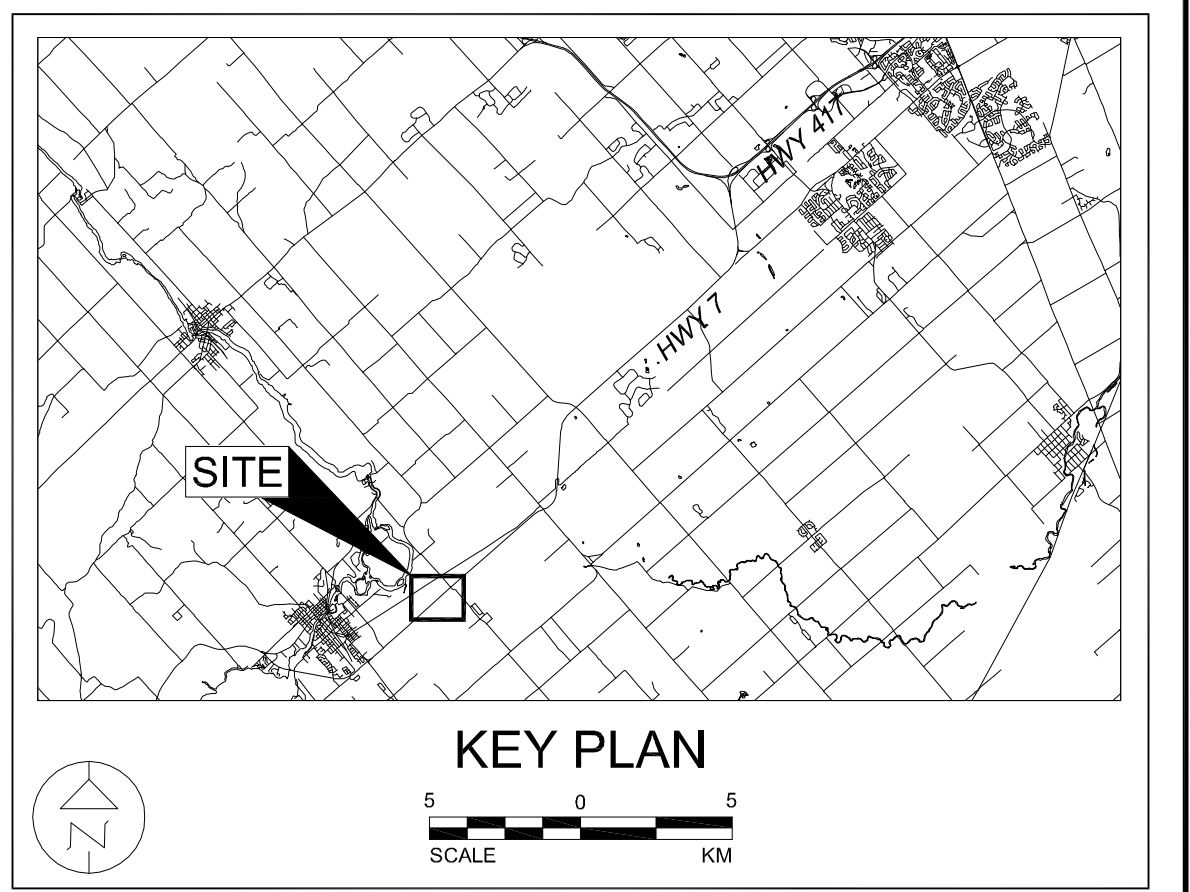
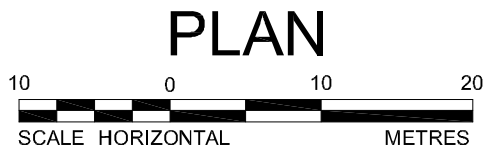
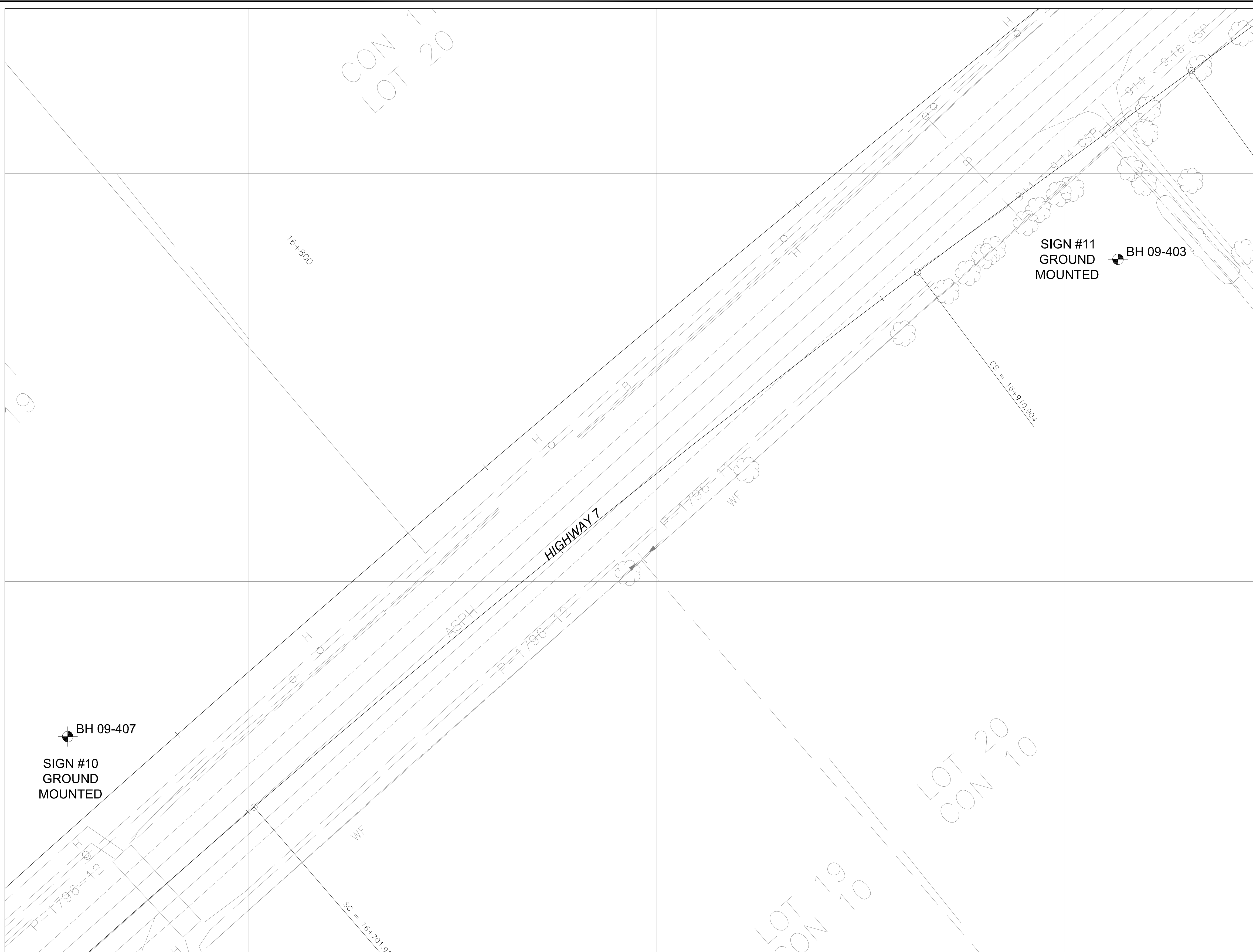
NOTES

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

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NO.	DATE	BY	REVISION		
Geocres No. 31F-171					
HWY. 7		PROJECT NO.06-1120-014		DIST.	
SUBM'D. K.L.		CHKD. M.I.C.		DATE: AUGUST 2008	
DRAWN: J.M.		CHKD. F.J.H.		APPD. DWG. 2	



LEGEND			
	Borehole	Current Golder Associates Ltd. Investigation	

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
09-403	128.8	5000879.0	336613.0
09-407	128.0	5000762.0	336355.6

REFERENCE	
Base plan supplied by the McCormick Rankin Corporation	

NOTES

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

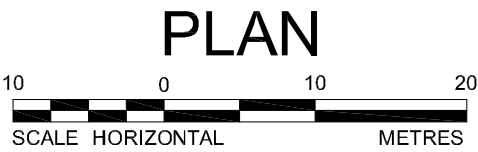
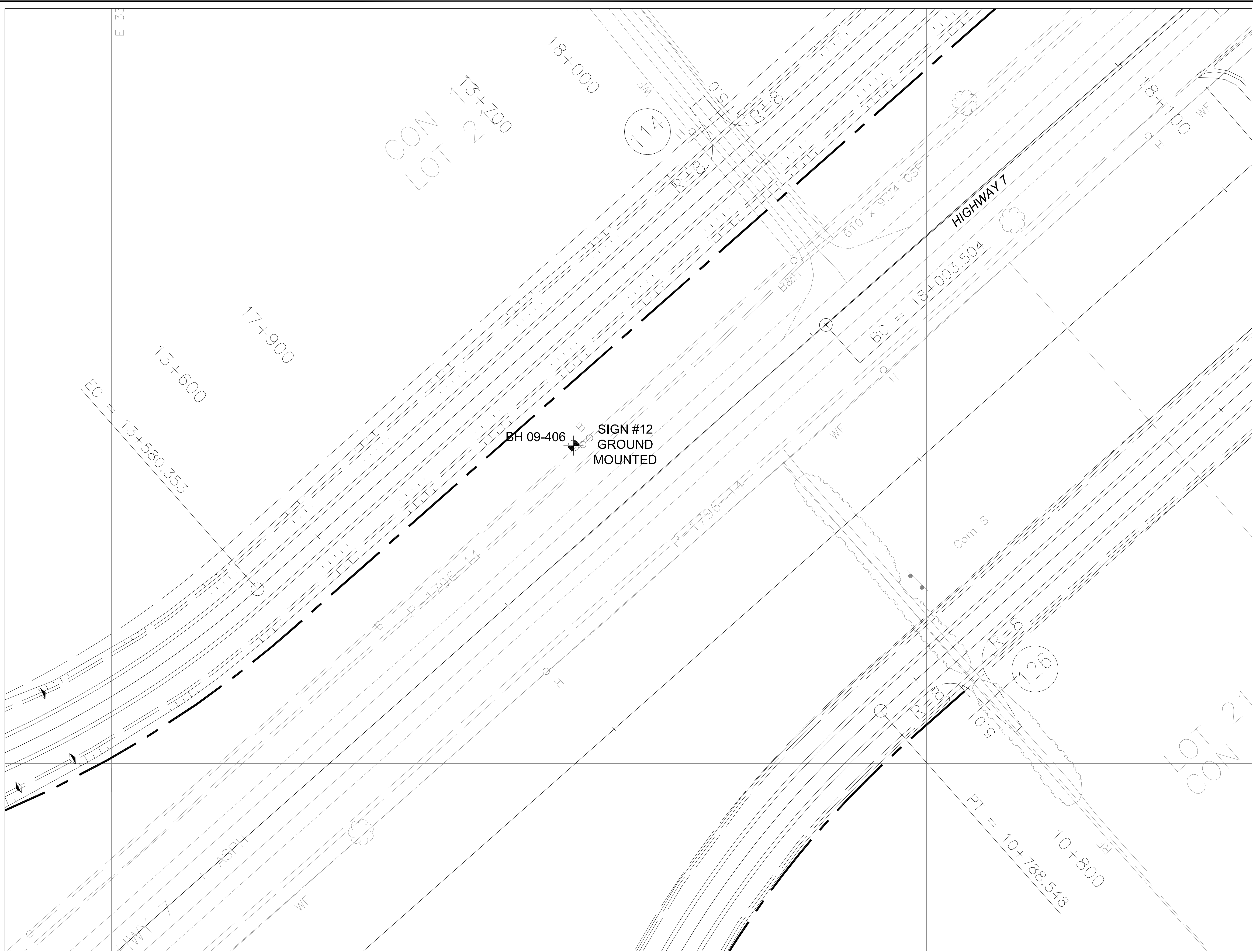
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NO.	DATE	BY	REVISION	
Geocres No. 31F-171				
HWY. 7		PROJECT NO.06-1120-014		DIST.
SUBM'D. K.L.	CHKD. M.I.C.		DATE: AUGUST 2008	SITE:
DRAWN: J.M.	CHKD. F.J.H.		APPD.	DWG. 3

