FOUNDATION INVESTIGATION AND DESIGN REPORT
STRUCTURAL CULVERTS
HIGHWAY 69 FOUR-LANING
FROM THE SOUTH JUNCTION OF HIGHWAY 529 NORTHERLY 15 KM
G.W.P. 5294-08-00
NORTH SECTION - NAISCOOT LAKE TO NORTH PROJECT LIMIT

Geocres Number: 41H-129

Report to

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted for nineteen (19) proposed structural culverts required along a section of the Highway 69 four-laning project extending from just north of Naiscoot Lake (approximately 3.8 km north of Highway 529) northerly to approximately 15 km north of Highway 529.

This report is one of two reports addressing a larger section of the four-laning project extending from the south junction of Highway 529 northerly for 15 km in the Townships of Harrison and Wallbridge, Ontario. This report deals with the north part of this section; the remaining south part of the section is dealt with in a separate report.

The purpose of the investigation was to explore the subsurface conditions at the proposed culvert sites and, based on the data obtained, to provide record of borehole sheets, borehole location plans, stratigraphic profiles, laboratory test results, and a generalized description of the subsurface conditions at each location. This information provides a model of the anticipated geotechnical conditions influencing design and construction of the structural culverts.

Thurber carried out the investigation as a sub-consultant to MMM Group Limited (MMM) under the Ministry of Transportation Ontario (MTO) Agreement Number 5006-E-0030.

2 SITE DESCRIPTION

Highway 69 in the study section is currently a two lane undivided roadway. The proposed four-lane alignment will run parallel to the existing alignment, with the new northbound lanes on the existing highway platform on the south part of the study section, and the new southbound lanes on the existing platform along the north part of the section.

The roadway corridor typically has a rolling topography with frequent bedrock outcrops of generally low relief, separated by low-lying swamp areas, water bodies, and small streams. In general, the area is heavily wooded except in swamp areas.

The site lies within the physiographic region known as the Georgian Bay Fringe, characterized by very shallow soils and bare rock knobs and ridges. Where present, the overburden materials consist of sand, silt and clay. Recent organic deposits of peat and muck occur in abundance in bedrock hollows and valleys. The area is underlain by strongly foliated and highly to intermediately deformed rocks of Precambrian age, primarily migmatitic rocks and gneisses.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for the nineteen (19) culverts included in this report consisted of thirty-four boreholes and five Dynamic Cone Penetration Tests (DCPT) completed during March 2011 and May to July 2012. In addition to these boreholes and DCPTs specific to the culverts, twenty-seven boreholes and seven DCPTs from the swamp crossings and high fill embankments investigation are included in this report for a total of sixty-one boreholes and twelve DCPTs.

The boreholes drilled at each culvert are listed below, along with additional information regarding the culvert location. In general, one borehole was located at each of the proposed culvert inlets, outlets, and mid points. The approximate borehole locations are shown on the Borehole Locations and Soil Strata drawings included in Appendices A through K.

Table 3.1 – Summary of Culvert Locations and Corresponding Boreholes

Culvert	Site Number	Location		Boreholes	Appendix
		Station	Road/Direction		
104	44-604/C1	21+800	Hwy 69 NB	C104-1 to 3, and BH15A-04L	A
105	44-604/C2	21+889	Hwy 69 SB	C105-1 to 3, BH16-03, and D16-01R/02L	B
124 125	44-605/C1 44-605/C2	24+881 24+898	Hwy 69 NB Hwy 69 SB	C124-1 to 3, C125-1&2, BH25-01, C124-D1, and C125-D1 to D3	C
200 201	44-606/C1 44-606/C2	10+415 10+416	Hwy 69 NB Hwy 69 SB	C200-1, BH28-07/08R/09, BH29-05/06L/07, D28-04L, and D29-03R	D
209	44-607C	10+108	Rest Area Rd	BH34-08R/09/10L	E
221 222	44-608/C1 44-608/C2	12+711 12+717	Hwy 69 NB Hwy 69 SB	C221-1 to 3 and C222-1 & 2	F
226 227	44-609/C1 44-609/C2	13+452 13+452	Hwy 69 NB Hwy 69 SB	C226-1 to 3 and C227-1 & 2	G
230 231	44-610/C1 44-610/C2	13+914 13+914	Hwy 69 NB Hwy 69 SB	BH45-02/03L/04, C231-1 to 3, and D45-01R	H
234 235	44-611/C1 44-611/C2	14+507 14+515	Hwy 69 NB Hwy 69 SB	BH47-04/05R/06, C235-1 to 3, and D47-02L	I

Culvert	Site Number	Location		Boreholes	Appendix
		Station	Road/Direction		
236 237	44-612/C1 44-612/C2	14+644 14+636	Hwy 69 NB Hwy 69 SB	BH47A-01/02L/03, C237-1 to 3, and C236-D1	J
238 239	44-613/C1 44-613/C2	15+118 15+107	Hwy 69 NB Hwy 69 SB	C238-1, BH48-02/03L/04, C239-1 & 2, BH49-02L/03/04R, and D49-02L	K

The boreholes were advanced to depths of 0.0 m (where bedrock was observed at surface) to 13.4 m (elevations 199.8 to 179.5). The DCPTs were advanced to depths of 0.2 to 6.5 m (elevations 197.0 to 178.6). Most of the boreholes and DCPTs were terminated upon refusal on probable bedrock. Those boreholes which were not terminated upon refusal on probable bedrock were either terminated due to cave-in or on refusal on probable rock fill or were advanced into the bedrock to confirm the rock fill-bedrock interface. The boreholes and DCPTs listed below were not terminated upon refusal on probable bedrock.

Borehole/DCPT	Termination Details
BH28-09 BH49-03 BH49-04R D28-04L	Terminated upon refusal on probable rock fill.
BH47A-02L BH47A-03	Terminated due to cave-in.
C124-2 C124-3 C222-1 C227-1 C235-2	Advanced 0.6 to 1.6 m into bedrock to confirm the rock fill-bedrock interface.

The borehole locations were established by Thurber relative to culvert centreline staking by MMM Group Limited. Ground elevations at the test locations were approximated from survey data and detailed topographic plans provided by MMM Group.

Prior to commencement of drilling, utility clearances were obtained for all borehole and DCPT locations.

Where accessible, a CME-45 track-mounted drill rig equipped with hollow stem augers was used to advance the boreholes. Wash-boring methods with casing and portable tripod were employed where drilling was conducted on ice. A truck-mounted drill rig was used for boreholes drilled on the existing Highway 69 platform. Hollow stem augers, HQ casing, and NQ coring techniques were used to advance these boreholes.

Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils. Where firm to soft cohesive soils were

encountered, samples were also obtained using a thin-walled (Shelby) tube sampler. In situ vane shear testing was carried out to assess the undrained shear strength of soft to firm cohesive deposits.

Where practical, groundwater conditions were observed in the open boreholes during the drilling operations. Standpipe piezometers were installed in selected boreholes to monitor groundwater levels. In general, the standpipe piezometers consisted of 19 mm diameter PVC pipe with a 1.5 m long slotted screen enclosed in filter sand. A bentonite seal was placed above the filter sand and the remainder of the borehole was backfilled with bentonite and/or cuttings to the ground surface. Boreholes without piezometer installations were backfilled with bentonite and/or auger cuttings upon completion. The completion details of the piezometers are summarized in Table 3.2.

Table 3.2 – Piezometer Completion Details

Culvert	Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
200	BH28-08R	5.8 / 189.3	Piezometer with 1.5 m slotted screen installed, sand filter from 5.8 to 3.6 m, bentonite seal from 3.6 m to ground surface.
201	BH29-05	3.8 / 191.2	Piezometer with 1.5 m slotted screen installed, sand filter from 3.8 to 2.1 m, bentonite seal from 2.1 m to ground surface.
226	C226-1	2.9 / 194.6	Piezometer with 0.9 m slotted screen installed, sand filter from 2.9 to 1.5 m, bentonite seal from 1.5 to 0.6 m, then cuttings to surface.
231	C231-3	12.2 / 181.1	Piezometer with 1.5 m slotted screen installed, sand filter from 12.2 to 8.0 m , bentonite seal from 8.0 to 1.4 m, then cuttings to surface.
234	BH47-05R	3.2 / 191.5	Piezometer with 1.5 m slotted screen installed, sand filter from 3.2 to 1.1 m, bentonite seal from 1.1 m to ground surface.
237	C237-3	7.2 / 187.1	Piezometer with 1.5 m slotted screen installed, sand filter from 7.2 to 4.0 m, bentonite seal from 4.0 to 1.9 m, then cuttings to surface.
238	BH48-04	7.7 / 184.1	Piezometer with 1.5 m slotted screen installed, sand filter from 7.7 to 6.0 m, bentonite seal from 6.0 m to ground surface.
239	C239-1	12.2 / 180.0	Piezometer with 1.5 m slotted screen installed, sand filter from 12.2 to 9.7, bentonite plug from 9.7 to 2.0, cuttings from 2.0 to 0.8, bentonite seal from 0.8 to 0.2, then cuttings to surface.

A member of Thurber's technical staff supervised the drilling and sampling operations on a full time basis. The supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets included in Appendices A to K.

Selected samples were also subjected to gradation analysis (sieve and hydrometer) and Atterberg Limits testing where appropriate. The results of the testing program are summarized on the Record of Borehole sheets and figures in the respective appendices.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets and the Borehole Locations and Soil Strata Drawings included in Appendices A to K of this report. A general description of the stratigraphy based on the conditions encountered in the boreholes is given in this section. However, the factual data presented in the borehole logs takes precedence over this general description and interpretation of the site conditions. It must be recognized that soil conditions may vary between and beyond borehole locations.

The specific conditions encountered at individual sites vary. Generalized descriptions of the individual strata at each culvert site are presented below.

5.1 Culvert 104 (Station 21+800 NBL) (Appendix A)

General

At the culvert inlet, bedrock was encountered at surface while at the culvert outlet the stratigraphy consists of deposits of peat, silty clay, and sand overlying bedrock. In the borehole drilled through the existing highway embankment, the asphalt was underlain by sand and gravel fill overlying native sand and gravel overlying bedrock.

Peat

A 0.3 to 1.1 m thick layer of peat was encountered surficially in Boreholes C104-1 and BH15A-04L. A thin veneer (50 mm) of peat was also encountered in Borehole C104-3. The thickness of peat and other organic material may vary between and beyond the borehole locations.

SPT ‘N’ values recorded in the peat layer were 1 blow for 0.3 m penetration, indicating a very soft consistency.

Moisture contents of 57 to 63% were measured in the peat.

Asphalt

A 50 mm thick layer of asphalt was encountered at surface in borehole C104-2, which was drilled on the shoulder of the existing highway.

Embankment Fill

Embankment fill was encountered below the asphalt in Borehole C104-2. The embankment fill consisted of brown sand and gravel containing some silt.

The embankment fill was 5.1 m thick with the lower boundary of the fill encountered at Elevation 184.7 m.

SPT 'N' values recorded in the sand and gravel fill ranged from 5 to 39 blows for 0.3 m penetration, indicating a loose to dense relative density. In general, the highest SPT 'N' values were recorded near the surface. Moisture contents of 2 to 6% were measured in the sand and gravel samples.

One sample of the sand and gravel fill underwent laboratory grain size analysis testing, the results of which are summarized below. The grain size distribution curve for this sample is presented on Figure A1 of Appendix A.

Gravel %	32
Sand %	56
Silt & Clay %	12

Silty Clay

A layer of silty clay was encountered below the peat in Boreholes C104-1 and BH15A-04L. The silty clay was brown to grey and contained trace sand to sandy.

The thickness of the silty clay layer was 1.9 m and 3.0 m in Boreholes C104-1 and BH15A-04L, respectively. The lower boundary of the silty clay layer was encountered at depths of 3.0 m and 3.3 m upon refusal on probable bedrock (Elev. 182.2 to 182.0 m).

SPT 'N' values recorded in the silty clay layer ranged from 2 to 18 blows for 0.3 m penetration, indicating a soft to very stiff consistency. The moisture content of samples of the silty clay ranged from 18 to 37%.

Two samples of the silty clay were selected for laboratory grain size analysis and Atterberg Limits testing. The results of these tests are plotted on Figures A2 and A3, Appendix A and are summarized as follows:

Gravel %	0
Sand %	5 to 11
Silt %	40
Clay %	49 to 55
Liquid Limit	46 to 58
Plastic Limit	18 to 21

The results of the Atterberg Limits tests indicate that the silty clay varies from intermediate to high plasticity with group symbols of CI to CH.

Sand to Sand and Gravel

A layer of grey sand containing some gravel was encountered below the silty clay in Borehole C104-1 and a layer of brown sand and gravel containing some cobbles was encountered below the embankment fill materials in Borehole C104-2.

In Borehole C104-1, the sand layer was 0.9 m thick with the lower boundary of the sand encountered at a depth of 3.9 m (Elev. 181.3 m) upon refusal on probable bedrock. In Borehole C104-2, the sand and gravel layer was 0.6 m thick with the lower boundary of this layer encountered at a depth of 5.7 m (Elev. 184.1 m) upon refusal on probable bedrock.

A SPT 'N' value of 10 blows for 0.3 m penetration was recorded in the sand layer, indicating a loose to compact relative density. Higher SPT 'N' values were recorded in both the sand and sand and gravel at refusal upon probable bedrock. Measured moisture contents ranged from 12 to 18%.

Bedrock

All four boreholes were terminated upon refusal on probable bedrock at depths of 0.05 to 5.7 m (Elev. 185.9 to 181.3 m). The depths and elevations of the probable bedrock surface at the borehole locations are summarized in Table 5.1.

Table 5.1 – Depth/Elevation of Probable Bedrock

Borehole	Probable Bedrock Surface	
	Depth below Ground Surface (m)	Elevation (m)
C104-1	3.9	181.3
BH15A-04L	3.3	182.0
C104-2	5.7	184.1
C104-3	0.05	185.9

Groundwater Conditions

Water levels were observed in the open boreholes during and upon completion of drilling. The water levels observed during drilling are summarized in Table 5.2.

Table 5.2 – Water Level Observations

Borehole	Date	Water Level		Comments
		Depth (m)	Elev. (m)	
C104-1	Mar. 10, 2011	0.3	184.9	Open borehole
BH15A-04L	Nov. 12, 2010	0.0	185.3	Open borehole
C104-2	June 14, 2012	5.1	184.7	Open borehole

The above values are short-term observations. The depths to groundwater will vary depending upon seasonal fluctuations, rainfall patterns and swamp outlet conditions such as presented by beaver dams. In particular, water levels may be higher after the spring snowmelt or periods of heavy rainfall.

5.2 Culvert 105 (Station 21+889 SBL) (Appendix B)

General

The stratigraphy encountered in these boreholes generally consisted of peat overlying silty clay overlying sand to gravelly sand. At one location near the proposed culvert, a layer of sand and silt was encountered above the silty clay. One DCPT encountered bedrock at surface.

Ice and Water

Boreholes C105-1 to 3 were drilled on the ice at these locations during the winter, therefore a layer of ice overlying water was encountered at surface. The thickness of the ice ranged from 225 to 350 mm. The total depth of ice and water ranged from 375 to 900 mm.

Peat and Organics

A layer of peat/organics was encountered at surface in Borehole BH16-03 and below the ice and water in Boreholes C105-1 to 3. The thickness of the organic layer ranged from 50 mm to 1.1 m, with the thickest location at Borehole C105-2. The thickness of the organic deposits may vary between and beyond the borehole locations.

Moisture contents of 48 and 1578% were measured in samples of the peat.

Sand and Silt

A layer of sand and silt was encountered locally in Borehole BH16-03 below a thin layer of organics. The sand and silt was grey and contained some clay.

The layer of sand and silt was 1.1 m thick, with the lower boundary of this layer encountered at a depth of 1.2 m (Elev. 183.7 m).

SPT ‘N’ values recorded in the sand and silt ranged from 2 to 5 blows for 0.3 m penetration, indicating a very loose to loose relative density. Moisture contents of 93% and 18% were measured in samples of the sand and silt. The moisture content of 93% is likely due to the presence of organics in the sample.

One sample of the sand and silt underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix B. The grain size distribution curve for this sample is plotted on Figure B1, Appendix B.

Gravel %	0
Sand %	50
Silt %	30
Clay %	20

Silty Clay

A layer of silty clay was encountered below the peat in Boreholes C105-1 to C105-3 and below the sand and silt in Borehole BH16-03. The silty clay was brown to grey and contains trace sand to sandy.

The thickness of this cohesive layer ranged from 0.9 to 4.0 m, with the lower boundary of this layer encountered at depths of 2.3 to 4.7 m (Elev. 182.9 to 181.1 m).

SPT 'N' values recorded in the silty clay ranged from 0 to 8 blows for 0.3 m penetration, indicating a very soft to firm consistency. The undrained shear strength of the silty clay, determined by a single in situ vane shear strength test, was 36 kPa (firm).

The moisture contents ranged from 18 to 59%.

Five samples of the silty clay were selected for laboratory grain size analysis and Atterberg Limits testing, the results of which are summarized below. The grain size distribution curves for these samples are presented on Figure B2, Appendix B. The results of the Atterberg Limits tests are presented on Figure B4, Appendix B.

Gravel %	0
Sand %	5 to 22
Silt %	31 to 65
Clay %	15 to 64
Liquid Limit	25 to 68
Plastic Limit	14 to 23

The above results show that the silty clay varies from low to high plasticity with group symbols of CL to CH. The high plastic clay was encountered in Borehole C105-3.

Sand to Gravelly Sand

A layer of sand to gravelly sand was encountered below the silty clay in Boreholes C105-1 to C105-3. The sand to gravelly sand was grey and contained trace to some silt and clay.

The thickness of the sand to gravelly sand layer ranged from 0.6 to 0.9 m. The lower boundary of this layer was encountered at depths of 3.3 to 5.3 m (Elev. 182.0 to 180.5 m) at refusal upon probable bedrock.

SPT 'N' values recorded in the sand to gravelly sand ranged from 29 to 45 blows for 0.3 m penetration, indicating a compact to dense relative density. A higher SPT 'N' value of 100 blows for 0.125 m penetration was recorded upon refusal on probable bedrock.

The moisture content of samples of the sand to gravelly sand ranged from 10 to 18%.

Two samples collected from this granular layer were selected for laboratory grain size analysis testing. The results of these tests are summarized below and indicate that the sand ranges to gravelly sand. The grain size distribution curves for these samples are presented on Figure B3, Appendix B.

Gravel %	17 to 31
Sand %	62 to 68
Silt & Clay %	7 to 15

Bedrock

The boreholes and DCPTs were terminated upon refusal on probable bedrock at depths of 0.2 to 6.5 m (Elev. 185.4 to 178.6 m). The depths and elevations of the probable bedrock surface at the borehole locations are summarized in Table 5.3.

Table 5.3 – Depth/Elevation of Probable Bedrock

Borehole	Probable Bedrock Surface	
	Depth below Ground Surface (m)	Elevation (m)
C105-1	4.5	181.3
D16-02L	0.2	185.4
C105-2	3.3	182.0
BH16-03	2.3	182.6
D16-01R	6.5	178.6
C105-3	5.3	180.5

Groundwater Conditions

A total depth of 375 to 900 mm of ice and water was encountered in Boreholes C105-1 to C105-3 drilled on the ice in March 2011. Previously, water was observed at a depth of 1.2 m in Borehole 16-03 drilled in February 2009. The water levels observed during drilling are summarized in Table 5.4.

Table 5.4 – Water Level Observations

Borehole	Date	Depth of Ice and Water (m)	Water Level	
			Depth (m)	Elev. (m)
C105-1	Mar. 12, 2011	0.9	-	185.8
C105-2	Mar. 12, 2011	0.4	-	185.3
BH16-03	Feb. 8, 2009	-	1.2	183.7
C105-3	Mar. 9, 2011	0.6	-	185.8

The above values are short-term observations. The depths to groundwater will vary depending upon seasonal fluctuations, rainfall patterns and swamp outlet conditions such as presented by beaver dams. In particular, water levels may be higher after the spring snowmelt or periods of heavy rainfall.

5.3 Culverts 124 and 125 (Station 24+881 NBL and 24+898 SBL) (Appendix C)

General

The subsurface stratigraphy encountered at this site generally consists of a thin layer of peat/organics overlying bedrock. Boreholes drilled at the northwest area of this site encountered a layer of silty clay overlying bedrock. The existing highway embankment consists of a pavement structure (asphalt overlying sand fill) underlain by rock fill, which overlies bedrock.

Pavement Structure and Existing Embankment Fill

A pavement structure consisting of approximately 50 mm of asphalt overlying granular road base (sand fill) was encountered in Borehole C124-2 and C124-3, both of which were advanced through the existing Highway 69 embankment.

The granular fill consists of dark grey to brown sand containing some gravel. The granular fill extended to depths of 1.0 and 1.1 m (Elev. 196.8 and 196.7 m), at which depth the boreholes encountered rock fill.

Coring techniques were required to advance through the rock fill. The rock fill was 3.8 to 5.4 m thick, with the lower boundary of the rock fill encountered at depths of 4.9 and 6.4 m (Elev. 192.9 and 191.4 m).

Peat and Organics

A layer of peat/organics was encountered at surface in Boreholes C124-1 and C125-1, below water in Boreholes C125-2 and BH25-01, and below the rock fill in Borehole C124-2. The peat/organic layer was generally dark brown to black and fibrous. The thickness of the peat/organics ranged from 0.3 to 0.8 m. The lower boundary of the peat/organic layer was encountered at Elevations 192.8 to 191.1 m. Moisture contents of 115 and 209% were measured in samples of the peat/organics.

The thickness of peat and organics may vary between and beyond the borehole locations.

Silty Clay

A layer of brown to grey silty clay was encountered below the peat/organics in Boreholes C125-2 and BH25-01. The silty clay contained trace sand to sandy.

The thickness of the silty clay layer ranged from 1.2 to 1.3 m, with the lower boundary of the silty clay encountered at depths of 2.6 and 3.5 m (Elev. 190.7 and 190.6 m) upon refusal on probable bedrock.

SPT ‘N’ values typically ranged from 0 to 4 blows for 0.3 m penetration, indicating a very soft to firm consistency. A higher ‘N’ value (108 blows/0.2 m) was recorded in Borehole C125-2 at refusal upon probable bedrock. Moisture contents of samples of the silty clay ranged from 28 to 51%.

Two samples of the silty clay were selected for laboratory grain size analysis testing and one sample also underwent Atterberg Limits testing, the results of which are summarized below. The grain size distribution curves for these samples are presented on Figure C1, Appendix C. The result of the Atterberg Limits test is presented on Figure C2, Appendix C.

Gravel %	0
Sand %	2 to 37
Silt %	29 to 46
Clay %	34 to 52
Liquid Limit	48
Plastic Limit	20

The results of the Atterberg Limits test indicate that the silty clay has an intermediate plasticity with a group symbol of CI.

Bedrock

All of the boreholes and DCPTs were terminated upon refusal on probable bedrock, except Boreholes C124-2 and C124-3 which were advanced into the bedrock when coring through the rock fill. The depths and elevations of the probable bedrock surface at the borehole locations are summarized in Table 5.5.

Table 5.5 – Depth/Elevation of Probable Bedrock

Location	Borehole	Probable Bedrock Surface	
		Depth below Ground Surface (m)	Elevation (m)
South Side	C124-D1	0.5	193.0
	C124-3	4.9*	192.9
	C125-D1	0.6	193.6
	C125-D3	0.5	193.5
	C125-D2	1.8	190.4
North Side	C124-1	0.8	192.4
	C124-2	6.7*	191.1
	C125-1	0.7	192.8
	BH25-01	2.1	190.6
	C125-2	1.5	190.7

** Bedrock proven by coring.*

Groundwater Conditions

Boreholes BH25-01 and C125-2 and DCPT C125-D2 were advanced from the ice/water surface approximately 0.6 to 1.4 m above the swamp bottom. The water/ice surface varied from Elevation 192.8 to 194.1 m.

The water depth will vary depending upon seasonal fluctuations, rainfall patterns and outlet conditions such as presented by beaver dams. In particular, water levels may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

5.4 Culverts 200 and 201 (Station 10+415 SBL and 10+416 NBL) (Appendix D)

General

The general subsurface stratigraphy encountered at this site consists of a layer of silty clay overlying silty sand to sand and silt over bedrock. At the east end of the site, a second layer of silty clay was encountered below the silty sand layer. The one borehole drilled through the existing highway embankment encountered sand fill, rock fill, and a thin layer of peat overlying the native deposits of silty clay and silty sand.

Pavement Structure and Existing Embankment Fill

A pavement structure consisting of approximately 40 to 50 mm of asphalt overlying granular road base (sand to sand and gravel fill) was encountered in Boreholes BH28-07, BH29-09, C200-1, and DCPT D28-04L, all of which were drilled through the existing Highway 69 embankment.

The granular fill consists of brown sand to sand and gravel containing trace silt and occasional rock fill fragments. The granular fill extended to depths of 0.9 to 1.4 m (Elev. 197.0 to 194.8 m), at which depth boreholes BH28-07, BH28-09, D28-04L encountered refusal on probable rock fill and borehole C200-1 was advanced through the rock fill.

A single SPT 'N' value of 17 blows for 0.3 m penetration was recorded in the sand and gravel fill in Borehole BH28-09, indicating a compact relative density. Natural moisture contents ranged from 2 to 6%.

One sample of the sand and gravel fill underwent laboratory grain size analysis testing, the results of which are summarized below. The grain size distribution curve for this sample is presented on Figure D1 of Appendix D.

Gravel %	35
Sand %	56
Silt & Clay %	9

Coring techniques were required to advance Borehole C200-1 through the rock fill. The rock fill was 3.2 m thick, with the lower boundary of the rock fill encountered at a depth of 4.3 m (Elev. 193.4 m).

Peat

A thin layer of fibrous peat was encountered at surface in Boreholes BH29-05, BH29-06L, and BH29-07. The thickness of the peat layer ranged from 25 to 50 mm.

A layer of dark brown peat, 0.4 m thick, was also encountered below the rock fill in Borehole C200-1. The lower boundary of the peat layer in this borehole was encountered at a depth of 4.7 m (Elev. 193.0 m). A moisture content of 270% was measured for a sample of the peat at this location.

The thickness of peat may vary between and beyond the borehole locations.

Silt and Sand to Silty Sand

A layer of silt and sand to silty sand was encountered below the peat in Boreholes BH29-05 and BH29-07, below the silty clay in Boreholes C200-1 and BH29-06L, and within the silty clay in Borehole BH28-08R. The silt and sand to silty sand was brown to grey and contained trace to some clay, trace to some gravel, and occasional peaty organics.

SPT 'N' values recorded in the silt and sand to silty sand ranged typically ranged from 1 to 12 blows for 0.3 m penetration, indicating a very loose to compact relative density. Higher 'N' values (50 blows for less than 0.3 m penetration) were recorded at refusal on probable bedrock in Boreholes C200-1, BH29-06L, and BH29-07.

Natural moisture contents of samples of the silt and sand to silty sand ranged from 15 to 45%, typically less than 29%.

Two samples of the silt and sand underwent laboratory grain size analysis testing. The grain size distribution curves for these samples are presented on Figure D2, Appendix D. The results of these tests are as follows:

Gravel %	0
Sand %	52 to 64
Silt %	28 to 40
Clay %	8

Silty Clay

Layers of silty clay were encountered below the embankment fill and peat in Borehole C200-1, surficially and below sand and silt in Borehole BH28-08R, below sand and silt in Borehole BH29-05, and below the thin peat layer in Borehole BH29-06L. The silty clay was brown to grey and contained trace sand to sandy, trace gravel and occasional peat/organics and wood fibres just below the peat layer.

The thickness of the various clay layers ranged from 1.1 to 3.3 m. The lower boundary was encountered at depths of 2.2 to 5.8 m (Elev. 192.9 to 187.5 m).

SPT 'N' values recorded in the silty clay ranged from 1 to 6 blows for 0.3 m penetration, indicating a very soft to firm consistency. The undrained shear strength of the silty clay determined by in situ vane shear strength testing ranged from 24 to 40 kPa (soft to firm).

Moisture contents of samples of the silty clay typically ranged from 23 to 46%. Higher moisture contents were measured in Boreholes C200-1 and BH29-06L (83 and 102 %). These higher values likely reflect a higher organic content within these samples.

Seven samples of the silty clay were selected for laboratory grain size analysis testing and two of these samples also underwent Atterberg Limits testing, the results of which are summarized below. The grain size distribution curves for these samples are presented on Figures D3 and D4, Appendix D. The results of the Atterberg Limits tests are presented on Figure D5, Appendix D.

Gravel %	0 to 1
Sand %	3 to 21
Silt %	35 to 77
Clay %	20 to 62
Liquid Limit	22 to 27
Plastic Limit	14 to 16

The results of the Atterberg Limits tests indicate that the silty clay is typically low plastic with a group symbol of CL.

Gravelly Sand

A thin layer of grey gravelly sand containing occasional cobbles was encountered locally in borehole BH29-05, below the silty clay.

The gravelly sand layer was 0.1 m thick, with the lower boundary of this layer encountered at a depth of 3.8 m (Elev. 191.2 m) upon refusal on probable bedrock.

A natural moisture content of 17% was measured in one sample of the gravelly sand.

Bedrock

All of the boreholes and DCPTs were terminated upon refusal, however three of the boreholes (BH28-07, BH28-09, and D28-04L) were terminated upon refusal on probable rock fill instead of probable bedrock. The depths and elevations of the probable bedrock surface at the remaining borehole locations are summarized in Table 5.6.

Table 5.6 – Depth/Elevation of Probable Bedrock

Borehole	Probable Bedrock Surface	
	Depth below Ground Surface (m)	Elevation (m)
C200-1	6.6	191.1
BH28-08R	7.6	187.5
BH29-05	3.8	191.2
BH29-06L	3.3	191.1
BH29-07	1.6	193.0
D29-03R	3.2	191.4

Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. A standpipe piezometer was installed in Boreholes BH28-08R and BH29-05 to monitor water levels after completion of drilling. The water levels observed in the open boreholes and selected water level readings in the piezometers are summarized in Table 5.7. The complete list of water level readings for the piezometers are listed on the corresponding Record of Borehole sheets included in Appendix D.

Table 5.7 – Water Level Observations

Borehole	Date	Water Level		Comment
		Depth (m)	Elev. (m)	
BH28-08R	Oct. 29, 2008	0.1	195.0	Piezometer
	Jan. 14, 2009	0.5	194.6	
	Apr. 21, 2009	0.0	195.1	
	Aug. 25, 2009	0.0	195.1	
BH29-05	Oct. 29, 2008	1.2	193.8	Piezometer
	Jan. 15, 2009	0.2	194.8	
	Apr. 21, 2009	0.4	194.6	
	Aug. 25, 2009	0.6	194.4	
BH29-06L	Sept. 25, 2008	2.5	191.9	Open borehole
BH29-07	Sept. 25, 2008	1.5	193.1	Open borehole

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall. Depths to groundwater will also vary depending on rainfall patterns and swamp outlet conditions such as presented by beaver dams.

5.5 Culvert 209 (Station 10+108 Rest Area Road) (Appendix E)

General

Exposed bedrock was observed at two of the three borehole locations in the vicinity of this proposed culvert and bedrock was encountered below ice and water at the remaining borehole location.

Ice and Water

Borehole BH34-08R was drilled on the ice at this location during the winter, therefore ice was encountered at surface overlying water. The depth of the water at this location was 1.5 m.

Bedrock

At two of the borehole locations bedrock was exposed at surface. At the remaining borehole location, bedrock was encountered below water. The elevations of the bedrock surface at the borehole locations are summarized in Table 5.8.

Table 5.8 –Elevation of Bedrock Surface

Borehole	Bedrock Surface Elevation (m)
BH34-08R	189.8
BH34-09	191.9
BH34-10L	191.3

Groundwater Conditions

Borehole BH34-08R was advanced from the ice surface 1.5 m above the bottom of the channel. At the time of drilling the ice surface was at Elevation 191.3 m.

The water depth will vary depending upon seasonal fluctuations, rainfall patterns and outlet conditions such as presented by beaver dams. In particular, water levels may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

5.6 Culverts 221 and 222 (Station 12+711 NBL and 12+717 SBL) (Appendix F)

General

The stratigraphy encountered at this site generally consists of peat overlying shallow bedrock at depths of 0.3 m to 0.8 m. In the one borehole drilled through the existing highway embankment, pavement structure overlying rock fill overlying bedrock was encountered.

Pavement Structure and Existing Embankment Fill

A pavement structure consisting of approximately 40 mm of asphalt overlying granular road base (sand fill) was encountered in Borehole C222-1 drilled through the existing Highway 69 embankment.

The granular fill consists of dark brown to brown sand containing some gravel and trace silt. The granular fill extended to a depth of 0.5 m (Elev. 202.7 m), at which depth the borehole encountered rock fill. Coring techniques were required to advance the borehole through the rock fill. The rock fill was 3.8 m thick, with the lower boundary of the rock fill encountered at a depth of 4.3 m (Elev. 198.9 m).

Peat

Black peat was encountered at surface in Boreholes C221-1 to 3 and C222-2.

The thickness of the layer of peat ranged from 0.3 m to 0.8 m with the lower boundary of the peat encountered at Elevation 199.8 to 198.6 m. The thickness of the peat may vary between and beyond the borehole locations.

Bedrock

The four boreholes drilled off of the existing highway embankment (C221-1 to 3 and C222-2) were terminated upon refusal on probable bedrock at depths of 0.3 m to 0.8 m below the ground surface. The borehole drilled though the existing highway embankment (C222-1) penetrated 1.6 m into the bedrock in order to confirm the transition from rock fill to bedrock. The depths and elevations of the probable bedrock surface at the borehole locations are summarized in Table 5.9.

Table 5.9 – Depth and Elevation of Probable Bedrock

Borehole	Probable Bedrock Surface	
	Depth below Ground Surface (m)	Elevation (m)
C221-1	0.8	198.6
C221-2	0.5	199.3
C221-3	0.3	199.8
C222-1	4.3*	198.9
C222-2	0.3	198.6

** Bedrock proven by coring.*

Groundwater Conditions

The surficial peat was described as wet, indicating the groundwater level is essentially at the ground surface at this site.

Seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

5.7 Culverts 226 and 227 (Station 13+452 NBL and SBL) (Appendix G)

General

The subsurface stratigraphy at this site generally consists of a thin organic layer of peat overlying layers of sand, silty clay, and silty sand. These overburden deposits are underlain by probable bedrock.

The one borehole drilled through the existing highway embankment encountered embankment fill overlying layers of sand, clayey silt, and gravelly sand to sand underlain by bedrock.

Pavement Structure and Existing Embankment Fill

A pavement structure consisting of approximately 50 mm of asphalt overlying granular road base (sand fill) was encountered in Borehole C227-1 drilled through the existing Highway 69 embankment.

The granular fill consists of dark brown to brown sand containing some gravel and trace silt. The granular fill extended to a depth of 0.7 m (Elev. 198.8 m), at which depth the borehole encountered rock fill. Coring techniques were required to advance the borehole through the rock fill. The rock fill was 2.4 m thick, with the lower boundary of the rock fill encountered at a depth of 3.1 m (Elev. 196.4 m).