MINISTRY OF TRANSPORTATION - ONTARIO

PLOT DATE: May 04, 2009
FILENAME: N:\Active\2008\1120 - Geotechnical\06-1120-014 MRC Hwy 7 Corridor\Plan\Local\Phase 4000\06112014-4000-01.dwg



METRIC

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

CONT No. -
WP No. 252-99-00

HIGHWAY 7
HIGHWAY 417 TO CARLETON PLACE
BOREHOLE LOCATION

SHEET
1

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA

KEY PLAN

SCALE 0 5 KM

LEGEND

Borehole – Current Golder Associates Ltd. Investigation

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
09-406	130.7	5001578.0	337313.4

REFERENCE

Base plan supplied by the McCormick Rankin Corporation

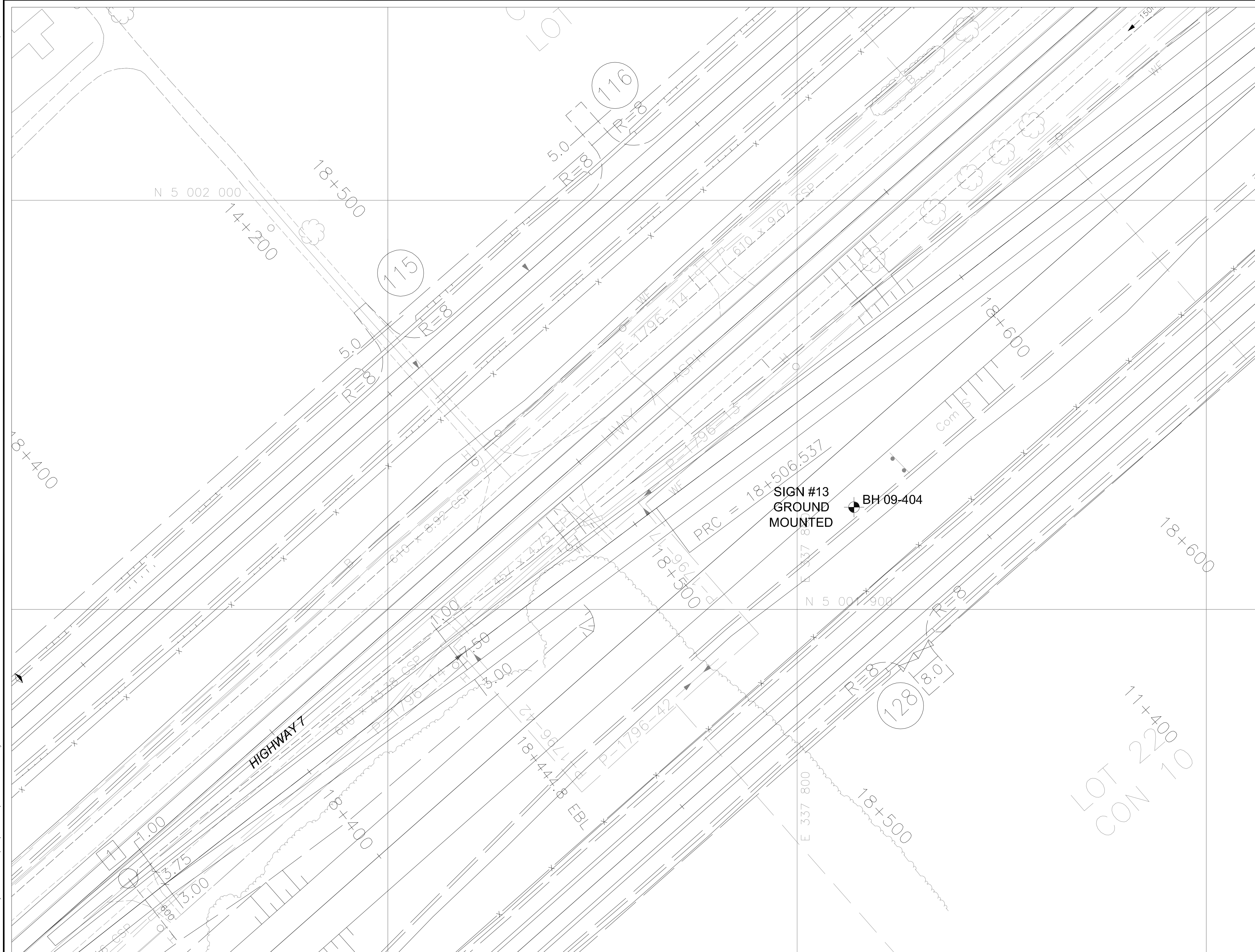
NOTES

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NO.	DATE	BY	REVISION	
Geocres No. 31F-171				
HWY. 7		PROJECT NO.06-1120-014		DIST.
SUBM'D. K.L.	CHKD. M.I.C.	DATE: AUGUST 2008	SITE:	
DRAWN: J.M.	CHKD. F.J.H.	APPD.	DWG. 4	



PLAN

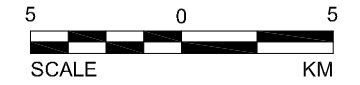
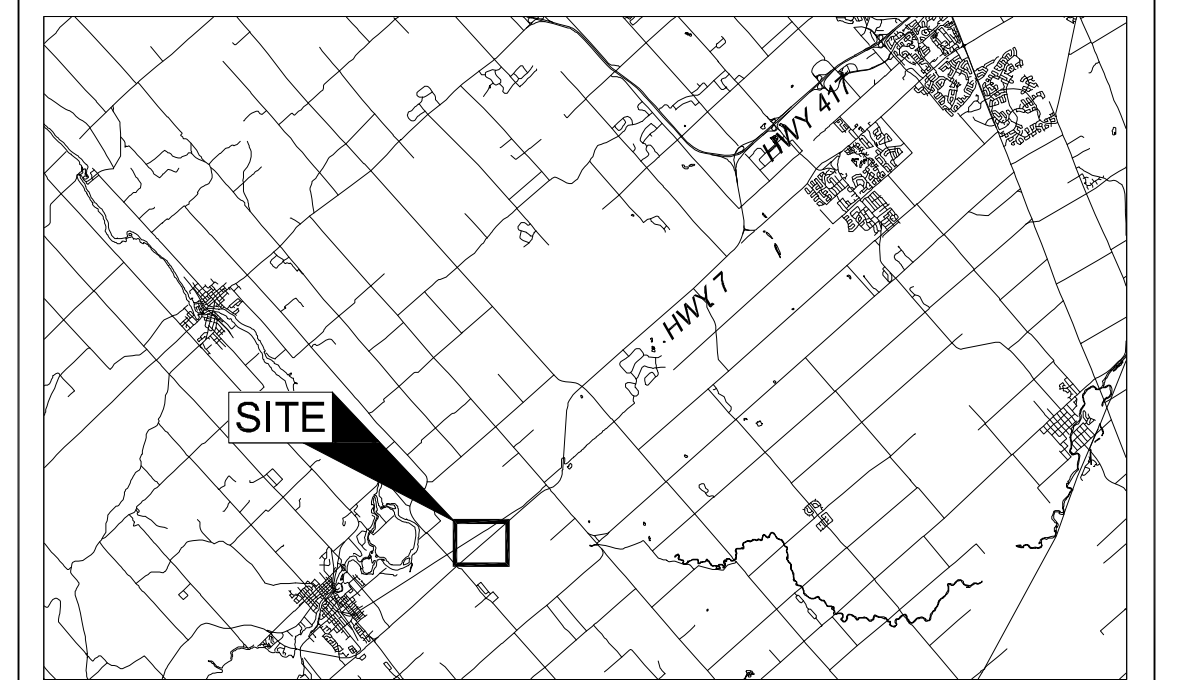
10 0 10 20

SCALE HORIZONTAL METRES

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

SHEET

1

Borehole – Current Golder Associates Ltd.
Investigation[illegible]

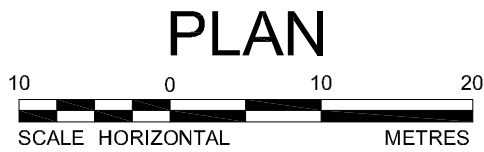
Base plan supplied by the McCormick Rankin Corporation

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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.