Peat

A thin layer of fibrous black peat was encountered at surface in Boreholes C226-1 to C226-3 and C227-2.

The layer of peat was 100 mm to 175 mm thick. The thickness of the peat may vary between and beyond the borehole locations.

Sand

A layer of dark brown to brown sand was encountered below the peat in Boreholes C226-1 to C226-3 and below the embankment fill in Borehole C227-1. The sand contained trace silt and trace gravel, and occasional cobbles.

The thickness of the sand layer ranged from 0.9 m to 2.6 m, with the lower boundary of the sand layer encountered at depths of 1.1 m to 4.2 m (Elevation 196.4 to 194.5).

SPT 'N' values recorded in the sand layer ranged from 1 to 17 blows for 0.3 m penetration, indicating a very loose to compact relative density. Samples of the sand had moisture contents ranging from 16 to 32%. In general, the moisture content decreased with depth.

One sample of the sand underwent laboratory grain size analysis testing, the results of which are summarized below. The grain size distribution curve for this sample is plotted on Figure G1, Appendix G.

Gravel %	1
Sand %	96
Silt and Clay%	3

Silty Clay

A layer of silty clay was encountered below the sand layer in Boreholes C226-1, C226-3, and C227-1. A 150 mm thick layer of silty clay was also encountered near the bottom of the sand layer in Borehole C226-2. The silty clay contained trace to some sand.

The thickness of the silty clay layer ranged from 0.2 to 0.7 m, with the lower boundary of this layer encountered at depths of 1.3 to 4.6 m (Elevation 196.2 to 194.9).

Where the silty clay layer was thick enough, SPT 'N' values of 3 to 9 blows for 0.3 m penetration were recorded. These 'N' values indicate a soft to stiff consistency. Moisture contents of 21 to 33% were measured in samples of the silty clay.

One sample of the silty clay underwent laboratory grain size analysis testing. The grain size distribution curve for this sample is plotted on Figure G2, Appendix G. The results of this test are as follows:

Gravel %	0
Sand %	7
Silt %	66
Clay %	27

Silty Sand

A layer of silty sand was encountered directly below the peat in Borehole C227-2, below the silty clay layer in Boreholes C226-1 and C226-3, and below the sand layer in Borehole

C226-2. The silty sand was typically grey and contained trace to some gravel, trace clay and occasional cobbles.

The thickness of the silty sand layer ranged from 1.6 m to 3.4 m, with the lower boundary of the silty sand layer encountered at depths of 2.6 m to 6.2 m (Elevation 194.6 to 191.1).

SPT 'N' values recorded in the silty sand layer typically ranged from 13 to 30 blows for 0.3 m penetration, indicating a compact relative density. Lower 'N' values of 2 and 7 (very loose to loose) were recorded near surface in Borehole C227-2. 'N' values for less than 0.3 m penetration were recorded in Boreholes C226-2 and C227-2 at refusal on probable bedrock.

The natural moisture content of samples of the silty sand ranged from 9 to 29%. In general, moisture contents decreased with depth.

Three samples of the silty sand underwent laboratory grain size analysis testing, the results of which are summarized below. The grain size distribution curves for these samples are plotted on Figure G3, Appendix G.

Gravel %	2 to 16
Sand %	57 to 74
Silt and Clay %	22 to 31

Gravelly Sand to Sand

Grey gravelly sand to sand containing trace to some silt and clay and occasional cobbles was encountered below the silty clay in Borehole C227-1.

The gravelly sand and sand was 2.6 m thick, with the lower boundary of the sand encountered at a depth of 7.2 m (Elev. 192.3 m).

SPT 'N' values recorded in the gravelly sand to sand ranged from 14 to 28 blows for 0.3 m penetration, indicating a compact relative density. Moisture contents of 11 to 19% were measured in samples of the gravelly sand and sand.

One sample of gravelly sand underwent laboratory grain size analysis testing, the results of which are summarized below. The grain size distribution curve for this sample is presented on Figure G4, Appendix G.

Gravel %	23
Sand %	64
Silt and Clay %	13

Bedrock

All the boreholes were terminated upon refusal on probable bedrock except Borehole C227-1 which was advanced 0.6 m into bedrock. The depths and elevations of the probable bedrock surface are summarized in Table 5.10.

Table 5.10 – Depth/Elevation of Probable Bedrock

Borehole	Probable Bedrock Surface	
	Depth below Ground Surface (m)	Elevation (m)
C226-1	2.9	194.6
C226-2	6.2	191.1
C226-3	5.6	191.9
C227-1	7.2*	192.3
C227-2	2.6	193.7

** Bedrock proven by coring*

Groundwater Conditions

Where practical, water levels were observed in the open boreholes upon completion of drilling. A standpipe piezometer was installed in Borehole C226-1 to monitor water levels after completion of drilling. The water levels observed during drilling and measured in the piezometer are summarized in Table 5.11.

Table 5.11 – Water Level Observations

Borehole	Date	Water Level		Comment
		Depth (m)	Elev. (m)	
C226-1	June 5, 2012 June 21, 2012 July 5, 2012	0.4 0.4 0.5	197.1 197.1 197.0	Piezometer
C226-2	May 25, 2012	0.4	196.9	Open borehole
C226-3	May 24, 2012	1.5	196.0	Open borehole
C227-2	June 21, 2012	0.05	196.3	Open borehole

The above values are short-term observations. The depths to groundwater will vary depending upon seasonal fluctuations, rainfall patterns and swamp outlet conditions such as presented by beaver dams. In particular, water levels may be higher after the spring snowmelt or periods of heavy rainfall.

5.8 Culverts 230 and 231 (Station 13+914 NBL and SBL) (Appendix H)

General

The existing Highway 69 crosses a swamp at this location. In the borehole drilled through the existing highway embankment, a pavement structure overlying rock fill was encountered above layers of native silty clay, silt and sand, and sandy gravel overlying probable bedrock.

The subsurface stratigraphy in the swamp generally consisted of layers of peat/organics or silty sand, overlying silty clay, and sand to sandy gravel. These deposits were underlain by probable bedrock. Boreholes drilled near the toes of the existing highway embankment encountered fill consisting of silty clay and sand overlying the native deposits.

Pavement Structure and Existing Embankment Fill

A pavement structure consisting of approximately 50 mm of asphalt overlying granular road base (sand and gravel fill) was encountered in Borehole C231-2 drilled through the existing Highway 69 embankment.

The granular fill consists of dark brown to brown sand and gravel containing trace silt. The granular fill extended to a depth of 2.3 m (Elev. 192.7 m), at which depth the borehole encountered rock fill. A layer of sand mixed with rock fill was also encountered in Borehole C231-1, located at the toe of the existing highway embankment, below a thin layer of organics. The sand and rock fill mixture was 1.2 m thick, with the lower boundary of this fill encountered at a depth of 1.4 m (Elev. 192.0 m).

SPT 'N' values recorded in the sand and gravel fill in Borehole C231-2 ranged from 22 to 38 blows for 0.3 m penetration, indicating a compact to dense relative density. Moisture contents ranged from 2 to 3%.

The results of a grain size distribution analysis conducted on one sample of the sand and gravel fill is presented below and the grain size distribution curve for this sample is presented on Figure H1 of Appendix H.

Gravel %	57
Sand %	35
Silt & Clay %	8

A SPT 'N' value of 5 blows for 0.3 m penetration was recorded in the sand and rock fill mixture in Borehole C231-1, indicating a loose relative density. A moisture content of 42% was measured for this material.

Coring techniques were required to advance borehole C231-2 through the rock fill. SPT 'N' values were recorded, where possible, in the rock fill and ranged from 7 to 19 blows for 0.3 m penetration, indicating a loose to compact relative density. The rock fill was 4.5 m thick, with the lower boundary of the rock fill encountered at a depth of 6.8 m (Elev. 188.2 m).

Silty clay fill was encountered at the toe of the existing embankment in Borehole C231-3, at surface. The silty clay fill was dark brown and contained some sand, trace gravel, occasional cobbles and some roots and rootlets. The silty clay fill was 1.5 m thick, with the lower boundary at Elevation 191.8 m. A SPT 'N' value of 10 blows for 0.3 m penetration was recorded in the silty clay fill, indicating a stiff consistency. An 'N' value of 50 blows for 0.125 m penetration was also recorded on a probable cobble in the silty clay fill. Moisture contents ranged from 21 to 23%.

Organics and Peat

A layer of peaty organics was encountered surficially in Boreholes BH45-02, BH45-03L, BH45-04, and C231-1. The thickness of this surficial organic layer ranged from 25 mm to

800 mm. A 1.2 m thick layer of peat was also encountered below the silty clay fill in Borehole C231-3. The thickness of the organics and peat may vary between and beyond the borehole locations.

SPT 'N' values recorded in the organics and peat ranged from 0 to 3 blows for 0.3 m penetration, indicating a very soft to soft consistency. Moisture contents ranged from 62 to 120%.

Silty Sand

A layer of brown to grey silty sand was encountered below the thin layer of organics in Boreholes BH45-02 and BH45-03L. The silty sand layer was 0.6 m thick in both boreholes, with the lower boundary of this layer encountered at Elevation 192.2 and 192.1 m.

SPT 'N' values of 1 and 3 blows for 0.3 m penetration were measured in the silty sand, indicating a very loose relative density. Samples of the silty sand had moisture contents of 20 and 23%.

Silty Clay

Brown to grey silty clay containing trace to some sand was encountered below the fill in Boreholes C231-1 and C231-2, below the peat and organics in Boreholes BH45-04 and C231-3, and below the silty sand in Boreholes BH45-02 and BH45-03L.

The thickness of the silty clay ranged from 0.9 to 6.7 m and in general, the thickness of the silty clay increased from the east end of the site to the west end. The lower boundary of the silt clay was encountered at depths of 1.5 to 10.8 m (Elev. 191.3 to 183.9 m).

SPT testing in the silty clay yielded SPT 'N' values of 0 to 9 blows for 0.3 m penetration, indicating a very soft to stiff consistency. Typically, 'N' values ranged from 0 to 4 (very soft to soft). Higher 'N' values were recorded upon refusal upon probable bedrock. The undrained shear strength of the silty clay determined from in situ vane shear strength testing ranged from 21 to 41 kPa (soft to firm). Moisture contents of samples of the silty clay ranged from 18 to 70%.

Seven samples of the silty clay underwent laboratory grain size analysis testing and six of these samples also underwent Atterberg Limits testing, the results of which are summarized below. The grain size distribution curves for these samples are presented on Figures H2 and H3 while the results of the Atterberg Limits tests are plotted on Figure H6, Appendix I.

Gravel %	0
Sand %	0 to 18
Silt %	34 to 74
Clay %	23 to 64
Liquid Limit	24 to 64
Plastic Limit	16 to 23

The above results indicate that the silty clay varies from low to high plasticity with group symbols of CL, CI and CH.

Silt and Sand to Sand

A deposit of grey silt and sand to sand was encountered below the silty clay in Boreholes C231-1 to C231-3 and BH45-02. At some locations this deposit contained some clay and trace gravel.

The thickness of the silt and sand to sand ranged from 0.2 to 4.0 m, with the lower boundary of this deposit encountered at depths of 1.7 to 13.4 m (Elev. 191.1 to 179.9 m).

SPT 'N' values recorded in the silt and sand to sand ranged from 16 to 36 blows for 0.3 m penetration, indicating a compact to dense relative density. Higher 'N' values were recorded in Boreholes BH45-02 and C231-1 at refusal upon probable bedrock. Natural moisture contents of the silt and sand to sand ranged from 10 to 24%.

Laboratory grain size analysis testing was performed for one sample of silt and sand and one sample of sand. The results of these tests are presented below and are summarized on the corresponding Record of Borehole sheets. The grain size distribution curves for these samples are presented on Figures H4 and H5, Appendix I.

	Silt and Sand Fig. H4	Sand Fig. H5
Gravel %	0	12
Sand %	40	72
Silt %	48	-
Clay %	12	-
Silt and Clay %	-	16

Sandy Gravel

Grey sandy gravel was encountered locally in Borehole C231-2, at depth, below the silt and sand deposit.

The sandy gravel was 1.2 m thick, with the lower boundary encountered at a depth of 12.7 m (Elevation 182.3) upon refusal on probable bedrock.

The sandy gravel was compact to very dense, based on SPT 'N' values of 27 and 71 blows for 0.3 m penetration. Moisture contents of 6 and 15% were measured from the sandy gravel samples.

Bedrock

All of the boreholes and the DCPT were terminated upon refusal on probable bedrock at depths of 1.7 to 13.4 m (Elev. 191.1 to 179.9 m). The depths and elevations of the probable bedrock surface at the borehole locations are summarized in Table 5.12.

Table 5.12 – Depth/Elevation of Probable Bedrock

Borehole	Probable Bedrock Surface	
	Depth below Ground Surface (m)	Elevation (m)
D45-01R	3.3	189.3
BH45-02	1.7	191.1
BH45-04	3.4	189.2
BH45-03L	3.2	189.5
C231-1	6.0	187.4
C231-2	12.7	182.3
C231-3	13.4	179.9

Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. A standpipe piezometer was installed in Borehole C231-3 to monitor water levels after completion of drilling. The water levels observed during drilling and measured in the piezometer are summarized in Table 5.13.

Table 5.13 – Water Level Observations

Borehole	Date	Water Level		Comment
		Depth (m)	Elev. (m)	
BH45-02	Sept. 09, 2008	0.9	191.9	Open borehole
BH45-04	Sept. 09, 2008	0.3	192.3	Open borehole
BH45-03L	Sept. 09, 2008	0.3	192.4	Open borehole
C231-1	May 25, 2012	0.8	192.6	Open borehole
C231-3	Jun. 5, 2012 Jun. 21, 2012 Jul. 5, 2012	0.1* 0.1* 0.0	193.4 193.4 193.3	Piezometer

** Artesian condition*

The above values are short-term observations. The surface water depth and depths to groundwater will vary depending upon seasonal fluctuations, rainfall patterns and swamp outlet conditions such as presented by beaver dams. In particular, water levels may be higher after the spring snowmelt or periods of heavy rainfall.

5.9 Culverts 234 and 235 (Station 14+507 NBL and 14+515 SBL) (Appendix I)

General

At the east end of the site, the stratigraphy generally consisted of organics overlying silty clay and sand to sand and gravel layers over probable bedrock. Bedrock was generally shallow at the west end of the site, overlain by embankment fill at Borehole C235-2 and thin layers of peat and sand on either side of the highway embankment.

Pavement Structure and Existing Embankment Fill

A pavement structure consisting of approximately 50 mm of asphalt overlying granular road base (sand fill) was encountered in Borehole C235-2 drilled through the existing Highway 69 embankment.

The granular fill consists of dark brown sand containing some gravel. The granular fill extended to a depth of 0.7 m (Elev. 196.2 m), at which depth the borehole encountered rock fill. A moisture content of 5% was measured in one sample of the sand fill.

Coring techniques were required to advance the borehole through the rock fill. The rock fill was 1.2 m thick, with the lower boundary of the rock fill encountered at a depth of 1.9 m (Elev. 195.0 m).

Organics and Peat

Brown to black organics or peat were encountered at surface in Boreholes BH47-04, BH47-05R, C235-1 and C235-2.

The thickness of the organics/peat ranged from 50 mm to 0.9 m. The lower boundary of the organics/peat was encountered at Elevation 194.7 to 193.8 m.

An SPT 'N' value of 2 blows for 0.3 m penetration was recorded in the surficial organic layer in Borehole BH47-05R, indicating a very soft to soft consistency. A moisture content of 873% was measured in one sample of the peaty organics.

Silty Clay

Brown to grey silty clay containing trace sand was encountered below the organic layer in Boreholes BH47-04 and BH47-05R and at surface in Borehole BH47-06. The thickness of the silty clay ranged from 1.7 to 2.6 m, with the lower boundary of the silty clay encountered at depths of 1.7 to 3.2 m (Elev. 193.2 to 191.5 m).

SPT 'N' values recorded in the silty clay indicate that the silty clay has a variable consistency, ranging from very soft to very stiff ('N' values of 1 to 29 blows for 0.3 m penetration). The undrained shear strength of the silty clay determined from a single in situ vane shear strength test (Borehole BH47-05R) was 47 kPa (firm).

The moisture contents of samples of the silty clay ranged from 14 to 71%. A moisture content of 579% was measured in a sample containing some peaty organics.

Three samples of the silty clay were selected for laboratory analysis. All three samples underwent grain size analysis testing and two of the three samples underwent Atterberg Limits testing. The results of these tests are summarized below and the results of grain size distribution curves for these samples are presented on Figure I1 of Appendix I. The results of the Atterberg Limits tests are plotted on Figure I3, Appendix I.

Gravel %	0
Sand %	1 to 7
Silt %	28 to 54
Clay %	39 to 68
Liquid Limit	44 to 49
Plastic Limit	16 to 22

The above results indicate that the silty clay is medium plastic with group symbol of CI.

Sand

Brown to grey sand containing trace to some silt and trace clay was encountered below the silty clay in Borehole BH47-04 and below the peat in Borehole C235-1.

The sand layer in Borehole BH47-04 was 1.7 m thick, with the lower boundary encountered at a depth of 4.3 m (Elev. 190.5 m). In Borehole C235-1, the sand was 0.6 m thick and the borehole was terminated at the bottom of the sand layer at 0.8 m depth (Elev. 194.0 m) upon refusal on probable bedrock.

SPT 'N' values recorded in the sand ranged from 1 to 8 blows for 0.3 m penetration, indicating a very loose to loose relative density. A higher 'N' value was recorded in Borehole C235-1 upon refusal on probable bedrock. Moisture contents of the sand typically ranged from 19 to 22%. A moisture content of 66% was measured in a sand sample from Borehole BH47-04 with a probable organic component.