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

NO.	DATE	BY	REVISION		
Geocres No. 31F-171					
HWY. 7			PROJECT NO.06-1120-014		DIST.
SUBM'D. K.L.		CHKD. M.I.C.	DATE: AUGUST 2008		SITE:
DRAWN: J.M.		CHKD. F.J.H.	APPD.	DWG. 5	



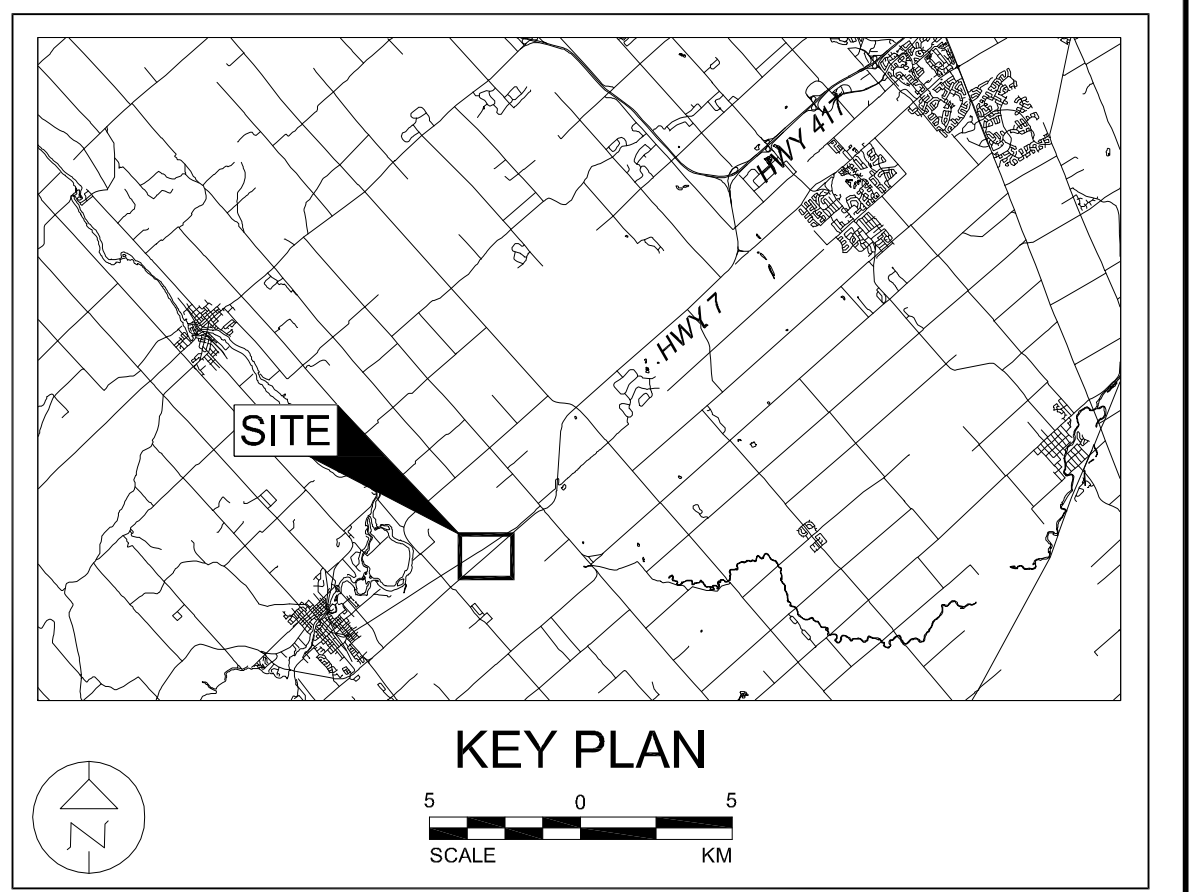
CONT No. -
WP No. 252-99-00

HIGHWAY 7
HIGHWAY 417 TO CARLETON PLACE
BOREHOLE LOCATION

SHEET
1

Golder Associates

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



LEGEND

Borehole - Current Golder Associates Ltd. Investigation

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
09-405	137.1	5002235.0	338069.1

REFERENCE

Base plan supplied by the McCormick Rankin Corporation

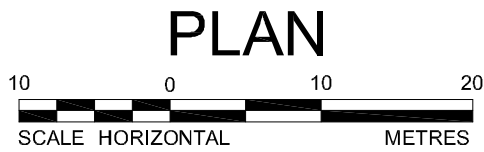
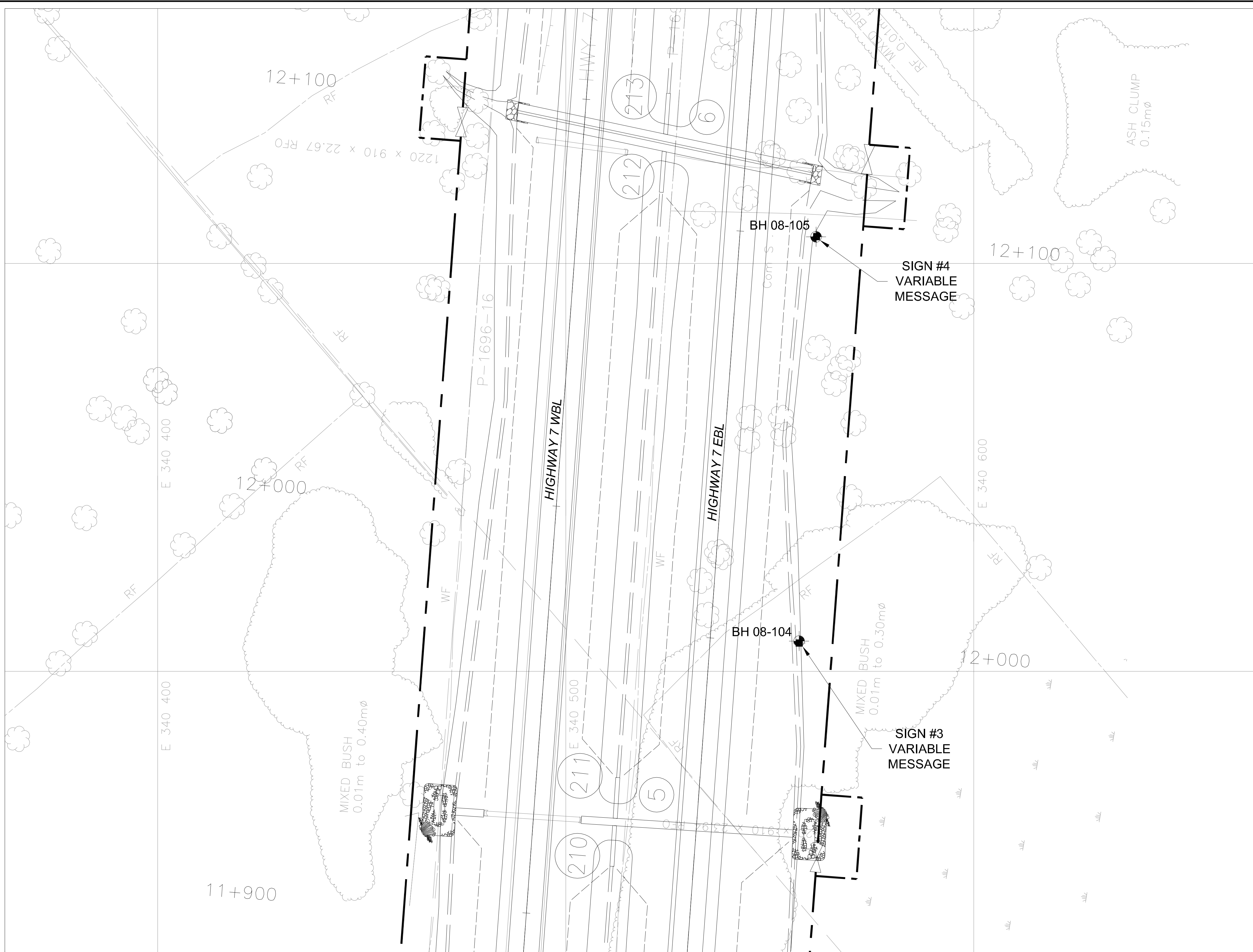
NOTES

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SUBM'D. K.L.		CHKD. M.I.C.	DATE: AUGUST 2008	SITE:
DRAWN: J.M.		CHKD. F.J.H.	APPD.	DWG. 6



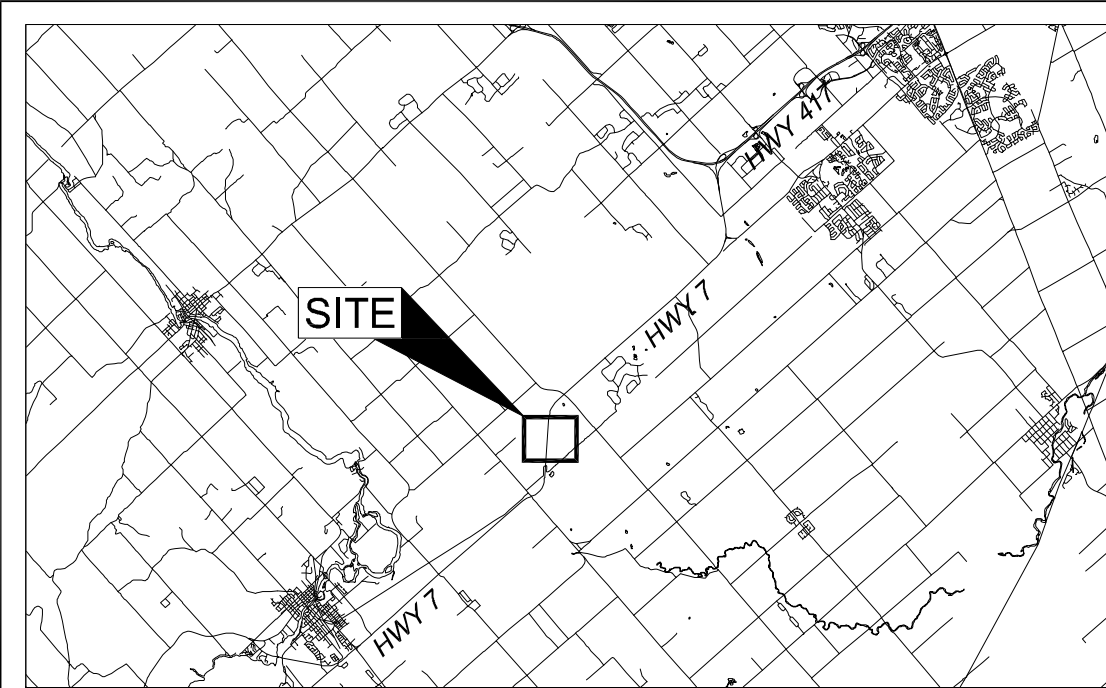
CONT No. -
WP No. 252-99-00

HIGHWAY 7
HIGHWAY 417 TO CARLETON PLACE
BOREHOLE LOCATIONS

SHEET
1



Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



LEGEND

Borehole - Current Golder Associates Ltd. Investigation

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
08-104	135.2	5005507.4	340557.2
08-105	135.6	5005606.5	340561.4

REFERENCE

Base plan supplied by the McCormick Rankin Corporation

NOTES

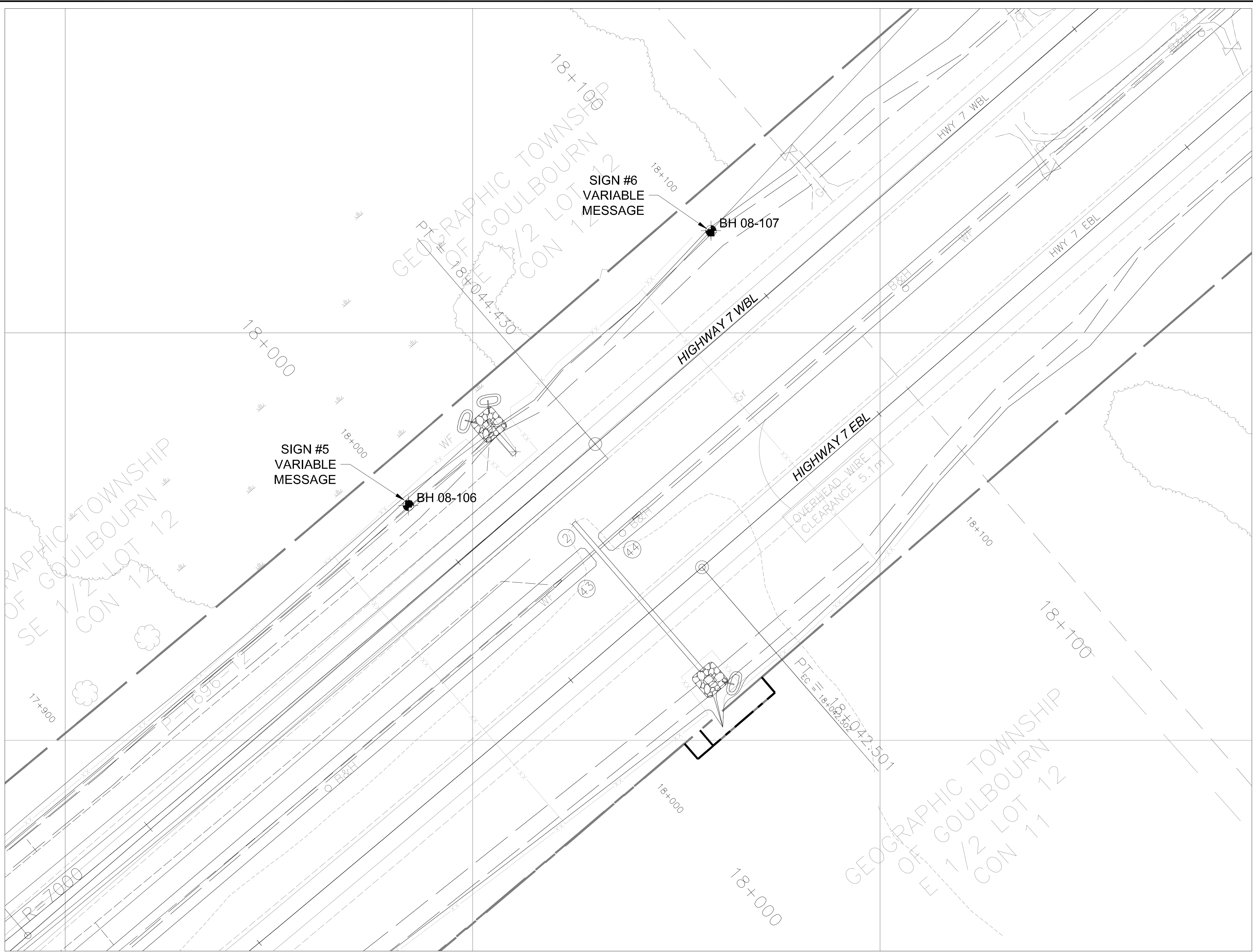
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SUBM'D. K.L.		CHKD. M.I.C.	DATE: AUGUST 2008	SITE:
DRAWN: J.M.		CHKD. F.J.H.	APPD.	DWG. 7

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



PLAN
SCALE HORIZONTAL METRES

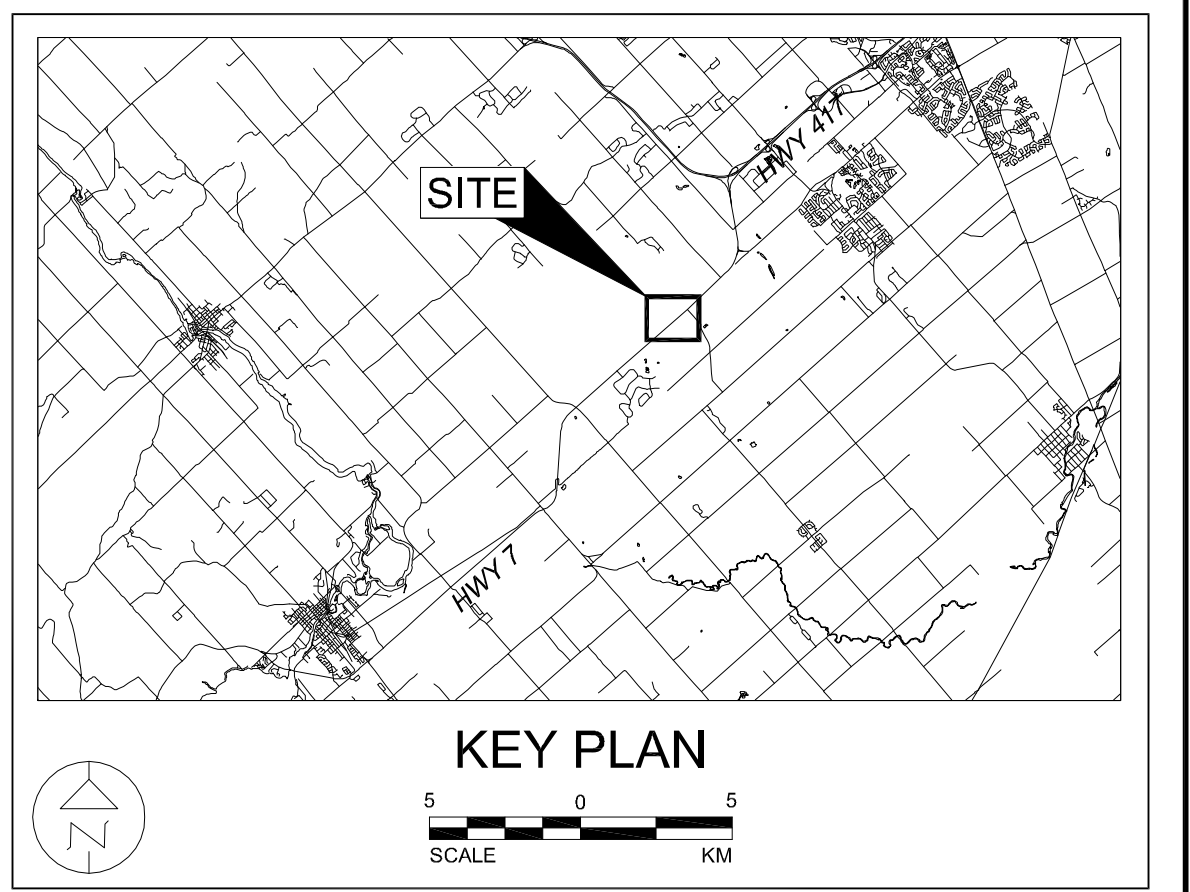
CONT No. -
WP No. 252-99-00

HIGHWAY 7
HIGHWAY 417 TO CARLETON PLACE
BOREHOLE LOCATIONS

SHEET
1

Golder Associates

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



LEGEND

Borehole - Current Golder Associates Ltd. Investigation

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
08-106	133.9	5009957.6	344184.2
08-107	134.5	5010025.0	344258.5

REFERENCE

Base plan supplied by the McCormick Rankin Corporation

NOTES

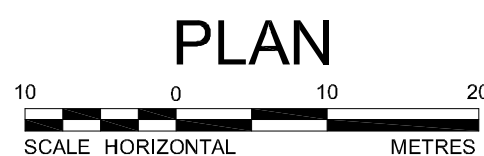
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HWY. 7		PROJECT NO.06-1120-014		DIST.
SUBM'D. K.L.		CHKD. M.I.C.	DATE: AUGUST 2008	SITE:
DRAWN: J.M.		CHKD. F.J.H.	APPD.	DWG. 8