One sample of the sand was selected for grain size analysis testing, the results of which are summarized below. The grain size distribution curve for this sample is plotted on Figure I2, Appendix I.

Gravel %	0
Sand %	88
Silt and Clay %	12

Sand and Gravel

Grey sand and gravel was encountered below the sand layer in Borehole BH47-04. The sand and gravel layer was 0.3 m thick, with the lower boundary of the sand and gravel encountered at a depth of 4.6 m (Elev. 190.2 m) upon refusal on probable bedrock.

A SPT 'N' value of 50 blows for 0.15 m penetration was recorded in the sand and gravel at refusal upon probable bedrock and is therefore not indicative of the relative density of the sand and gravel. A moisture content of 9% was measured in one sample of the sand and gravel.

Bedrock

All of the boreholes and the one DCPT were terminated upon refusal on probable bedrock, except in Borehole C235-2 where 1.3 m of bedrock was cored in order to confirm the transition from rock fill to bedrock. The depths and elevations of the probable bedrock surface at the borehole locations are summarized in Table 5.14.

Table 5.14 – Depth/Elevation of Probable Bedrock

Borehole	Probable Bedrock Surface	
	Depth below Ground Surface (m)	Elevation (m)
BH47-04	4.6	190.2
BH47-05R	3.2	191.5
BH47-06	1.7	193.2
D47-02L	1.7	193.0
C235-1	0.8	194.0
C235-2	1.9*	195.0
C235-3	0.3	194.5

** Bedrock proven by coring*

Groundwater Conditions

Where practical, water levels were measured in the open boreholes upon completion of drilling. A standpipe piezometer was installed in Borehole BH47-05R to monitor water levels after completion of drilling. Selected water levels measured in the piezometer and open boreholes are summarized in Table 5.15. The complete list of water level measurements for BH 47-05R are listed on the Record of Borehole sheet included in Appendix I.

Table 5.15 – Water Level Observations

Borehole	Date	Water Level		Comment
		Depth (m)	Elev. (m)	
BH47-04	Sept. 10, 2008	0.0	194.8	Open borehole
BH47-05R	Sept. 24, 2008 Feb. 19, 2009 Jun. 5, 2009 Nov. 20, 2009	0.0 0.2 0.0 0.0	194.7 194.5 194.7 194.7	Piezometer
BH47-06	Sept. 11, 2008	0.0	194.9	Open borehole

The above values are short-term observations. The surface water depth and depths to groundwater will vary depending upon seasonal fluctuations, rainfall patterns and swamp outlet conditions such as presented by beaver dams. In particular, water levels may be higher after the spring snowmelt or periods of heavy rainfall.

5.10 Culverts 236 and 237 (Station 14+644 NBL and 14+636 SBL) (Appendix J)

General

Generally, the subsurface stratigraphy at this site consists of multiple layers of sand to silty sand and silty clay overlying bedrock. The borehole drilled through the existing highway embankment encountered sand fill overlying the native deposits.

Pavement Structure and Existing Embankment Fill

A pavement structure consisting of approximately 50 mm of asphalt overlying granular road base (sand fill) was encountered in Borehole C237-2 drilled through the existing Highway 69 embankment.

The granular fill consists of dark brown to brown sand containing trace to some gravel. The granular fill extended to a depth of 1.5 m (Elev. 195.2 m). Based on a SPT 'N' value of 10 blows for 0.3 m penetration, the sand fill had a compact relative density. Moisture contents of 3 and 10% were measured in samples of the sand fill.

Peat and Organics

A layer of peat/fibrous organics was encountered at surface in all of the boreholes, except Borehole C237-2 which was drilled on the highway. The peat/organics was typically black and contained some sand at some borehole locations.

The thickness of the peat/organics layer ranged from 0.1 to 0.6 m. The lower boundary of the peat/organics was encountered at Elevation 195.2 to 194.1 m. The thickness of the peat and organic material may vary between and beyond the borehole locations.

A single SPT 'N' value of 2 blows for 0.3 m penetration was recorded in the organic layer in Borehole BH47A-02L, indicating a very soft to soft consistency. A moisture content of 40% was measured for one sample of the organics containing sand.

Sand to Silt and Sand

A deposit of sand to silt and sand was encountered below the peat/organics and fill in all boreholes. This deposit was interrupted by silty clay layers near the ground surface, resulting in various thickness of sand/silt ranging from 0.3 to 9.0 m. The lower boundary of these layers ranged from depths of 0.6 to 12.0 m (Elev. 194.8 to 184.7 m).

The sand to silt and sand was generally brown and grey and contained trace to some clay, trace to some gravel, and occasional cobbles at depth.

SPT 'N' values recorded in the silt and sand to sand ranged from 1 to 32 blows for 0.3 m penetration, indicating a variable relative density ranging from very loose to dense. In general, SPT 'N' values ranged from 4 to 27 blows for 0.3 m penetration (loose to compact). An 'N' value of 100 blows was recorded in Borehole C237-2 at refusal upon probable bedrock at a depth of 12.0 m. Moisture contents ranged from 13 to 40%, typically less than 27%.

Six samples of the sand to silt and sand underwent laboratory grain size analysis testing. The grain size distribution curves for these samples are presented on Figures J1 and J2, Appendix J. The results of these tests are summarized as follows:

	Silt and Sand to Silty Sand (Fig.J1)	Sand (Fig.J2)
Gravel %	0 to 14	2 to 7
Sand %	52 to 60	78 to 93
Silt %	28 to 40	14
Clay %	2 to 12	4
Silt and Clay %	34	5 to 6

Silty Clay

Layers of silty clay were encountered in the upper part of the sand/silt deposit in all of the boreholes. The silty clay was typically brown and contained trace sand and occasional sand seams. When the clay layer was fully penetrated, the thickness ranged from 0.4 to 1.2 m. In Boreholes BH47A-02L and 47A-03, a second clay layer was encountered, however the borehole sidewalls caved after penetrating 0.3 and 0.9 m into the clay. The lower boundary ranged from 1.2 to 3.0 m depth (Elev. 193.9 to 192.7 m).

SPT 'N' values recorded in the silty clay layers ranged from 4 to 33 blows for 0.3 m penetration, indicating a firm to hard consistency. Samples of the silty clay had moisture contents ranging from 23 to 48%.

Five samples of the silty clay were selected for grain size analysis and Atterberg Limits testing, the results of which are summarized below. The grain size distribution curves for these samples are presented on Figure J3, Appendix J and the results of the Atterberg Limits tests are presented on Figure J4 of Appendix J.

Gravel %	0
Sand %	2 to 18
Silt %	42 to 49
Clay %	35 to 52
Liquid Limit	42 to 58
Plastic Limit	18 to 24

The above results indicate that the silty clay is of medium to high plasticity with group symbols of CI to CH.

Bedrock

Four of the boreholes and the one DCPT at this site were terminated upon refusal on probable bedrock. Boreholes BH47A-02L and BH47A-03 did not reach refusal due to borehole cave-in during advance with portable split spoon sampling equipment. The depths and elevations of the probable bedrock surface at the borehole locations are summarized in Table 5.16.

Table 5.16 – Depth/Elevation of Probable Bedrock

Borehole	Probable Bedrock Surface	
	Depth below Ground Surface (m)	Elevation (m)
D236-D1	5.1	190.0
BH47A-01	1.8	193.6
C237-1	5.3	189.6
C237-2	12.0	184.7
C237-3	7.4	186.9

Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. A standpipe piezometer was installed in Borehole C237-3 to monitor water levels after completion of drilling. The water levels observed during drilling, and the water levels measured in the piezometer are summarized in Table 5.17.

Table 5.17 – Water Level Observations

Borehole	Date	Water Level		Comment
		Depth (m)	Elev. (m)	
BH47A-02L	Dec. 1, 2010	0.4	194.7	Open borehole
BH47A-03	Dec. 1, 2010	1.2	193.9	Open borehole
C237-1	May 23, 2012	1.2	193.7	Open borehole
C237-3	Jun. 5, 2012 Jun. 21, 2012 Jul. 5, 2012	0.3 0.3 0.4	194.0 194.0 193.9	Piezometer

The above values are short-term observations. The depth to groundwater will vary depending upon seasonal fluctuations, rainfall patterns and swamp outlet conditions such as presented by beaver dams. In particular, water levels may be higher after the spring snowmelt or periods of heavy rainfall.

5.11 Culverts 238 and 239 (Station 15+118 NBL and 15+107 SBL) (Appendix K)

General

In general, the subsurface stratigraphy at this site consisted of peat/organics overlying layers of sand, clayey silt to silty clay, sand and probable bedrock. In the boreholes drilled on the highway, a pavement structure overlying granular fill containing cobbles and rock fill fragments was encountered above the native deposits.

Pavement Structure and Existing Embankment Fill

A pavement structure consisting of approximately 40 to 50 mm of asphalt overlying granular road base (sand fill) was encountered in Boreholes BH49-03, BH49-04R, and C239-2 drilled on the existing Highway 69 platform.

The road base/embankment fill consists of brown sand containing some gravel, some silt and occasional cobbles, boulders and rock fill fragments. Boreholes BH49-03 and BH49-04R were terminated at depths of 0.7 and 1.2 m (Elev. 193.5 and 192.9 m), upon auger refusal on probable rock fill. Coring techniques were used in Borehole C239-2 to advance the borehole through probable rock fill between 1.4 to 2.2 m depth (Elevation 192.6 to 191.8 m).

SPT 'N" values of 15 blows/0.3 m penetration and 115 blows/0.225 m penetration were recorded in the fill. An 'N' value of 15 is indicative of a compact relative density while the 'N' value of 115 is indicative of the presence of cobbles and/or rock fill fragments with the fill. Moisture contents ranged from 3 to 7%.

Peat and Organics

Dark brown to black fibrous peat or organic material was encountered at surface in Boreholes BH48-04, C238-1, and C239-1. The thickness of this layer ranged from 0.2 to 1.3 m. The lower boundary of the peat/organics was encountered at Elevation 191.6 to 190.9 m. The thickness of the peat and organic material may vary between and beyond the borehole locations.

The peat was very soft to soft, based on SPT 'N' values of 1 to 2 blows for 0.3 m penetration. A moisture content of 279% was measured in one sample of the peat.

Upper Sand to Sandy Silt

A layer of sand to sandy silt was encountered at surface in Boreholes BH48-02, BH48-03L, and BH49-02L, below the peat/organics in Boreholes BH48-04, C238-1, and C239-1, and below the sand fill in Borehole C239-2. The sand/silt was typically brown and contained trace gravel. The sand/silt contained trace roots and rootlets and peat/organics.

The thickness of the upper sand/silt layer ranged from 0.7 to 1.7 m, with the lower boundary of this layer encountered at depths of 0.7 to 3.1 m (Elev. 191.5 to 189.2 m).

SPT 'N' values recorded in the upper sand ranged from 0 to 21 blows for 0.3 m penetration, indicating a very loose to compact relative density. In general, 'N' values were less than 4 (very loose).

Moisture contents of samples of the upper sand/silt typically ranged from 20 to 37%. Moisture contents of 82 and 411 % were measured for two samples containing peaty organics.

Two samples of the sandy silt underwent laboratory grain size analysis testing, the results of which are summarized below. The grain size distribution curves for these samples are presented on Figure K1, Appendix K.

Gravel %	0
Sand %	34 to 36
Silt %	50 to 52
Clay %	12 to 16

Silty Clay

Silty clay was encountered below the upper sand layer in all boreholes, except Boreholes BH49-03 and BH49-04R. The silty clay was typically grey and contained trace sand to sandy.

The thickness of the silty clay layer ranged from 2.5 to 8.9 m, with the lower boundary of this layer encountered at depths of 3.9 to 10.7 m (Elev. 187.9 to 181.6 m). Borehole BH48-02 was terminated at the lower boundary of the silty clay layer upon refusal on probable bedrock. The silty clay layer in Borehole BH49-02L was interrupted by a 1.6 m thick layer of very loose sandy silt at 5.0 m depth.

SPT 'N' values recorded in the silty clay layer ranged from 0 to 7 blows for 0.3 m penetration, indicating a very soft to firm consistency. The undrained shear strength of the clay determined by in situ vane testing ranged from 21 to 80 kPa (soft to stiff), typically less than 50 kPa (soft to firm), with localized values of 6 to 8 kPa (very soft) in Borehole BH49-02L. Moisture contents of the silty clay samples ranged from 21 to 63%.

Ten samples of silty clay were selected for laboratory grain size analysis testing, the results of which are summarized below and are presented on the Record of Borehole sheets. The grain size distribution curves for these samples are presented on Figures K2 and K3 of Appendix K. Atterberg Limits tests were performed on nine of these samples. The results of the Atterberg Limits testing are presented on Figures K5 and K6, Appendix K and are summarized below.

Gravel %	0
Sand %	0 to 31
Silt %	44 to 76
Clay %	19 to 54
Liquid Limit	24 to 50
Plastic Limit	14 to 20

The above results indicate that the silty clay varies from low to intermediate plasticity with group symbols of CL to CI.

Lower Sand

A lower layer of sand was encountered below the silty clay in Boreholes BH48-03L, BH48-04, BH49-02L, C238-1, C239-1, and C239-2. This sand was grey and generally contained trace to some gravel and trace silt and clay. It varied from silty to gravelly in Borehole BH49-02L.

The thickness of the lower sand layer ranged from 1.1 to 4.1 m, with the lower boundary of this layer encountered at depths of 7.3 to 12.5 m (Elev. 184.5 to 179.7 m), upon refusal on probable bedrock.

SPT 'N' values recorded in the lower sand layer ranged from 0 to 76 blows for 0.3 m penetration, indicating a variable relative density ranging from very loose to very dense. In general, the lower sand had a very loose to compact relative density ('N' values from 2 to 18). Higher 'N' values were recorded in Boreholes C239-1 and BH48-04 at refusal on probable bedrock.

Moisture contents of samples of the sand ranged from 14 to 22%.

Laboratory grain size analysis testing was performed on four samples of the lower sand. The results of these tests are summarized below and the grain size distribution curves for these samples are presented on Figure K4, Appendix K. These results are also presented on the Record of Borehole sheets included in Appendix K.

Gravel %	0 to 15
Sand %	81 to 98
Silt and Clay %	2 to 4

Bedrock

Probable bedrock was encountered in seven of the boreholes and the one DCPT. Where probable bedrock was not encountered (Boreholes BH49-03 and BH49-04R), the boreholes were terminated upon refusal on probable rock fill. The depths and elevations of the probable bedrock surface at the borehole locations are summarized in Table 5.18.

Table 5.18– Depth/Elevation of Probable Bedrock

Borehole	Probable Bedrock Surface	
	Depth below Ground Surface (m)	Elevation (m)
C238-1	7.3	184.5
BH48-02	7.2	185.0
BH48-04	7.7	184.1
BH48-03L	9.1	182.8
C239-1	12.5	179.7
C239-2	11.8	182.2
D49-02L	4.9	187.3
BH49-02L	12.3	179.8

Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. Standpipe piezometers were installed in Boreholes BH48-04 and C239-1 to monitor water levels after completion of drilling. The water levels observed during drilling, and selected water levels measured in the piezometers are summarized in Table 5.19. The complete list

of water level measurements in the piezometers are presented on the Record of Borehole sheets included in Appendix K.

Table 5.19 – Water Level Observations

Borehole	Date	Water Level		Comment
		Depth (m)	Elev. (m)	
C238-1	May 23, 2012	0.8	191.0	Open borehole
BH48-02	Sept. 12, 2008	1.5	190.7	Open borehole
BH48-03L	Sept. 12, 2008	0.9	191.0	Open borehole
BH48-04	Oct. 29, 2008 Apr. 21, 2009 Jun. 5, 2009 Oct. 27, 2009	0.1 0.2 0.0 0.3	191.7 191.6 191.8 191.5	Piezometer
C239-1	Jun. 5, 2012 Jun. 21, 2012 Jul. 5, 2012	0.5 0.5 0.6	191.7 191.7 191.6	Piezometer
BH49-02L	Feb. 9, 2009	0.0	192.1	Open borehole

The above values are short-term observations. The surface water depth and depths to groundwater will vary depending upon seasonal fluctuations, rainfall patterns and swamp outlet conditions such as presented by beaver dams. In particular, water levels may be higher after the spring snowmelt or periods of heavy rainfall.

6 MISCELLANEOUS

MMM Group survey personnel staked the centreline alignment of the culverts prior to drilling of the boreholes. The borehole locations were established by measuring offset distances from the centreline staking. The approximate ground surface elevations at the boreholes were interpreted from the contour plan provided by MMM Group Limited.

Eastern Ontario Diamond Drilling Ltd. of Hawkesbury, Ontario and Ohlmann Geotechnical Services (OGS) Inc. supplied and operated the drilling and sampling equipment for the field program. Supervision of the field activities, including obtaining utility clearances, was carried out by Ms. Eckie Siu, Mr. Stephane Loranger, Mr. Jason Mei, Mr. Luke Gilarski and Mr. Will Ball of Thurber.

Supervision of the field program was carried out by Ms. Lindsey Blaine, E.I.T. and Mrs. Rocío Palomeque Reyna, P. Eng. Interpretation of the field data and preparation of the report was performed by Ms. Lindsey Blaine, E.I.T. and Mr. Murray Anderson, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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FOUNDATION INVESTIGATION AND DESIGN REPORT

STRUCTURAL CULVERTS

HIGHWAY 69 FOUR-LANING

FROM THE SOUTH JUNCTION OF HIGHWAY 529 NORTHERLY 15 KM

G.W.P. 5294-08-00

NORTH SECTION - NAISCOOT LAKE TO NORTH PROJECT LIMIT

Geocres Number: 41H-129

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 INTRODUCTION

This report presents interpretation of the geotechnical data in the factual report and presents foundation recommendations for design of the structural culverts.