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

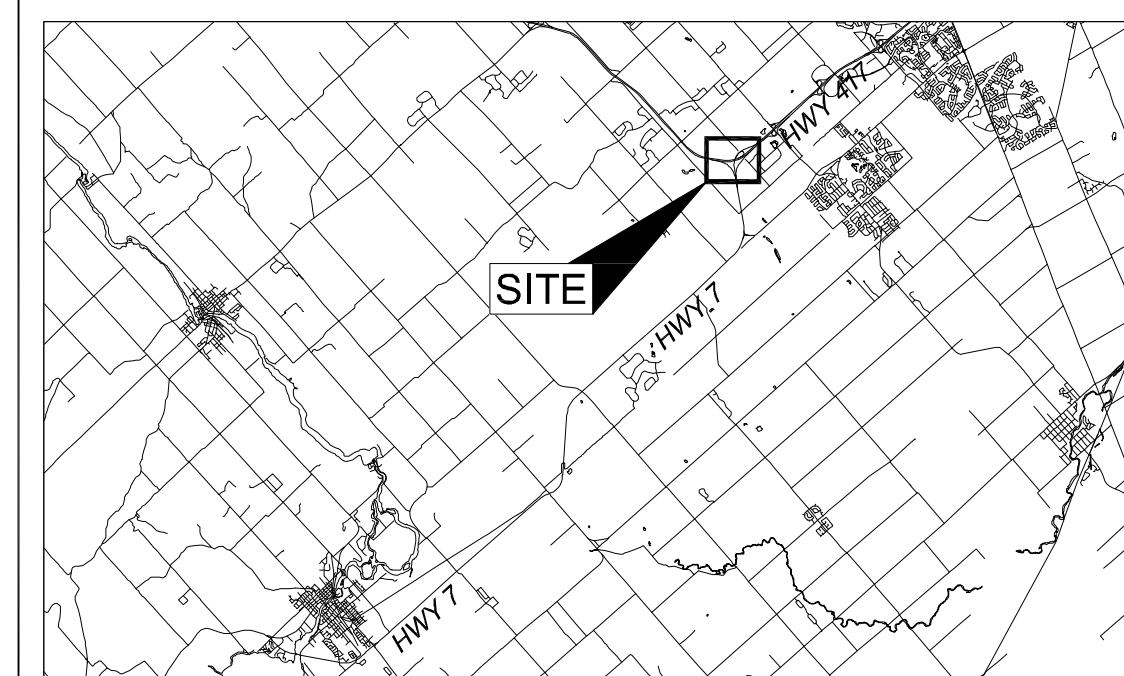


METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN
STATIONS IN KILOMETRES + METRES

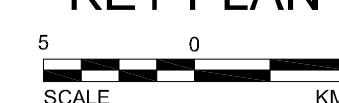
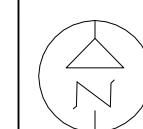
SHEET
1



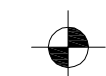
Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



KEY PLAN



LEGEND

Borehole – Current Golder Associates Ltd.
Investigation[illegible]

REFERENCE

Base plan supplied by the McCormick Rankin Corporation

NOTES

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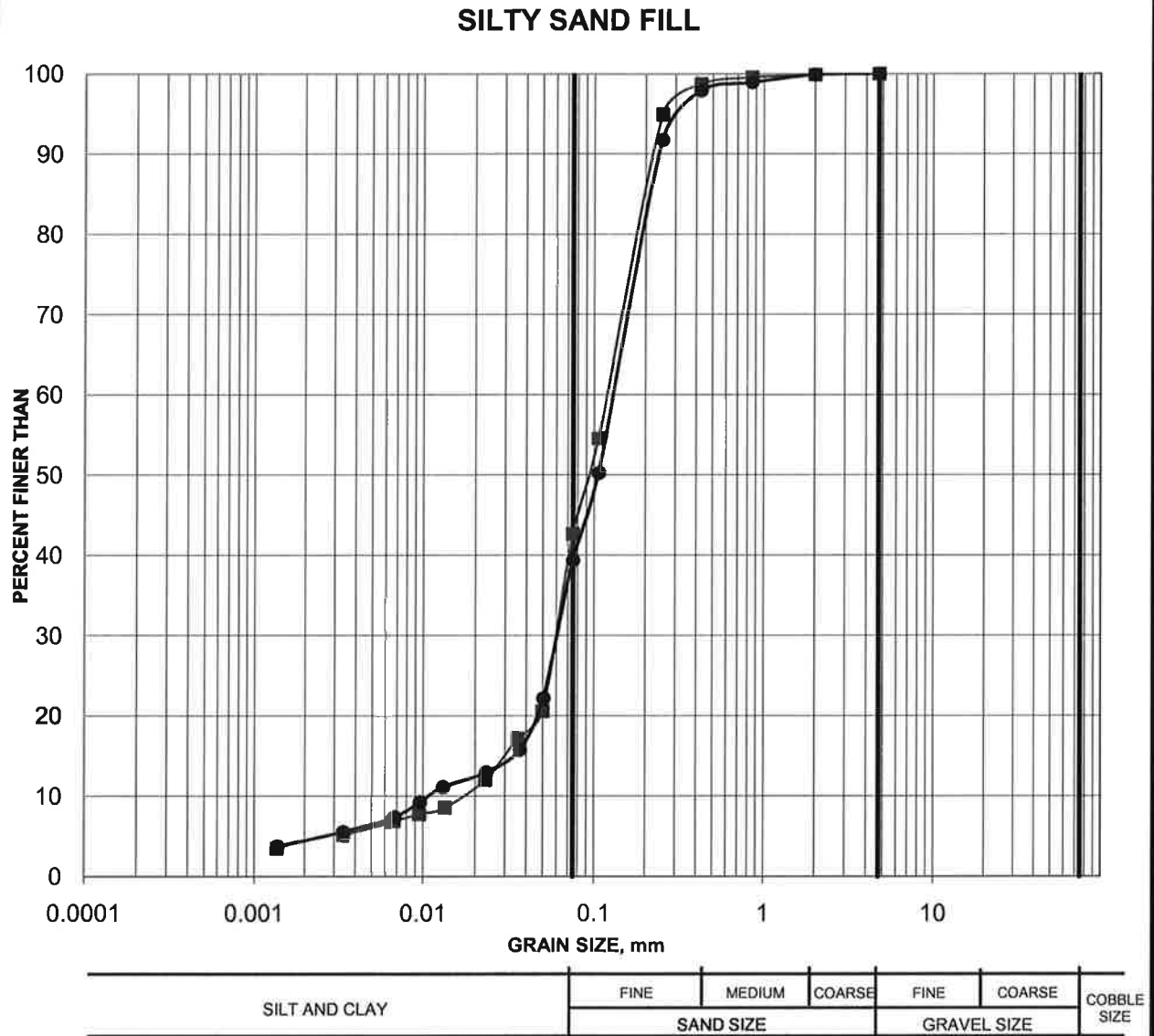
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SUBM'D. K.L.		CHKD. M.I.C.		DATE: AUGUST 2008	
DRAWN: J.M.		CHKD. F.J.H.		APPD. DWG. 9	

GRAIN SIZE DISTRIBUTION

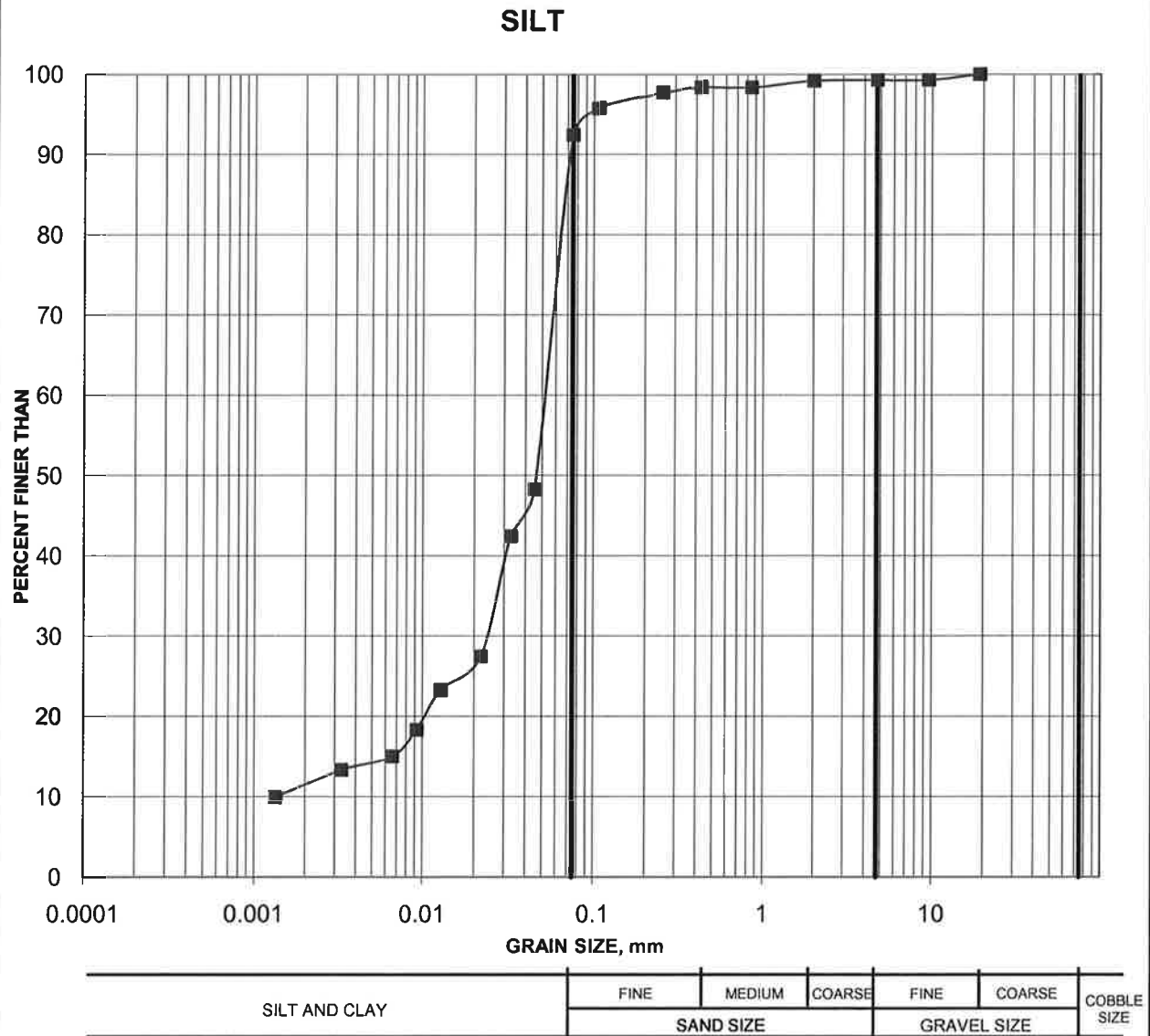
FIGURE 1



Borehole	Sample	Depth (m)
—■— 08-108	2	1.52-2.13
—●— 08-108	6	4.57-5.18

GRAIN SIZE DISTRIBUTION

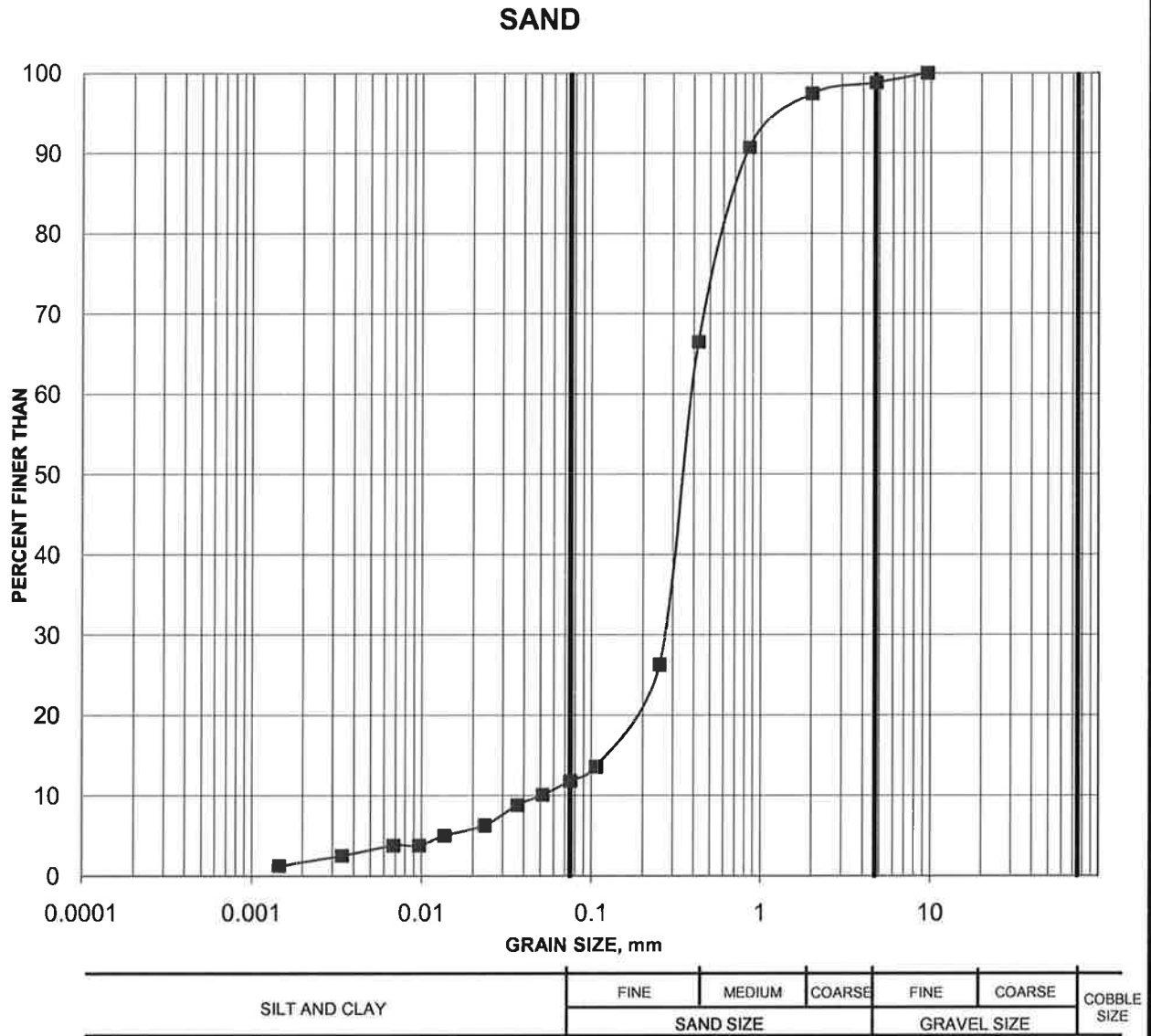
FIGURE 2



Borehole	Sample	Depth (m)
08-108	8A	6.10-6.52

GRAIN SIZE DISTRIBUTION

FIGURE 3



Borehole	Sample	Depth (m)
08-106	3	2.29-2.90

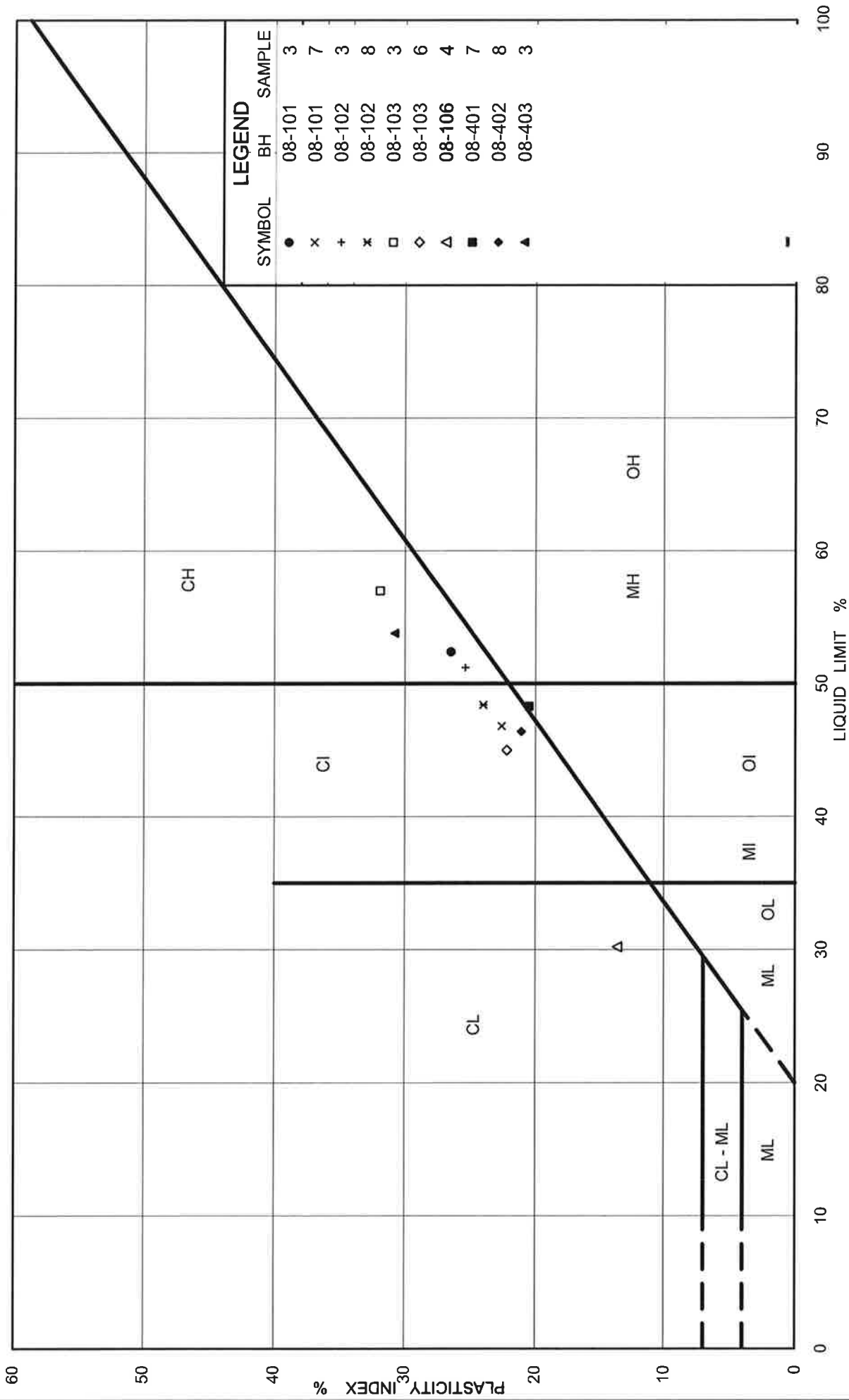


FIG No. 4

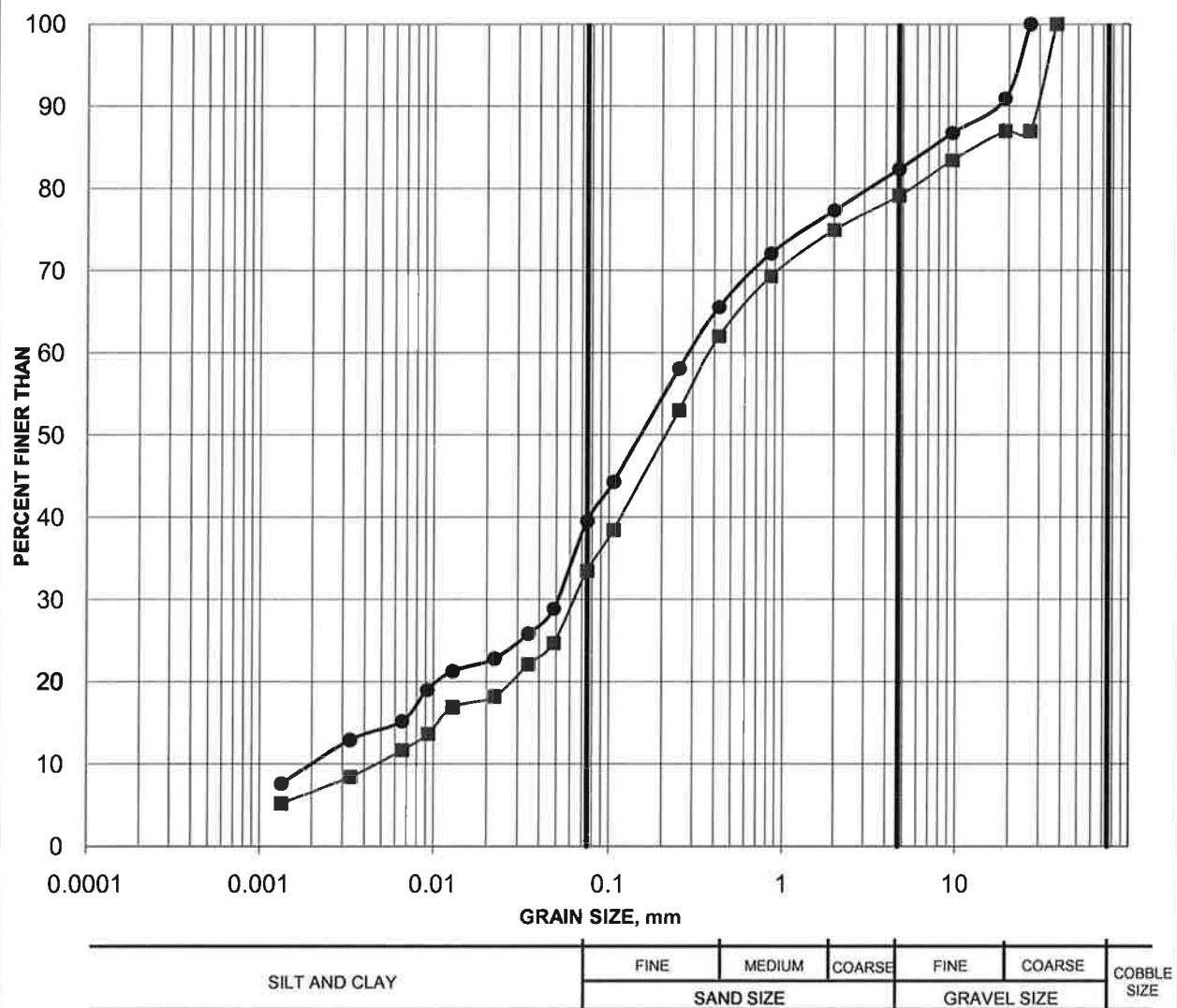
Project No. 06-1120-0014

Ministry of Transportation



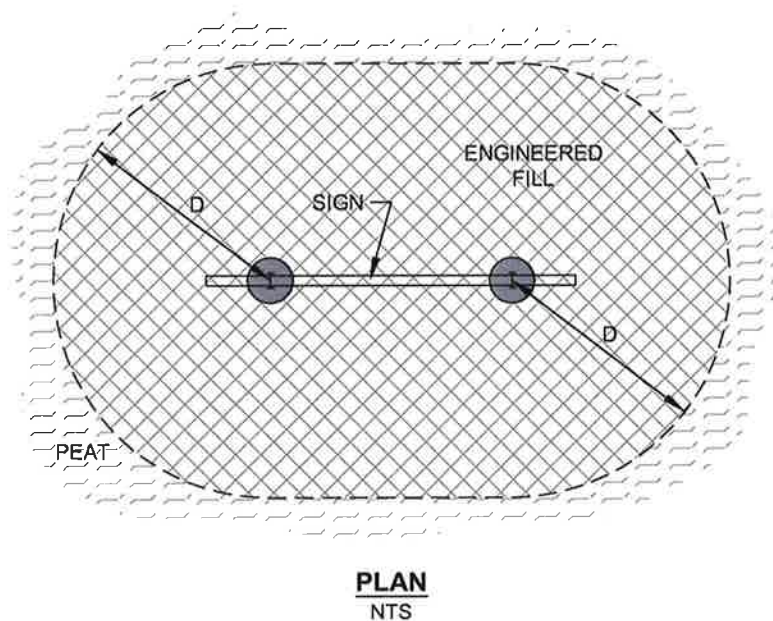
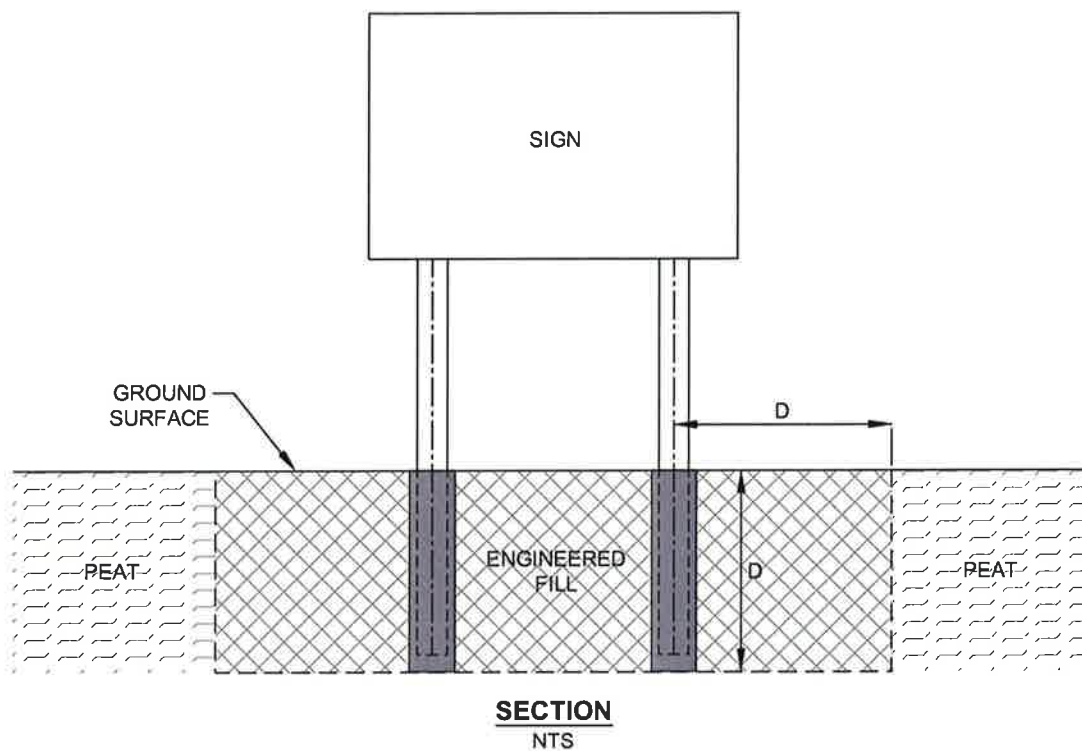
Ontario

SILTY SAND TILL



Borehole	Sample	Depth (m)
● 08-107	2	1.52-2.13
■ 08-108	8B	6.52-6.71

PLOT DATE: April 22, 2009
FILENAME: N:\Active\2006\1120 - Geotechnical\06-1120-014 MRC Hwy 7 Carleton Place\acad\Phase 4000\061120014-4000-06.dwg





APPENDIX A

Non Standard Special Provisions

**CONTROL OF OVERBURDEN SOILS AND GROUNDWATER DURING SIGN
SUPPORT FOUNDATION INSTALLATION - Item No.**

Special Provision

Excavations for some of the sign support foundations will be advanced through fill materials (where present) and cohesionless soils below the groundwater level. Where these conditions are encountered, appropriate construction procedures and equipment (e.g., temporary or permanent liners) will be required to minimize ground loss during drilling and concrete placement.

Basis of Payment

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

END OF SECTION

SIGN SUPPORT CAISSON SOCKETS IN BEDROCK - Item No.

Special Provision

The bedrock at the sign support foundation locations includes limestone, sandy limestone, dolostone, and/or dolomitic limestone. These rock types are medium strong to strong. Appropriate construction equipment and procedures will be required for construction of caisson foundation sockets within the bedrock.

Basis of Payment

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

END OF SECTION

**BOULDERS/OBSTRUCTIONS DURING SIGN SUPPORT FOUNDATION
INSTALLATION - Item No.**

Special Provision

The till soils at the site are glacially-derived and should be expected to contain cobbles and boulders. In addition, obstructions may be present within the existing embankment fill. Appropriate equipment and procedures will be required to penetrate these obstructions during excavation for the sign support foundations.

Basis of Payment

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

END OF SECTION

DOWELS INTO ROCK – Item No.

Special Provision

1.0 GENERAL

1.1 Scope

The work for the above noted tender item shall be in accordance with OPSS 904, including all special provisions, except as extended herein. This document specifies additional requirements for the supply, installation and testing of Dowels into Rock for the structure footings.

1.2 Instructions to Contractor

- 1.2.1 These instructions are to be read in conjunction with the Contract Drawings.
- 1.2.2 A total of 1 test Dowels into Rock are required for the Dowels into Rock at each structure footing.