The north section of the Highway 69 four-laning project, extending from just north of Naiscoot Lake (approximately 3.8 km north of Highway 529) northerly to approximately 15 km north of Highway 529, will require installation of ten structural culverts under new highway embankments and nine structural culverts through the existing Highway 69 embankment. A description of the proposed culvert installations is presented in Table 7.1.

Table 7.1 – Proposed Culverts

Culvert No.	Station	Description	Box Culvert Size (m)	Proposed Length (m)	Approx. Fill Height Above Crown (m)
C104	NBL 21+800	New culvert under existing Hwy 69/future NBL	3.6 x 3.0	39.2	3.5
C105	SBL 21+889	New culvert under future SBL	3.6 x 3.6	93.2	3.7
C124	NBL 24+881	New culvert under existing Hwy 69/future NBL	3.0 x 2.4	35.5	3.7
C125	SBL 24+898	New culvert under future SBL	3.0 x 2.4	40.3	4.0
C200	NBL 10+415	New culvert under existing Hwy 69/future NBL	3.0 x 2.4	30.8	1.8
C201	SBL 10+416	New culvert under future SBL	3.0 x 2.4	31.6	2.0
C209	Rest Area Road 10+108	New culvert under future Rest Area Road	3.0 x 2.1	19.2	2.8
C221	NBL 12+711	New culvert under future NBL	3.0 x 2.4	31.5	2.0
C222	SBL 12+717	New culvert under existing Hwy 69/future SBL	3.0 x 2.4	31.9	2.2
C226	NBL 13+452	New culvert under future NBL	3.0 x 1.8	28.3	1.4
C227	SBL 13+452	New culvert under existing Hwy 69/future SBL	3.0 x 2.4	30.0	1.3

Culvert No.	Station	Description	Box Culvert Size (m)	Proposed Length (m)	Approx. Fill Height Above Crown (m)
C230	NBL 13+914	New culvert under future NBL	3.0 x 1.8	34.8	1.8
C231	SBL 13+914	New culvert under existing Hwy 69/future SBL	3.0 x 2.4	29.3	1.2
C234	NBL 14+507	New culvert under future NBL	3.0 x 1.2	28.4	1.9
C235	SBL 14+515	New culvert under existing Hwy 69/future SBL	3.0 x 1.8	31.9	1.4
C236	NBL 14+644	New culvert under future NBL	3.0 x 1.2	27.1	1.4
C237	SBL 14+636	New culvert under existing Hwy 69/future SBL	3.0 x 1.2	29.2	1.8
C238	NBL 15+118	New culvert under future NBL	3.0 x 2.4	31.1	1.5
C239	SBL 15+107	New culvert under existing Hwy 69/future SBL	3.0 x 2.4	34.3	1.9

The plans and sections used for preparation of this report were provided by MMM Group Limited. The discussion and recommendations are based on the information provided by MMM Group Limited and on the factual data obtained in the course of the investigation.

8 FOUNDATION DESIGN

In general, the proposed culverts will be installed through the existing Highway 69 embankment or within sections of swamp where foundation treatment will be required for construction of the new highway embankments. Recommendations for the treatment of swamp crossings are presented in a separate Foundation Investigation and Design Report: *Swamp Crossings and High Fill Embankments, Highway 69 Four-Laning from the south junction of Highway 529 northerly 15 km, North Section – Naiscoot Lake to North Project Limit*, dated December 13, 2012. The current report should be read in conjunction with the Swamp Crossings and High Fill Embankments report.

Following treatment of the swamps, the culvert subgrade conditions within swamp sections will be different from the conditions shown on the borehole logs. The recommendations presented in this report take into consideration the proposed swamp treatments when discussing the culvert foundation conditions.

As the culvert sites are generally located within swamp areas with standing water or high groundwater levels, closed box culverts are the recommended option in order to expedite installation, and recommendations regarding foundation treatment for this culvert type are presented below. Comments regarding foundations for open footing culverts are also presented in the event that the design concept changes. A comparison of the technical advantages and disadvantages of the different foundation options, i.e. box culvert vs. open footing culvert, is provided in Table 8.1 appended at the end of the report text.

Use of precast segmental concrete culverts is preferred over cast-in-place culverts to expedite installation as dewatering below the culvert base level is unlikely to be practical at most locations.

8.1 Culvert 104

Box Culvert

Culvert 104 will be installed through the existing Highway 69 embankment (future northbound lane) consisting of sand and gravel fill. The design invert level will range from Elev. 184.7 at the east to Elev. 184.6 at the west.

The existing strata below the culvert base level consist of bedrock at the inlet, very dense sand and gravel to stiff clay at the middle section and firm clay at the outlet. The groundwater level observed at the time of the investigation was near the proposed invert level, at Elev. 184.7 to 185.3.

Establishment of the subgrade level will require excavation of bedrock locally at the east end (inlet), peat and silty clay near the outlet and sand and gravel to stiff clay at the middle section. It is recommended that the peat and clay beyond the west toe of the existing embankment be fully excavated and replaced with rock fill to 450 mm below the culvert base level. Preparation of the culvert subgrade will be carried out underwater, and compaction and chinking of the rock fill, as well as compaction of granular bedding material, will not be possible without dewatering.

To improve the uniformity of support, subgrade preparation should then include placement of a uniform 450 mm thick bedding and levelling layer of 53 mm clear stone (OPSS.PROV 1004) along the entire length of the culvert. To facilitate establishment of a reasonably level rock fill surface below the culvert bedding, the rock fill must be placed in a manner that avoids having large boulders protruding into the bedding layer producing a hard point below the culvert base. The recommended wording for an NSSP addressing this requirement is as follows: "Rock fill placed under the culvert base must have a suitable gradation and be placed in a manner that establishes a reasonably flat, level surface on which to place the culvert bedding material. Care shall be taken to avoid large boulders and rock fragments protruding into the bedding layer."

The culvert founded directly on a 53 mm clear stone bedding layer and subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	300 kPa
Geotechnical Resistance at SLS	=	200 kPa

The existing embankment will be widened to the east and west, and raised by 2 m. Differential settlement in the order of 25 mm may be anticipated due to the increased embankment loading and the variable subgrade conditions along the length of the culvert. The culvert must be designed to accommodate this magnitude of settlement.

Open Footing Culvert

Construction of an open footing culvert at this location would require footing to be founded partially on native clay below the groundwater level and partially on bedrock, which will require a bedding transition below the footing. Dewatering in a swamp setting

and in the presence of shallow sand and gravel is anticipated to be problematic. Therefore use of an open footing culvert is not recommended from a foundations perspective and this option has not been developed further.

8.2 Culvert 105

Box Culvert

Culvert 105 will extend under the new southbound lane of Highway 69. The design invert level will range from Elev. 184.5 at the east to Elev. 184.3 at the west.

The existing strata at the culvert base level typically consist of peat and soft to firm silty clay and locally loose sand and silt at the east section. However, swamp treatment at this location will involve full excavation of the peat and underlying clay followed by backfilling with rock fill. Consequently the culvert subgrade will consist of rock fill.

The culvert location is currently a pond with water depths of 0.4 to 0.9 m measured at the time of the field investigation. The culvert base level will be approximately 1.5m below the free water surface. Preparation of the culvert subgrade will therefore be carried out underwater, and compaction and chinking of the rock fill, as well as compaction of granular bedding material, will not be possible.

To provide a uniform subgrade for the conditions at this site, it is recommended that culvert subgrade preparation involve excavation and replacement of the peat and clay with rock fill (as per the proposed swamp treatment) to 450 mm below the culvert base level, then placement of a uniform 450 mm thick bedding and levelling layer of 53 mm clear stone (OPSS.PROV 1004). To facilitate establishment of a reasonably level rock fill surface below the culvert bedding, the rock fill must be placed in a manner that avoids having large boulders protruding into the bedding layer producing a hard point below the culvert base. The recommended wording for an NSSP addressing this requirement is as follows: "Rock fill placed under the culvert base must have a suitable gradation and be placed in a manner that establishes a reasonably flat, level surface on which to place the culvert bedding material. Care shall be taken to avoid large boulders and rock fragments protruding into the bedding layer."

The culvert founded directly on a 53 mm clear stone bedding layer and subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	450 kPa
Geotechnical Resistance at SLS	=	300 kPa

Differential settlements in the order of 30 mm may be anticipated due to the variable loading and subgrade conditions along the length of the culvert. The culvert design must be capable of accommodating this magnitude of settlement.

Open Footing Culvert

Construction of an open footing culvert would require placement of footings on rock fill and preparation of the founding surface below water. Therefore use of open footing culvert is not recommended from a foundations perspective, and this option has not been developed further.

8.3 Culvert 124

Box Culvert

Culvert 124 will be installed through the existing Highway 69 embankment (future northbound lane) consisting of sand fill and rock fill. The design invert level will range from Elev. 192.6 at the east to Elev. 192.4 at the west. The subgrade below the culvert base level generally consists of bedrock. However, the bedrock surface dips near the middle of the north side of the culvert, and existing rock fill over compressed peat is present in this section. Water/ice was present in the swamp to the west of the culvert, at Elev. 194.1 in February 2009 and at Elev. 192.8 to 193.3 in June 2012.

Preparation of the culvert subgrade will involve bedrock excavation as well as excavation of the existing rock fill and compressed peat along the middle section. Subgrade preparation should involve backfilling with rock fill to 450 mm below the culvert base along the middle section and placement of a uniform 450 mm thick bedding and levelling layer of 53 mm clear stone (OPSS.PROV 1004) below the entire length of the culvert.

The culvert founded on a subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	450 kPa
Geotechnical Resistance at SLS	=	300 kPa

The existing embankment will be widened to the west. Settlement induced by the widening is anticipated to be negligible given the competent subgrade consisting of bedrock and rock fill.

To minimize rock excavation and potential disturbance of a large beaver dam to the east, consideration should be given to relocation of the proposed culvert northerly further into the swamp.

Open Footing Culvert

Construction of an open footing culvert at this location would require a dewatering system. Therefore use of an open footing culvert is not recommended from a foundations perspective and this option has not been developed further.

8.4 Culvert 125

Box Culvert

Culvert 125 will extend under the new southbound lane of Highway 69. The design invert level will range from Elev. 192.4 at the east to Elev. 192.1 at the west.

The culvert is located at the edge of a swamp. The existing strata at the culvert base level typically consist of soft silty clay at the outlet and north middle section, and bedrock at the inlet and south middle section. However, swamp treatment at this location will involve excavation of the peat and clay followed by backfilling with rock fill. Consequently the culvert subgrade will consist of rock fill and bedrock.

The culvert location is currently a pond with water depth up to 1.4 m measured at the time of the field investigation. The culvert base level will be approximately 2 m below the free water surface. Preparation of the culvert subgrade will therefore be carried out underwater, and compaction and chinking of the rock fill, as well as compaction of the granular bedding material, will not be possible.

To provide a uniform subgrade for the conditions at this site, it is recommended that culvert subgrade preparation involve excavation and replacement of the peat and clay with rock fill (as per the proposed swamp treatment) to 450 mm below the culvert base level, then placement of a uniform 450 mm thick bedding and levelling layer of 53 mm clear stone (OPSS.PROV 1004). To facilitate establishment of a reasonably level rock fill surface below the culvert bedding, the rock fill must be placed in a manner that avoids having large boulders protruding into the bedding layer producing a hard point below the culvert base. The recommended wording for an NSSP addressing this requirement is as follows: "Rock fill placed under the culvert base must have a suitable gradation and be placed in a manner that establishes a reasonably flat, level surface on which to place the culvert bedding material. Care shall be taken to avoid large boulders and rock fragments protruding into the bedding layer."

The culvert founded directly on a 53 mm clear stone bedding layer and subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	450 kPa
Geotechnical Resistance at SLS	=	300 kPa

Differential settlements in the order of 15 mm may be anticipated due to the variable loading and subgrade conditions along the length of the culvert. The culvert design must be capable of accommodating this magnitude of settlement.

To minimize rock excavation, consideration should be given to relocation of the proposed culvert northerly further into the swamp.

Open Footing Culvert

In view of the water depth and planned backfilling with rock fill as part of the swamp treatment at this location, use of an open footing culvert is not recommended from a foundations perspective, and this option has not been developed further.

8.5 Culvert 200

Box Culvert

Culvert 200 will be installed partially through the existing Highway 69 embankment and partially under the new widening to the east. The existing embankment consists of sand fill and rock fill. The design invert level will range from Elev. 194.1 at the east to Elev. 194.0 at the west. The existing soil strata below the culvert base level consist primarily of soft silty clay and loose sand/silt, locally with existing rock fill over compressed peat at the central section. The groundwater level observed at the time of the investigation was at the ground surface, at Elev. 195.1.

Preparation of the culvert subgrade should involve full excavation of the existing rock fill and all peat and clay under both the existing embankment and widening. Subgrade preparation will require backfilling with rock fill to 450 mm below the culvert base level and placement of a uniform 450 mm thick bedding and levelling layer of 53 mm clear stone (OPSS.PROV 1004). To facilitate establishment of a reasonably level rock fill surface below the culvert bedding, the rock fill must be placed in a manner that avoids having large boulders protruding into the bedding layer producing a hard point below the culvert base. The recommended wording for an NSSP addressing this requirement is as follows: "Rock fill placed under the culvert base must have a suitable gradation and be placed in a manner that establishes a reasonably flat, level surface on which to place the culvert bedding material. Care shall be taken to avoid large boulders and rock fragments protruding into the bedding layer."

The culvert founded directly on a 53 mm clear stone bedding layer and subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	450 kPa
Geotechnical Resistance at SLS	=	300 kPa

The existing embankment will be shifted to the east. Differential settlements in the order of 40 mm may be anticipated due to the variable loading and subgrade conditions along the length of the culvert. The culvert design must be capable of accommodating this magnitude of settlement.

Open Footing Culvert

Given the variable subgrade conditions, depth to competent founding material, and dewatering requirement, use of an open footing culvert is not recommended from a foundations perspective and this option has not been developed further.

8.6 Culvert 201

Box Culvert

Culvert 201 will extend under the new southbound lane of Highway 69. The design invert level will range from Elev. 193.9 at the east to Elev. 193.8 at the west.

The culvert is located in a swamp. The existing strata at the culvert base level typically consist of soft to firm silty clay. However, swamp treatment at this location will involve excavation of the peat and clay followed by backfilling with rock fill. Consequently the culvert subgrade will consist of rock fill.

The measured water level is near the existing ground surface in the swamp, varying from Elev. 193.8 to 194.8 recorded in a piezometer. The culvert base level will be approximately 1 m below the groundwater level. Preparation of the culvert subgrade will therefore be carried out underwater, and compaction and chinking of the rock fill, as well as compaction of granular bedding material, will not be possible.

To provide a uniform subgrade for the conditions at this site, it is recommended that culvert subgrade preparation involve excavation and replacement of the peat and clay with rock fill (as per the proposed swamp treatment) to 450 mm below the culvert base level, then placement of a uniform 450 mm thick bedding and levelling layer of 53 mm clear stone (OPSS.PROV 1004). To facilitate establishment of a reasonably level rock fill surface below the culvert bedding, the rock fill must be placed in a manner that avoids having large boulders protruding into the bedding layer producing a hard point below the culvert base. The recommended wording for an NSSP addressing this requirement is as follows: "Rock fill placed under the culvert base must have a suitable gradation and be placed in a manner that establishes a reasonably flat, level surface on which to place the culvert bedding material. Care shall be taken to avoid large boulders and rock fragments protruding into the bedding layer."

The culvert founded directly on a 53 mm clear stone bedding layer and subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	450 kPa
Geotechnical Resistance at SLS	=	300 kPa

Differential settlements in the order of 25 mm may be anticipated due to the variable loading and subgrade conditions along the length of the culvert. The culvert design must be capable of accommodating this magnitude of settlement.

Open Footing Culvert

Construction of an open footing culvert would require placement of footings on rock fill and preparation of the founding surface below water. Therefore use of open footing culvert is not recommended from a foundations perspective, and this option has not been developed further.

8.7 Culvert 209

Box Culvert

Culvert 209 will extend under the new Rest Area Road at the proposed Harris Lake Road Interchange. The design invert level will range from Elev. 189.7 at the inlet to Elev. 189.5 at the outlet.

The culvert is located within a narrow channel in the bedrock surface. Excavation of bedrock as well as any organics or fluvial deposits within the bedrock channel will be required to reach the culvert base level. The culvert subgrade will consist of bedrock.

At the time of the field work in January 2009, 1.5 m of ice and water was encountered at one borehole location within the channel. However, this water was not present after a beaver dam had subsequently been breached. To expedite culvert installation, it is strongly recommended that any beaver dam, if present, be removed prior to any excavation work being carried out.

To provide a uniform subgrade for the conditions at this site, it is recommended that culvert subgrade preparation involve excavation of all surficial stream deposits and the bedrock to 300 mm below the culvert base level, then placement of a minimum 300 mm thick bedding and levelling layer of compacted Granular A material (OPSS 1010).

The culvert base founded on a subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	450 kPa
Geotechnical Resistance at SLS	=	300 kPa

Culvert settlement is anticipated to be negligible for a culvert placed on bedrock.

Open Footing Culvert

Given dry subgrade conditions during culvert construction, footings on bedrock are feasible at this culvert location. Following excavation to the design founding level, any topsoil, peat, streambed deposits, soft/loose soils or rock fragments on the bearing surface should be removed.

A factored geotechnical resistance at ULS of 1000 kPa is recommended for design of spread footings founded directly on the undisturbed bedrock surface. The geotechnical resistance at SLS does not govern in this case.