- 1.2.3 Dowels shall extend through tremie concrete and into sound bedrock to the specified embedment depth.

1.3 Qualifications

- 1.3.1 **Qualifications of Staff from Contractor or Sub-Contractor Completing Work for the Dowels into Rock:** All work shall be performed under the direction of personnel experienced with all aspects associated with the installation of Dowels into Rock. Such experience shall have been obtained within the preceding five (5) years on projects of similar nature and scope to the work required for this project.
- 1.3.2 **Qualifications of the Quality Verification Engineer:** A resume of the work experience of the Quality Verification Engineer shall be submitted to the Contract Administrator for record purposes. The Quality Verification Engineer shall be a Professional Engineer licensed in the Province of Ontario having a minimum of five years of experience on projects of similar nature and scope to the work required for this project.
- 1.3.3 **Qualifications of the Design Engineer:** A resume of the work experience of the Design Engineer shall be submitted to the Contract Administrator for record purposes. The Design Engineer shall be a Professional Engineer

licensed in the Province of Ontario having a minimum of five years of experience of projects of similar nature and scope to the work required for this project.

1.4 Responsibilities of the Contractor

- 1.4.1 The Contractor shall prove the allowable bond stress by tests of the Dowels into Rock on non-production Dowels into Rock.
- 1.4.2 The Contractor shall supply equipment, materials and skilled personnel to install production Dowels into Rock and conduct the specified acceptance tests. It shall be the responsibility of the Contractor to constantly monitor the acceptance tests, maintain specified test loads and record test measurements as specified by the Contract Administrator.
- 1.4.3 The Contractor is responsible for materials and workmanship. Any remedial measures, required because of defects in materials or workmanship, shall be completed by the Contractor at no cost to the Owner.
- 1.4.4 The Contractor shall submit 4 copies of all Working Drawings to the Contract Administrator as outlined in Section 1.6.

1.5 Definitions

- 1.5.1 Dowels into Rock: reinforcing steel bar and non-shrink grout.
- 1.5.2 Design Engineer: An Engineer who has a minimum of five (5) years experience in all aspects associated with the installation of Dowels into Rock, including drilling, grouting and doweling work. The Design Engineer shall be retained by the Contractor to design various components for the installation and testing for the Dowels into Rock.
- 1.5.3 Quality Verification Engineer: An Engineer who has a minimum of five (5) years experience in all aspects associated with the installation of Dowels into Rock, including drilling, grouting and doweling work. The Quality Verification Engineer shall be retained by the Contractor to ensure conformance with the contract documents and issue certificate(s) of conformance.