A dewatering system, if required, must be in place to maintain a dry founding bedrock surface throughout the footing construction. The founding bedrock surface should be protected from disturbance during construction. Footings should be cast in place on the prepared bearing surface as soon as practical following inspection and approval.

The lateral resistance of the footings founded on bedrock may be computed using an unfactored friction coefficient of 0.7. This is an "ultimate" value and requires a degree of sliding movement (typically less than 5 mm) to occur to fully mobilize the resistance.

Footing settlements are expected to be negligible on bedrock.

8.8 Culvert 221

Box Culvert

Culvert 221 will extend under the new northbound lane of Highway 69. The design invert level will range from Elev. 199.3 at the east to Elev. 199.2 at the west.

The existing strata at the culvert base level consist of up to 0.8 m of peat overlying bedrock. Excavation of the peat is recommended. Consequently the culvert subgrade will consist of bedrock.

Water was not observed in the boreholes at the time of the fieldwork (May 2012) but may be seasonally present at the ground surface. Provided culvert installation is carried out at the drier time of the year, groundwater should not be an issue.

To provide a uniform subgrade for the conditions at this site, it is recommended that culvert subgrade preparation involve excavation of all peat and the bedrock to 300 mm below the culvert base level, then placement of a minimum 300 mm thick bedding and levelling layer of compacted Granular A material (OPSS 1010). The bedding thickness may exceed 300 mm locally where peat will be fully removed in the swamp treatment.

The culvert base founded on a subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	450 kPa
Geotechnical Resistance at SLS	=	300 kPa

Culvert settlement is anticipated to be negligible given the bedrock subgrade.

Open Footing Culvert

Given dry subgrade conditions during culvert construction, footings on bedrock are feasible at this culvert location. Following excavation to the design founding level, any topsoil, peat, streambed deposits, soft/loose soils or rock fragments on the bearing surface should be removed.

A factored geotechnical resistance at ULS of 1000 kPa is recommended for design of spread footings founded directly on the undisturbed bedrock surface. The geotechnical resistance at SLS does not govern in this case.

A dewatering system, if required, must be in place to maintain a dry founding bedrock surface throughout the footing construction. The founding bedrock surface should be protected from disturbance during construction. Footings should be placed or cast in place on the prepared bearing surface as soon as practical following inspection and approval.

The lateral resistance of the footings founded on bedrock may be computed using an unfactored friction coefficient of 0.7. This is an "ultimate" value and requires a degree of sliding movement (typically less than 5 mm) to occur to fully mobilize the resistance.

Footing settlements are expected to be negligible on bedrock.

8.9 Culvert 222

Box Culvert

Culvert 222 will be installed through the existing Highway 69 embankment (future southbound lane) consisting of sand fill and rock fill. The design invert level will range from Elev. 199.2 at the east to Elev. 199.1 at the west. The existing strata below the culvert base level primarily consist of bedrock and locally up to 0.3 m of peat.

Water was not observed in the boreholes at the time of the fieldwork (May 2012) but may be seasonally present at the ground surface. Provided culvert installation is carried out at the drier time of the year, groundwater should not be an issue.

To provide a uniform subgrade for the conditions at this site, it is recommended that culvert subgrade preparation involve excavation of all peat and the bedrock to 300 mm below the culvert base level, then placement of a minimum 300 mm thick bedding and levelling layer of compacted Granular A material (OPSS 1010). The bedding thickness may exceed 300 mm locally where peat will be fully removed in the swamp treatment.

The culvert founded on a subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	450 kPa
Geotechnical Resistance at SLS	=	300 kPa

The existing embankment will be widened to the west and east. Settlement induced by the widening is anticipated to be negligible given the competent subgrade consisting of bedrock.

Open Footing Culvert

Given dry subgrade conditions during culvert construction, footings on bedrock are feasible at this culvert location. Following excavation to the design founding level, any topsoil, peat, streambed deposits, soft/loose soils or rock fragments on the bearing surface should be removed.

A factored geotechnical resistance at ULS of 1000 kPa is recommended for design of spread footings founded directly on the undisturbed bedrock surface. The geotechnical resistance at SLS does not govern in this case.

A dewatering system, if required, must be in place to maintain a dry founding bedrock surface throughout the footing construction. The founding bedrock surface should be

protected from disturbance during construction. Footings should be cast in place on the prepared bearing surface as soon as practical following inspection and approval.

The lateral resistance of the footings founded on bedrock may be computed using an unfactored friction coefficient of 0.7. This is an "ultimate" value and requires a degree of sliding movement (typically less than 5 mm) to occur to fully mobilize the resistance.

Footing settlements are expected to be negligible on bedrock.

8.10 Culvert 226

Box Culvert

Culvert 226 will extend under the new northbound lane of Highway 69. The design invert level will range from Elev. 197.0 at the east to Elev. 196.6 at the west.

The existing strata at the culvert base level consist of loose to very loose sand to silt and a thin layer of soft clay. Groundwater levels measured in a piezometer at the site were 0.4 to 0.5 m below the ground surface (Elev. 197.0 to 197.1). Excavation for culvert installation will therefore extend below the measured water level.

Given the loose cohesionless soil and high groundwater level at this site, dewatering measures, such as well points and/or a sheet pile cofferdam, must be installed and effective to lower the groundwater to 0.5 m below the excavation level prior to starting excavation.

Provided effective dewatering is established resulting in a stable dry subgrade, it is recommended that subgrade preparation involve placement of a uniform 300 mm thick bedding layer of compacted Granular A material (OPSS 1010) over the native subgrade soils.

The culvert base founded on a subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	200 kPa
Geotechnical Resistance at SLS	=	100 kPa

If higher geotechnical resistances are required, excavation of sand and silty clay below the base of bedding layer and replacement with rock fill or provision of thicker bedding layer should be considered.

Differential settlements in the order of 25 mm may be anticipated due to the variable loading and subgrade conditions along the length of the culvert. The culvert design must be capable of accommodating this magnitude of settlement.

Open Footing Culvert

In view of the low geotechnical resistance available in the upper part of the foundation soils at this site, use of open footing culvert is not recommended from a foundations perspective, and this option has not been developed further.

8.11 Culvert 227

Box Culvert

Culvert 227 will be installed through the existing Highway 69 embankment (future southbound lane) consisting of sand fill and rock fill. The design invert level will range from Elev. 196.5 at the east to Elev. 196.2 at the west. The existing strata below the culvert base level consist primarily of loose to compact silty sand to sand and a thin layer of stiff silty clay.

The water level observed during the investigation was near the ground surface, at Elev. 196.3. Excavation for culvert installation is therefore expected to extend below the water level.

Given the loose cohesionless soil and high groundwater level at this site, dewatering measures, such as well points and/or a sheet pile cofferdam, must be installed and effective to lower the groundwater to 0.5 m below the excavation level prior to starting excavation. Excavation of the existing rock fill will be required prior to installation of a sheet pile cofferdam.

Provided effective dewatering is established resulting in a stable dry subgrade, it is recommended that subgrade preparation involve placement of a uniform 300 mm thick bedding layer of compacted Granular A material (OPSS 1010) over the native subgrade soils.

The culvert founded on a subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	225 kPa
Geotechnical Resistance at SLS	=	150 kPa

The existing embankment will be widened to the west and east. Differential settlement induced by the widening is anticipated to be in the order of 25 mm. The culvert design must be capable of accommodating this magnitude of settlement.

Open Footing Culvert

In view of the low geotechnical resistance available in the upper part of the foundation soils at this site, use of open footing culvert is not recommended from a foundations perspective, and this option has not been developed further.

8.12 Culvert 230

Box Culvert

Culvert 230 will be installed under the new northbound lane of Highway 69. The design invert level will range from Elev. 192.0 at the east to Elev. 191.9 at the west.

The existing strata at the culvert base level consist primarily of very soft to soft clay. However, swamp treatment at this location will include full excavation of the clay

followed by backfilling with rock fill. Consequently the culvert subgrade will consist of rock fill. Water levels observed during the investigation ranged from Elev. 191.9 to Elev. 192.6. Preparation of the culvert subgrade will therefore be carried out underwater, and compaction and chinking of the rock fill, as well as compaction of granular bedding material, will not be possible.

To provide a uniform subgrade for the culvert, it is recommended that culvert subgrade preparation involve excavation and replacement of the peat and clay with rock fill (as per the proposed swamp treatment) to 450 mm below the culvert base level, then placement of a uniform 450 mm thick bedding and levelling layer of 53 mm clear stone (OPSS.PROV 1004). To facilitate establishment of a reasonably level rock fill surface below the culvert bedding, the rock fill must be placed in a manner that avoids having large boulders protruding into the bedding layer producing a hard point below the culvert base. The recommended wording for an NSSP addressing this requirement is as follows: "Rock fill placed under the culvert base must have a suitable gradation and be placed in a manner that establishes a reasonably flat, level surface on which to place the culvert bedding material. Care shall be taken to avoid large boulders and rock fragments protruding into the bedding layer."

The culvert founded directly on a 53 mm clear stone bedding layer and subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	450 kPa
Geotechnical Resistance at SLS	=	300 kPa

Differential settlements in the order of 25 mm may be anticipated due to the variable loading and subgrade conditions along the length of the culvert. The culvert design must be capable of accommodating this magnitude of settlement.

Open Footing Culvert

Construction of an open footing culvert would require placement of footings on rock fill and preparation of the founding surface below water. Therefore use of open footing culvert is not recommended from a foundations perspective, and this option has not been developed further.

8.13 Culvert 231

Box Culvert

Culvert 231 will be installed through the existing Highway 69 embankment (future southbound lane) consisting of sand and gravel fill and rock fill. The design invert level will range from Elev. 191.93 at the east to Elev. 191.87 at the west. The existing soil strata below the culvert base level consist primarily of existing rock fill, and soft to very soft silty clay at the inlet and peat over clay at the outlet.

The groundwater level measured in the installed standpipe piezometer was at the ground surface, at Elev. 193.4. Preparation of the culvert subgrade will therefore be carried out underwater, and compaction and chinking of the existing or new rock fill, as well as compaction of granular bedding material, will not be possible.

To improve the uniformity of the culvert subgrade, it is recommended that preparation of the culvert subgrade involve excavation of the peat and clay to a depth of approximately 2m below the culvert base level (Elev. 190.0), followed by replacement with rock fill to 450 mm below the culvert base level. The existing rock fill should also be excavated to 450 mm below the culvert base level. Then a uniform 450 mm thick bedding and levelling layer of 53 mm clear stone (OPSS.PROV 1004) should be placed above the rock fill. To facilitate establishment of a reasonably level rock fill surface below the culvert bedding, the rock fill must be placed in a manner that avoids having large boulders protruding into the bedding layer producing a hard point below the culvert base. The recommended wording for an NSSP addressing this requirement is as follows: "Rock fill placed under the culvert base must have a suitable gradation and be placed in a manner that establishes a reasonably flat, level surface on which to place the culvert bedding material. Care shall be taken to avoid large boulders and rock fragments protruding into the bedding layer."

The culvert founded directly on a 53 mm clear stone bedding layer and subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	200 kPa
Geotechnical Resistance at SLS	=	100 kPa

The existing embankment will be widened by about 2 m to the west and east. Differential settlements in the order of 40 mm may be anticipated due to the additional embankment loading and variable subgrade conditions along the length of the culvert. The culvert design must be capable of accommodating this magnitude of settlement.

Open Footing Culvert

Construction of an open footing culvert would require placement of footings on rock fill and preparation of the founding surface below water. Therefore use of open footing culvert is not recommended from a foundations perspective, and this option has not been developed further.

8.14 Culvert 234

Box Culvert

Culvert 234 will extend under the new northbound lane of Highway 69. The design invert level will range from Elev. 194.4 at the east to Elev. 194.3 at the west. The existing strata at the culvert base level consist of peat (at the inlet) and soft clay. However, swamp treatment at this location will involve full excavation of the peat and clay followed by backfilling with rock fill. Consequently the culvert subgrade will consist of rock fill.

The water level measured in the installed standpipe piezometer was at the ground surface, at Elevation 194.7. Preparation of the culvert subgrade will therefore be carried out underwater, and compaction and chinking of the rock fill, as well as compaction of granular bedding material, will not be possible.

To provide a uniform subgrade for the culvert, it is recommended that culvert subgrade preparation involve excavation and replacement of the peat and clay with rock fill (as per the proposed swamp treatment) to 450 mm below the culvert base level, then placement of a uniform 450 mm thick bedding and levelling layer of 53 mm clear stone (OPSS.PROV 1004). To facilitate establishment of a reasonably level rock fill surface below the culvert bedding, the rock fill must be placed in a manner that avoids having large boulders protruding into the bedding layer producing a hard point below the culvert base. The recommended wording for an NSSP addressing this requirement is as follows: "Rock fill placed under the culvert base must have a suitable gradation and be placed in a manner that establishes a reasonably flat, level surface on which to place the culvert bedding material. Care shall be taken to avoid large boulders and rock fragments protruding into the bedding layer."

The culvert founded directly on a 53 mm clear stone bedding layer and subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	450 kPa
Geotechnical Resistance at SLS	=	300 kPa

Differential settlements in the order of 25 mm may be anticipated due to the variable loading and subgrade conditions along the length of the culvert. The culvert design must be capable of accommodating this magnitude of settlement.

Open Footing Culvert

Construction of an open footing culvert would require placement of footings on rock fill and preparation of the founding surface below water. Therefore use of open footing culvert is not recommended from a foundations perspective, and this option has not been developed further.

8.15 Culvert 235

Box Culvert

Culvert 235 will be installed through the existing Highway 69 embankment (future southbound lane) consisting of sand fill and rock fill. The design invert level will range from Elev. 194.25 at the east to Elev. 194.14 at the west. Bedrock is present above the culvert base level.

The water level was measured in a piezometer installed in the adjacent swamp at Elev. 194.7. Preparation of the culvert subgrade will therefore be carried out underwater, and preparation of the bedrock surface as well as compaction of granular bedding material, will

not be possible. Preparation of the culvert subgrade should involve excavation of existing rock fill and bedrock to 300 mm below the culvert base level and then placement of a uniform 300 mm thick bedding and levelling layer of 53 mm clear stone (OPSS.PROV 1004).

The culvert founded on a subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	450 kPa
Geotechnical Resistance at SLS	=	300 kPa

The existing embankment will be widened to the west. Culvert settlement is anticipated to be negligible given the bedrock subgrade.

Open Footing Culvert

In view of the variable subgrade conditions and dewatering requirement at this location, use of open footing culvert is not recommended from a foundations perspective, and this option has not been developed further.

8.16 Culvert 236

Box Culvert

Culvert 236 will extend under the new northbound lane of Highway 69. The design invert level will range from Elev. 194.7 at the east to Elev. 194.5 at the west. The existing strata at the culvert base level consist of loose sand and firm to very stiff clay. However, swamp treatment at this location will involve excavation of peat and soft clay to a maximum depth of 1.5 m followed by backfilling with rock fill. Consequently the culvert subgrade will vary from rock fill at the inlet to loose to compact sand and firm/very stiff clay along the remainder of the culvert.

Water levels observed during the investigation ranged from Elev. 193.7 to Elev. 194.7. The culvert base level will be at or above the observed water levels.

Given the loose cohesionless soil and high groundwater level at this site, and considering that rock fill may not be placed under the full length of culvert during swamp treatment, it is recommended that dewatering measures, such as well points and/or a sheet pile cofferdam, be installed if necessary to lower the groundwater to 0.5 m below the excavation level prior to starting excavation. Excavation of localized rock fill may be required to enable installation of sheet piling if swamp treatment is carried out prior to culvert installation.

To provide a uniform subgrade for the culvert, it is recommended that culvert subgrade preparation involve excavation and replacement of the peat and clay with rock fill (as per the proposed swamp treatment), establishment of the subgrade at 450 mm below the culvert base level, chinking of the rock fill, then placement of a uniform 450 mm thick bedding and levelling layer of compacted Granular A material (OPSS 1010). To facilitate

establishment of a reasonably level rock fill surface below the culvert bedding, the rock fill must be placed in a manner that avoids having large boulders protruding into the bedding layer producing a hard point below the culvert base. The recommended wording for an NSSP addressing this requirement is as follows: "Rock fill placed under the culvert base must have a suitable gradation and be placed in a manner that establishes a reasonably flat, level surface on which to place the culvert bedding material. Care shall be taken to avoid large boulders and rock fragments protruding into the bedding layer."

The culvert founded directly on a 53 mm clear stone bedding layer and subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	300 kPa
Geotechnical Resistance at SLS	=	150 kPa

Differential settlements in the order of 40 mm may be anticipated due to the variable loading and subgrade conditions along the length of the culvert. The culvert design must be capable of accommodating this magnitude of settlement.

Open Footing Culvert

Given the variable subgrade conditions and dewatering requirement at this location, use of open footing culvert is not recommended from a foundations perspective, and this option has not been developed further.

8.17 Culvert 237

Box Culvert

Culvert 237 will be installed through the existing Highway 69 embankment (future southbound lane) consisting of sand fill. The design invert level will range from Elev. 194.4 at the east to Elev. 194.1 at the west. The existing soil strata below the culvert base level consist primarily of native loose to compact sand and stiff silty clay. The culvert subgrade will consist of native sand and silty clay.

The groundwater level measured in the installed standpipe piezometer was 0.3 m below the ground surface, at Elev. 194.0. Given the cohesionless soil and high groundwater level at this site, it is recommended that dewatering measures, such as well points and/or a sheet pile cofferdam, be installed and effective to lower the groundwater to 0.5 m below the excavation level prior to starting excavation for culvert installation.