1.6 Submissions and Working Drawings

- 1.6.1 Working Drawings shall consist of drawings, testing and installation records, procedures and reports, and work plans.

- 1.6.2 The Contractor shall submit Working Drawings to the Contract Administrator as follows:
- All Working Drawings that include drawing, testing and installation procedures and reports, and work plans shall be sealed and signed by the Design Engineer.
 - All Working Drawings that include testing and installation results and reports shall be signed and sealed by the Quality Verification Engineer.
- 1.6.3 Upon completion of testing or installation and testing for each component, the Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by a Quality Verification Engineer. The Certificate shall state that the work has been carried out in conformance with the Working Drawings and in general conformance with the contract documents.
- 1.6.4 Working Drawings consisting of testing and installation records and reports shall be submitted four days after completion of testing and installation. All other Working Drawings shall be submitted two weeks prior to construction.
- 1.6.5 Working Drawings to be submitted include the following with further details outlined in the remainder of this specification:
- Design calculations, specifications and shop drawings covering all aspects of fabrication, installation and acceptance testing of Dowels into Rock.
 - Test results verifying the 28 day strength of non-shrink grout.
 - The method for constructing of the holes, maintaining the holes, and placing reinforcing steel bars, grout and other materials in the holes, including casing sizes, bit sizes and tremie grouting methods.
 - The procedures to verify hole length. Records of measurements that verify the hole length.
 - Records of all drilling procedures, rock conditions encountered, and installation times.
 - Test procedures for Dowels into Rock.
 - Drawings and design calculations for a suitable reaction system for the applied test loads.

- Records of vertical and horizontal movements of the reaction system, and elongation of the reinforcing steel bar.
- Drawings and details for reference system arrangement.
- Current calibration curves shall be provided for all gauges.
- Complete test records for all tests including plots of dowel movement versus dowel load, dowel load versus time, and dowel movement versus time.
- Remedial measures for unacceptable stressing results.

1.7 Subsurface Conditions

- 1.7.1 Soils, rock and groundwater conditions are described in the Foundation Investigation Report for this Contract.

2.0 MATERIALS

The non-shrink grout shall be an approved DSM 9.10.35 non-shrink grout.

The Contractor shall provide the following information from the manufacturer for non-shrink grout:

- Data sheets for the non-shrink grout,
- installation procedures

3.0 EQUIPMENT

3.1 General

- 3.1.1 All equipment for the installation of the Dowels into Rock shall be suitable for the intended purposes and capable of working on the site under the prevailing access and clearance conditions.

- 3.1.2 The equipment shall not cause damage to the reinforcing steel bars.

4.0 INSTALLATION

All work for the installation of Dowels into Rock shall be inspected by the Quality Verification Engineer.

4.1 Construction of Holes

- 4.1.1 The sides and end of the hole shall not be disturbed. The Contractor shall submit Working Drawings to the Contract Administrator that include the method for constructing of the holes, maintaining the holes, and placing reinforcing steel bar, grout and other materials in the holes. All excavated material shall be removed from the site.
- 4.1.2 The hole diameters and hole length for this project are as specified on the Contract Drawings. Prior to commencing drilling operations, the Contractor shall submit Working Drawings to the Contract Administrator outlining devised procedures to verify hole length. The Contractor shall submit Working Drawings that include drilling operations records to the Contract Administrator that include the above noted records.
- 4.1.3 At all times, the Contractor shall keep a record of all drilling procedures, rock conditions encountered, and installation times. The Contractor shall submit Working Drawings to the Contract Administrator that include the above noted records.

4.2 Installation of Reinforcing Steel Bar

- 4.2.1 Reinforcing steel bar shall be installed in strict accordance with the Contract Drawings and installation procedures.
- 4.2.2 Centering devices shall be provided to ensure that the reinforcing steel bar is located centrally in the hole.
- 4.2.3 Dowels shall extend through the tremie concrete for the footing and into sound bedrock.
- 4.2.4 Reinforcing steel bar shall be installed after the dowel hole has been filled with non-shrink grout.

4.3 Grout

- 4.3.1 The non-shrink grout shall entirely fill the annular space between the reinforcing steel bar and side for the dowel hole.
- 4.3.2 The placement of grout for the test Dowels into Rock shall be identical to the production Dowels into Rock.
- 4.3.3 Non-shrink grout shall be placed into the dowel hole using tremie placement methods.

5.0 TESTING REQUIREMENTS

All work for the testing of Dowels into Rock shall be inspected by the Quality Verification Engineer.

5.1 General Testing Requirements

- 5.1.1 Refer to the attached Instructions to Contractor and the Contract Drawings for specific test details.
- 5.1.2 The Contractor shall install the number of Dowels into Rock specified in the contract documents for testing purposes. The purpose of the testing the Dowels into Rock is to prove the adequacy of the proposed anchor configuration and installation procedures under the site conditions, and to provide design parameters.
- 5.1.3 The equipment, labour and materials for test dowels shall be identical to Dowels into Rock at the each structure location.
- 5.1.4 The Contractor shall submit Working Drawings that include proposed procedures for testing of the dowels into Rock to the Contract Administrator. Such testing shall be executed in strict accordance with the proposed procedures of the Contractor.
- 5.1.5 The Quality Verification Engineer shall supervise the testing of the Dowels into Rock. The Contractor will notify the Contract Administrator of the testing schedule at least 10 days prior to commencement of the testing program. Testing for Dowels into Rock shall be conducted concurrently, as scheduled by the Contract Administrator. The tests shall normally be conducted between 8:00 hrs and 20:00 hrs from Monday to Friday, unless otherwise directed by the Contract Administrator.
- 5.1.6 The Contractor shall supply materials and skilled personnel to conduct the tests for the Dowels into Rock. The equipment and materials shall be capable of stressing the Dowels into Rock to the specified loads. It shall be the responsibility of the Contractor to constantly monitor the test, maintain specified test loads and to record test measurements as specified by the Quality Verification Engineer.
- 5.1.7 The test site shall be restored to its pre-test condition. Reinforcing steel bars used in tests shall be cut down 25 mm below the top of the sound bedrock.

5.2 Testing Location

- 5.2.1 The Contractor shall remove all loose rock down to sound bedrock at the test location.

5.2.2 The test Dowels into Rock shall be constructed at locations specified by the Contract Administrator.

5.2.3 If site conditions dictate, changes to the test locations will be considered. The Contractor shall provide the Contract Administrator at least 2 days notice in writing of this operation.

5.3 Testing Equipment

5.3.1 The dowels into rock will be carried out generally in accordance with the prevailing requirements of A.S.T.M. (Designation D1143-81) superseded where applicable by the procedures specified in this document.

5.3.2 The Contractor shall submit Working Drawings for a suitable reaction system for the applied test loads to the Contract Administrator. Jacks must be secured with chains to provide adequate protection for the personnel in the event of breakage of the reinforcing steel bar or stressing system.

5.3.3 The Contractor shall submit Working Drawings for the reference system arrangement to the Contract Administrator. All reference beams shall be as follows:

- The beams shall be independently supported with the support firmly embedded in the ground.
- The testing device shall not apply compression to the bedrock surrounding the test for the Dowels into Rock, within a circle concentric with the dowel hole and a diameter equal to 4.0 m.
- Reference beams shall be sufficiently rigid to support instrumentation such that variations in readings do not occur.

5.3.4 The Contractor shall construct suitable enclosures to provide complete protection for equipment and instruments from variations in the weather conditions and disturbances during the test program. These provisions must meet the approval of the Quality Verification Engineer and will include that the test enclosures must be weather-proof and provide a consistent temperature in order to eliminate temperature variations that could affect instrumentation.

5.4 Testing for Dowels Into Rock, and Report

5.4.1 At all times, the Contractor shall keep records of vertical and horizontal movements of the reaction system, elongation of reinforcing steel bar, and the record of test enclosure temperature. The movements shall be recorded with respect to an independent fixed reference point. The Contractor shall

submit Working Drawings that include the above noted records to the Contract Administrator.

- 5.4.2 Dial gauges shall have at least a 76.2 mm (3.0 in.) travel. Longer gauge stems or sufficient gauge blocks shall be provided to allow for greater travel if required. Gauges shall have precision of at least 0.025 mm (0.0001 in.). The dial gauges shall be placed on smooth bearing surfaces mounted perpendicular to the direction of movement. All gauges, scales or reference points attached to the test anchor shall be mounted so as to prevent movement relative to the test anchor during the test. The Contractor shall submit Working Drawings that include details for current calibration and curves for all gauges to the Contract Administrator.
- 5.4.3 Jacks used for reinforcing steel bars shall have a minimum ram dimension of 153 mm (6.0 in.). The Contractor shall submit Working Drawings that include details for current calibration and curves for all gauges to the Contract Administrator.
- 5.4.4 Requirements for Clauses 5.4.1 to 5.4.4 shall be repeated as required at different testing locations.

5.5 Testing Loading

- 5.5.1 The testing procedures shall safely load test the Dowels into Rock in tension at a rate of approximately 100kN per minute to the specified test load. The load shall be increased by an additional 50 kN beyond this level as directed by the Quality Verification Engineer.
- 5.5.2 Each load shall be maintained for a minimum time of 15 minutes and until the rate of displacement is not greater than 0.25 mm (0.01 inches) per hour.

5.6 Acceptance Criteria

- 5.6.1 The following acceptance criteria apply:

The testing of dowels shall be carried out in advance of the instalment of Dowels into Rock at each structure location.

Tests for Dowels into Rock shall have a capacity of at least [insert value] kN. The Quality Verification Engineer shall report on the acceptance of the tests for Dowels into Rock. The Quality Verification Engineer shall report on the testing of the Dowels into Rock including recommendations for increasing embedment depth, if necessary.

6.0 BASIS OF PAYMENT

Payment at the contract unit price for the above tender item shall include full compensation for all labour, equipment, and materials to do the work. No additional payment will be made for tests for Dowels into Rock which are deemed as included as part of the work for the above noted item.