Provided effective dewatering is established resulting in a stable dry subgrade, it is recommended that subgrade preparation involve placement of a uniform 300 mm thick bedding layer of compacted Granular A material (OPSS 1010) over the native subgrade soils.

The culvert founded on a subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	300 kPa
Geotechnical Resistance at SLS	=	150 kPa

The existing embankment will be widened to the west. Differential settlements in the order of 15 mm may be anticipated due to the variable loading and subgrade conditions along the length of the culvert. The culvert design must be capable of accommodating this magnitude of settlement.

Open Footing Culvert

In view of the low geotechnical resistance available, the need for dewatering and the variable subgrade conditions at this site, use of an open footing culvert is not recommended from a foundations perspective and this option has not been developed further.

8.18 Culvert 238

Box Culvert

Culvert 238 will extend under the new northbound lane of Highway 69. The design invert level will range from Elev. 191.2 at the east to Elev. 190.9 at the west. The existing strata at the culvert base level consist primarily of very loose sand and soft to very soft clay. However, swamp treatment at this location will involve full excavation of the peat and clay followed by backfilling with rock fill. Consequently the culvert subgrade will consist of rock fill.

Water levels measured in the installed standpipe piezometer were 0.0 to 0.3 m below the ground surface, at Elev. 191.5 to 191.8. Preparation of the culvert subgrade will therefore be carried out underwater, and compaction and chinking of the rock fill, as well as compaction of granular bedding material, will not be possible.

To provide a uniform subgrade for the culvert, it is recommended that culvert subgrade preparation involve excavation and replacement of the peat and clay with rock fill (as per the proposed swamp treatment) to 450 mm below the culvert base level, then placement of a uniform 450 mm thick bedding and levelling layer of 53 mm clear stone (OPSS.PROV 1004). To facilitate establishment of a reasonably level rock fill surface below the culvert bedding, the rock fill must be placed in a manner that avoids having large boulders protruding into the bedding layer producing a hard point below the culvert base. The recommended wording for an NSSP addressing this requirement is as follows: “Rock fill placed under the culvert base must have a suitable gradation and be placed in a manner that establishes a reasonably flat, level surface on which to place the culvert bedding material. Care shall be taken to avoid large boulders and rock fragments protruding into the bedding layer.”

The culvert founded directly on a 53 mm clear stone bedding layer and subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	450 kPa
Geotechnical Resistance at SLS	=	300 kPa

Differential settlements in the order of 30 mm may be anticipated along the length of the culvert. The culvert design must be capable of accommodating this magnitude of settlement.

Open Footing Culvert

Construction of an open footing culvert would require placement of footings on rock fill and preparation of the founding surface below water. Therefore use of open footing culvert is not recommended from a foundations perspective, and this option has not been developed further.

8.19 Culvert 239

Box Culvert

Culvert 239 will be installed through the existing Highway 69 embankment (future southbound lane) consisting of sand fill and rock fill. The design invert level will range from Elev. 190.9 at the east to Elev. 190.5 at the west. The existing strata below the culvert base level consist of very loose sand to sandy silt at the inlet and primarily soft silty clay under the remainder of the culvert.

Water levels measured in the installed standpipe piezometer were 0.5 to 0.6 m below the ground surface, at Elev. 191.6 to 191.7. Excavation for culvert installation will extend below the measured water level.

Given the loose cohesionless soil and high groundwater level at this site, dewatering measures, such as well points and/or a sheet pile cofferdam, must be installed and effective to lower the groundwater to 0.5 m below the excavation level prior to starting excavation. Excavation of the existing rock fill will be required to enable installation of sheet piling.

Provided effective dewatering is established resulting in a stable dry subgrade, preparation of the culvert subgrade should involve excavation to 300 mm below the culvert base level and then placement of a uniform 300 mm thick bedding and levelling layer of Granular A material (OPSS 1010).

The culvert founded on a subgrade prepared as outlined above may be designed using the following resistance values:

Factored Geotechnical Resistance at ULS	=	120 kPa
Geotechnical Resistance at SLS	=	80 kPa

The existing embankment will be raised by about 1 m and widened up to 4 m to the west. Differential settlements in the order of 50 mm may be anticipated due to the variable

loading and subgrade conditions along the length of the culvert. The culvert design must be capable of accommodating this magnitude of settlement.

Open Footing Culvert

In view of the low geotechnical resistance available in the soils at this location, use of open footing culvert is not recommended from a foundations perspective, and this option has not been developed further.

9 BACKFILL AND LATERAL EARTH PRESSURES

Backfill to the culvert must consist of free-draining granular material conforming to OPSS Granular A or B specifications. The granular material must be placed to the extents shown in OPSD803.010.

Backfill should be placed and compacted in simultaneous equal lifts on both sides of the culvert, and the top of backfill elevation should be within 400 mm on both sides of the culvert at all times. Heavy compaction equipment should not be used adjacent to the walls and roof of the culvert. Compaction should be carried out in accordance with OPSS 501.

Earth pressures acting on the culvert walls may be assumed to impose a triangular distribution governed by the characteristics of the backfill. For a fully drained condition, the pressures should be computed in accordance with the CHBDC but generally are given by the expression:

$$p = K(\gamma h + q)$$

where: p = horizontal pressure on the wall at depth h (kPa)

K = earth pressure coefficient (see table below)

γ = unit weight of retained soil (see table below)

h = depth below top of fill where pressure is computed (m)

q = value of any surcharge (kPa)

Earth pressure coefficients for backfill to the culvert walls are dependent on the soil strength parameters of backfill material. Recommended unfactored values are shown in Table 9.1. The at-rest coefficients should be employed for closed box culvert walls. Active pressures should be used for any wing walls or unrestrained walls.

The parameters presented in the table correspond to full mobilization of active and passive earth pressures, and require certain relative movements between the wall and adjacent soil to produce these conditions. The values to be used in design can be assessed from Figure C6.16 of the Commentary to the CHBDC.

In accordance with Clause 6.9.3 of the CHBDC, a compaction surcharge should be added. The magnitude should be 12 kPa at the top of fill and decreasing to 0 kPa at a depth of 2.0 m for Granular B Type I or 1.7 m for Granular A or Granular B Type II.

Table 9.1 – Earth Pressure Coefficients (K)

Condition	Earth Pressure Coefficient (K)					
	OPSS Granular A or OPSS Granular B Type II $\phi = 35°$, $\gamma = 22.8$ kN/m^3		OPSS Granular B Type I $\phi = 32°$, $\gamma = 21.2$ kN/m^3		Rock Fill (Limited to 300 mm size) $\phi = 42°$, $\gamma = 19$ kN/m^3	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active K_A (Unrestrained Wall)	0.27	0.40*	0.31	0.48*	0.20	0.28*
At rest K_0 (Restrained Wall)	0.43	-	0.47	-	0.33	-
Passive K_P (Movement Towards Soil Mass)	3.7	-	3.3	-	5.0	-

* For wing walls

The design of the culvert must incorporate measures such as weepholes to permit drainage of the culvert backfill and avoid the potential build-up of hydrostatic pressures behind the walls.

10 SEISMIC CONSIDERATIONS

The following seismic parameters should be used for design:

Velocity Related Seismic Zone	1
Zonal Velocity Ratio	0.05
Acceleration Related Seismic Zone	1
Zonal Acceleration Ratio	0.05

The Soil Profile Type at this site has been classified as Type I. Thus, according to Table 4.4.6.1 of the CHBDC, a Site Coefficient "S" of 1.0 should be used in seismic design.

The seismic earth pressure coefficients for active (K_{AE}) and passive (K_{PE}) conditions to be used in design at this site are shown in Table 10.1. In accordance with Clause 4.6.4 of the CHBDC, structures should be designed using earth pressure coefficients that incorporate the effects of earthquake loading.

In Table 10.1, the angle of friction between the wall and the backfill, δ, is taken as 50% of the angle of internal friction of the backfill, ϕ.

The potential for liquefaction of the foundation soils has been assessed using the Seed and Idriss (1971) method[1]. Using this method, it was determined that the foundation soils at the abutments are not in danger of liquefaction under earthquake loading.

[1] Seed, H.B. and Idriss, I.M. 1971, "Simplified Procedure for Evaluating Soil Liquefaction Potential" *Journal of Soil Mechanics and Foundations Division,* ASCE, Vol. 101, No. SM9, pp. 1249 – 1273.

Table 10.1 – Earth Pressure Coefficients (K_E) for Seismic Design

Condition	Earth Pressure Coefficient (K_E) for Earthquake Loading					
	OPSS Granular A or OPSS Granular B Type II $\phi = 35°, \delta = 17°$		OPSS Granular B Type I $\phi = 32°, \delta = 16°$		Rock Fill (Limited to 300 mm size) $\phi = 42°, \delta = 21°$	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active*, K_{AE} (Unrestrained Wall)	0.30	0.47	0.34	0.58	0.22	0.31
At rest**, K_{0E} (Restrained Wall)	0.53	-	0.57	-	0.43	-
Passive*, K_{PE} (Movement Towards Soil Mass)	3.6	-	3.2	-	4.9	-

* After Mononobe and Okabe, passive case assumes a horizontal surface in front of the wall.
** After Woods (1973).

11 SCOUR PROTECTION AND EROSION CONTROL

Erosion protection should be provided at the culvert inlet and outlet areas not comprising rock fill or bedrock. Design of the erosion protection measures must consider hydrologic and hydraulic concerns and should be carried out by specialists experienced in this field.

Typically, rock protection should be provided over all surfaces with which creek water is likely to be in contact. A vegetation cover should be established on all other exposed earth surfaces to protect against surficial erosion, in accordance with OPSS804.

It is recommended that a clay seal or a concrete cut-off wall be used to minimize the potential for erosion near the inlet area where the culvert is not installed within bedrock or rock fill. The clay seal should extend at least 0.3 m above the high water level, have a minimum thickness of 0.5 m, and extend laterally the width of the granular backfill material. The material requirements should be in accordance with OPSS1205. A prefabricated geosynthetic clay liner, such as Bentofix NSL, may be used as an alternative to clay.

12 EXCAVATION AND GROUNDWATER CONTROL

In general, surface vegetation, topsoil, peat, organic deposits, disturbed material or otherwise loose/soft soils should be stripped from the culvert area and embankment footprint prior to culvert installation.

All excavation must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purpose of assessing excavation slope requirements in compliance with the OHSA, the existing granular fill, loose to compact sand and stiff to firm silty clay are classified as Type 3 soils above the water level, and Type 4 soil below the water level.

The existing Highway 69 embankment typically consists of rock fill. Installation of temporary shoring to retain the embankment fill during culvert installation is unlikely to be required or feasible in this material. If required in other areas, temporary shoring should be designed by a

licensed Professional Engineer experienced in design of shoring with consideration of adjacent traffic loads and any sloping retained surfaces. Roadway protection should be supplied in accordance with OPSS539 and designed for Performance Level 2.

Where possible, temporary stream diversion measures such as impervious dykes should be provided to divert surface water runoff and stream flow away from the culvert excavations at all times during construction. An NSSP should be included in the Contract Documents specifying that an appropriate dewatering operation shall be provided to maintain a stable and reasonably dry excavation where installation of a dewatering system is required. Since most of the culverts will be installed in rock fill, pond and swamp areas, maintaining a dewatered excavation will generally not be possible and installation of culverts "in the wet" will be required.

Decisions regarding dewatering, shoring methods and sequencing should be made by the Contractor and submitted to the Contract Administrator for information purposes.

13 CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to:

- Excavation for installation of the culverts in the existing highway embankment will encounter rock fill, and appropriate sized equipment must be supplied for this operation.
- At culvert locations where bedrock protrudes above the culvert base level, rock excavation will be required to reach the subgrade elevation. Appropriate rock excavation equipment and methods should be made available for such operations.
- Soft organic alluvial material may be present in the stream channels extending to greater depths than encountered at the borehole locations. The subgrade exposed at the design level should be examined and any deleterious materials removed and replaced with compacted bedding material. The culvert subgrade must be uniformly competent and should be inspected and approved by the Contractor's QVE as per OPSS 902.
- Excavation of soft, loose, organic, peat, wet or otherwise deleterious materials may require flattening of excavation side slopes or installation of temporary shoring. Temporary shoring systems should be properly designed by a Professional Engineer experienced in such designs.
- Care must be exercised during excavation to avoid disturbing the founding subgrade. The exposed subgrade should be protected from physical disturbance, and the granular/clear stone bedding must be placed on the approved subgrade expeditiously following excavation. Temporary stream diversion, in conjunction with sump pumping as required, is essential to maintaining a reasonably dry excavation where culverts will not be placed on rock fill.
- Where the culvert subgrade will be prepared below the water level, care must be exercised to provide a uniform, level bedding surface on which to place the culvert. Rock fill placed

in such areas should be limited to a maximum size of 300 mm to facilitate a reasonable level surface on which to place the bedding layer.

The successful performance of the culverts will depend largely upon good workmanship and quality control during construction. Subgrade examination and field density testing should be carried out by qualified geotechnical personnel where applicable during construction to confirm that foundation recommendations are correctly implemented and material specifications are met.

14 CLOSURE

Engineering analysis and preparation of the foundation design report was conducted by Mr. Keli Shi, P.Eng. and Mr. Murray Anderson, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

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Review Principal

TABLE 8.1 - COMPARISON OF FOUNDATION ALTERNATIVES

Closed Box Culvert	Open Footing Culvert on Native Soil
Advantages: **i.** Ease of construction. **ii.** Minimizes differential settlement. **iii.** Applies lower bearing pressures on foundation soils compared to open footing. **iv.** Compared to open footing, more suited for culvert founded below groundwater table. **v.** Lower cost than deep foundations. ***Disadvantages:*** **i.** Requires subexcavation of soft or organic material from streambed if encountered. **ii.** Potential settlement due to embankment loading must be addressed in culvert design. **RECOMMENDED**	***Advantages:*** **i.** Ease of construction. **ii.** Eliminates bedding requirement. **iii.** Potentially less area of subexcavation to remove soft/loose native soil below culvert base. **iv.** Lower cost than deep foundations. ***Disadvantages:*** **i.** Higher geotechnical resistance required. **ii.** Additional depth of excavation required to provide frost protection and achieve higher resistance. **iii.** Low geotechnical resistance is available at most sites, possibly resulting in impractical large footings. **iv.** More extensive dewatering required. **v.** Possible differential settlement due to variable subgrade conditions. **vi.** Subexcavation may be required to penetrate upper soft or organic material, if encountered. **FEASIBLE AT SELECTED CULVERT SITES WITH SHALLOW BEDROCK**

Appendix A

Culvert 104 (Station 21+800 NBL)
Boreholes C104-1 to 3 and BH15A-04L

Record of Borehole Sheets
Laboratory Test Results
Borehole Locations and Soil Strata Drawings

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample		TP Thin Wall Piston Sample
	PH Sampler Advanced by Hydraulic Pressure		PM Sampler Advanced by Manual Pressure
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

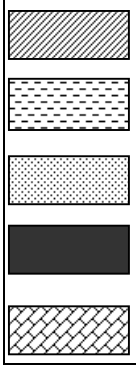
ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

DISCONTINUITY SPACING

Bedding	**Bedding Plane Spacing**
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

BEDROCK

STRENGTH CLASSIFICATION

Rock Strength	**Approximate Uniaxial Compressive Strength (MPa)**	**(psi)**	**Field Estimation of Hardness***
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length
Solid Core Recovery:(SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run
Rock Quality Designation:(RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a % of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index:(FI)	Frequency of natural fractures per 0.3m of core run.

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C104-1 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 057 553.7 E 234 075.8 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Wash Boring COMPILED BY AN
DATUM Geodetic DATE 2011.03.10 - 2011.03.10 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
185.2	**Ground Surface**										
0.0 / 0.0	**ICE:** (25mm)					▽	185				
	PEAT, some sand Very Soft Dark Brown Wet		1	SS	1						
184.1			2	SS	5		184				
1.1	Silty **CLAY**, trace sand to sandy Firm to Stiff Grey		3	SS	8						0 5 40 55
182.2			1	TW			183				
3.0	**SAND**, some gravel Loose Grey Wet		4	SS	10		182				
181.3			5	SS	100/						
3.9	END OF BOREHOLE AT 3.9m UPON REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT 0.3m UPON COMPLETION.				0.100						

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C104-2 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 057 566.9 E 234 096.5 ORIGINATED BY ES/GM

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2012.06.14 - 2012.06.14 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
189.8	**Ground Surface**										
0.0	**ASPHALT:** (50mm)										
0.0	**SAND** and **GRAVEL**, some silt, occasional cobbles Dense to Loose Brown Dry to Moist (FILL)		1	GS					○		
			1	SS	39		189		○		32 56 12 (SI+CL)
			2	SS	29		188		○		
			3	SS	5				○		
			4	SS	7		187				
			5	SS	16		186		○		
			6	SS	16	▽	185		○		
184.7											
5.1	**SAND** and **GRAVEL**, some cobbles Very Dense Brown		7	SS	63/ 0.225				○		
184.1	Wet										
5.7	END OF BOREHOLE AT 5.7m UPON REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT 5.1m DURING DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.										

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

$15 \oplus^{20}_{10} 5$ (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C104-3 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 057 579.7 E 234 105.3 ORIGINATED BY ES

HWY 69 BOREHOLE TYPE Wash Boring COMPILED BY AN

DATUM Geodetic DATE 2011.03.12 - 2011.03.12 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
185.9	**Ground Surface**										
0.0 / 0.0	**PEAT**, mixed with silty clay, fibrous Dark Brown Moist END OF BOREHOLE AT 0.05m ON BEDROCK.		1	SS					○		

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH15A-04L 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Harrison Twp., Station 21+800 O/S 16.0L, NBL ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Portable Split Spoon Sampling Equipment COMPILED BY AN

DATUM Geodetic DATE 2010.11.12 - 2010.11.12 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
185.3	**Ground Surface**										
0.0 185.0	**PEAT**, fibrous: (250mm)										
0.3	Silty **CLAY**, some sand Soft to Very Stiff Brown to Grey		1	SS	1		185				
			2	SS	12						
			3	SS	18		184				0 11 40 49
	with thin sand seams		4	SS	12		183				
			5	SS	2						
182.0											
3.3	END OF BOREHOLE AT 3.3m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN AND WATER LEVEL AT SURFACE UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.										

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

15 20 10 5 (%) STRAIN AT FAILURE

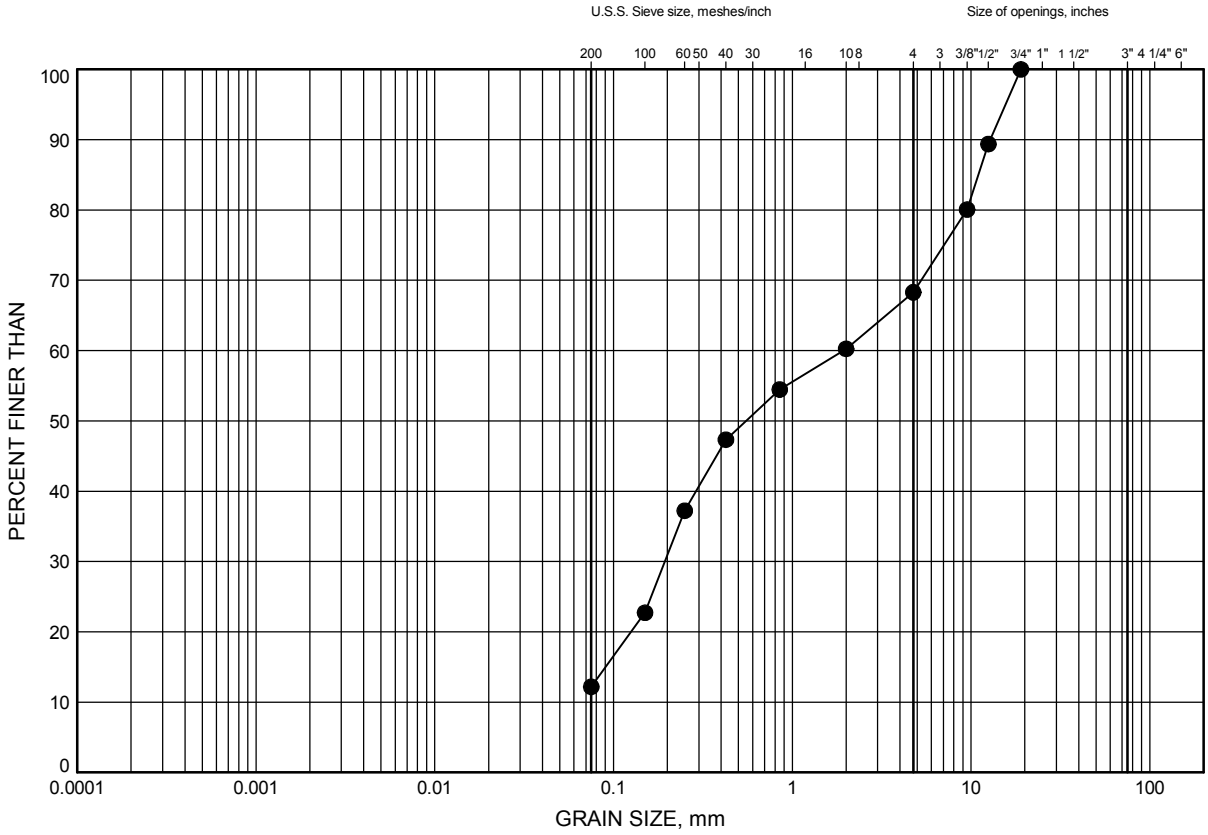
ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE A1

Sand and Gravel Fill



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C104-2	1.07	188.73

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

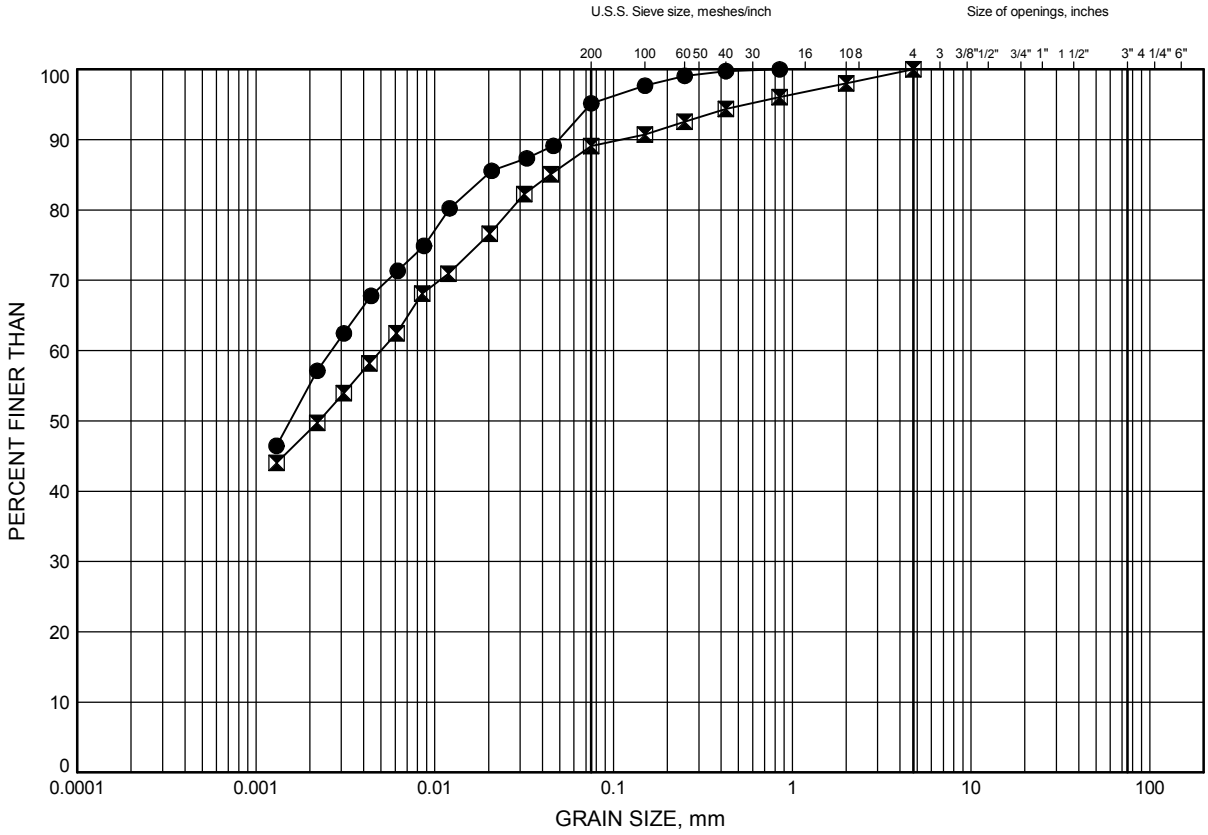
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE A2

Silty Clay



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C104-1	1.98	183.22
⊠	BH15A-04L	1.52	183.78

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

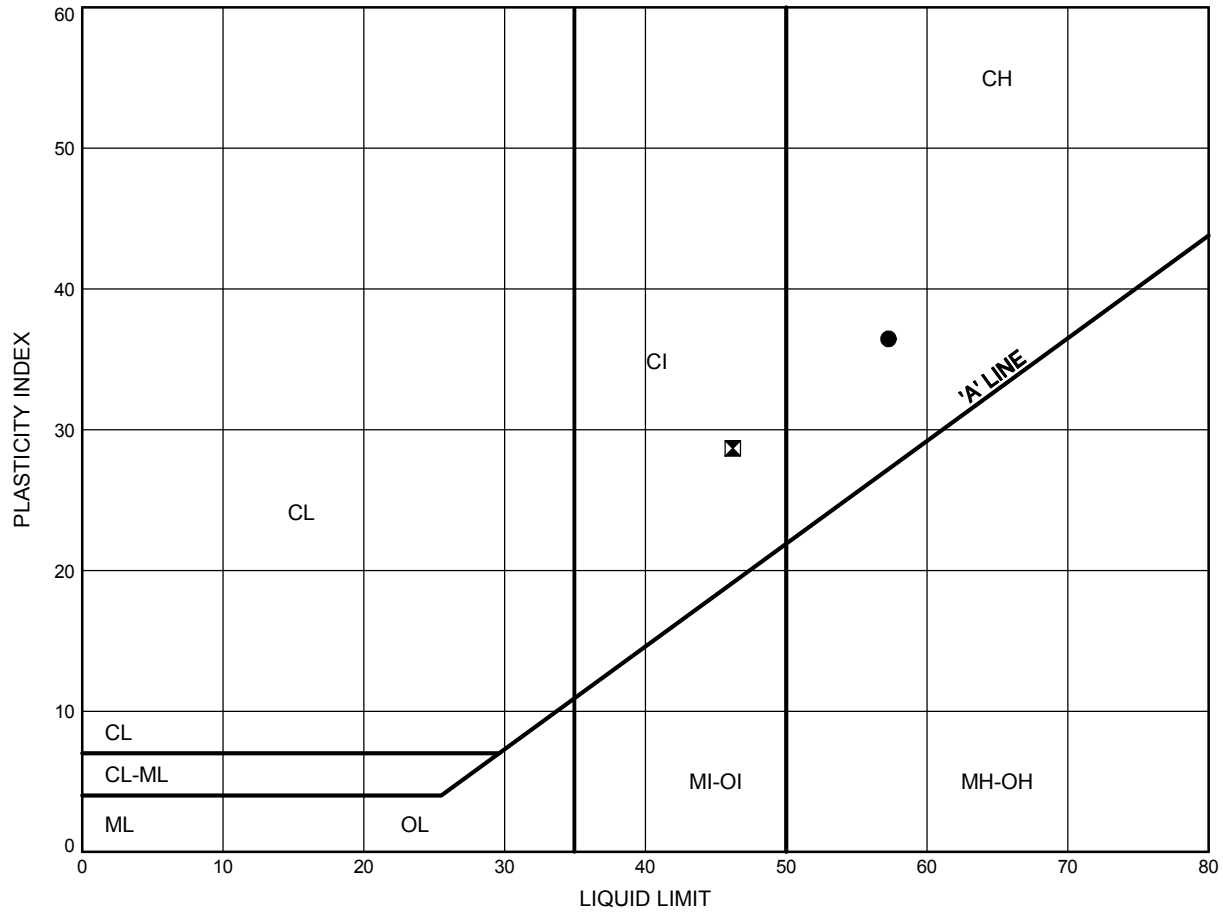
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

ATTERBERG LIMITS TEST RESULTS

FIGURE A3

Silty Clay



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C104-1	1.98	183.22
⊠	BH15A-04L	1.52	183.78

Date August 2014

GWP# 5294-08-00

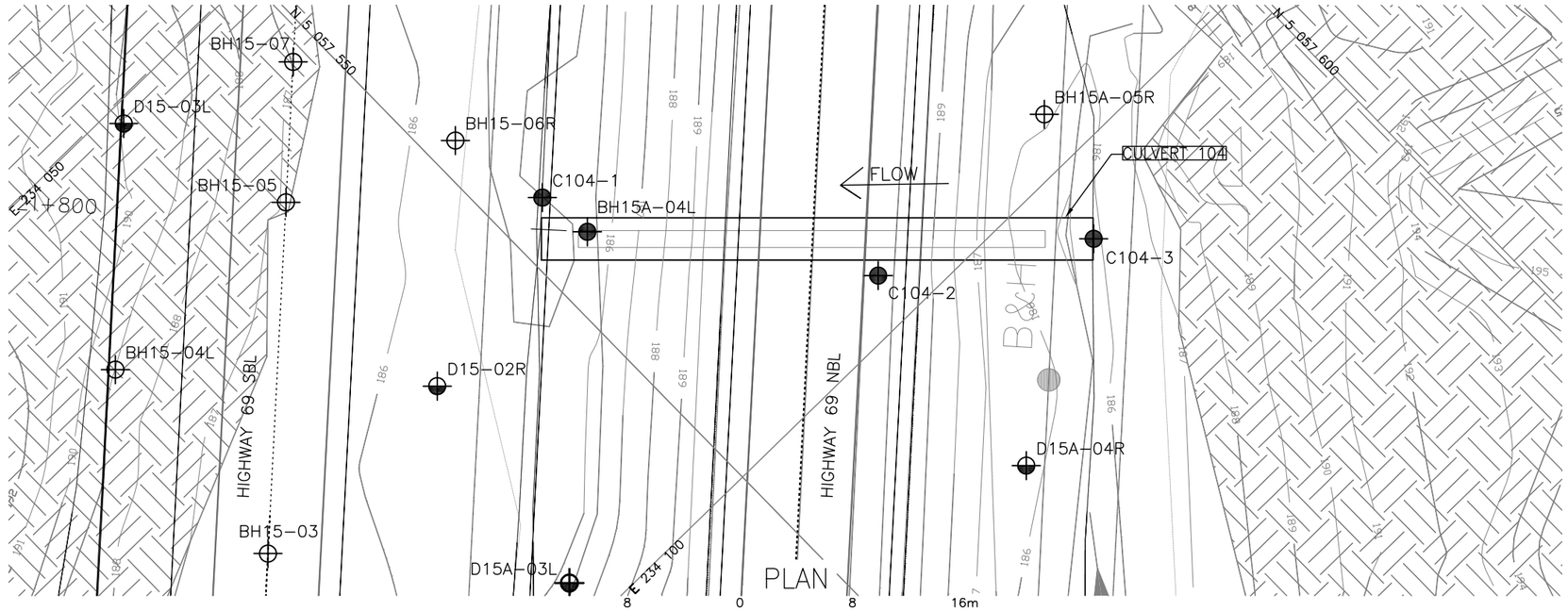
THURBER

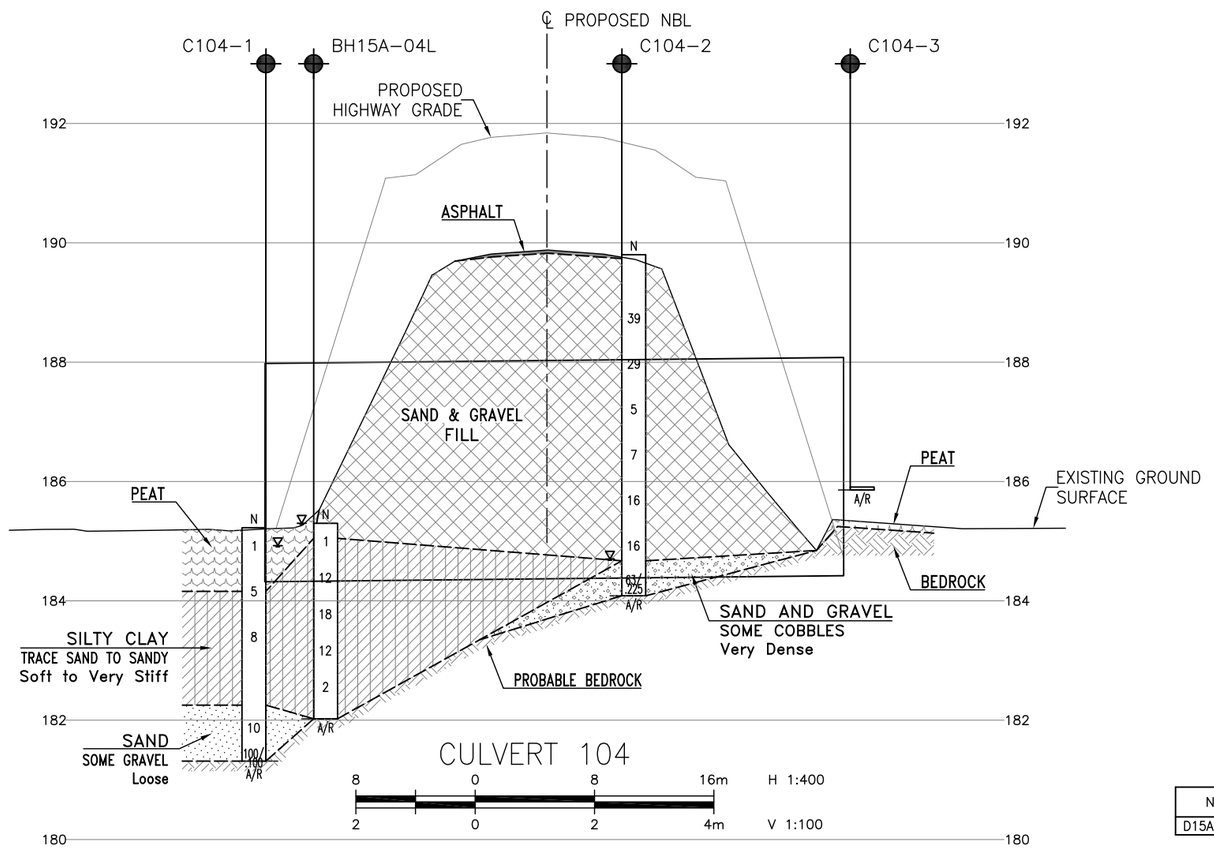
Prep'd MFA

Chkd. MRA

THURBALT 6121(CULVERTS).GPJ 8/20/14

MINISTRY OF TRANSPORTATION, ONTARIO





NO	ELEVATION	NORTHING	EASTING
D15A-04R	186.2	5 057 565.0	234 113.5

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

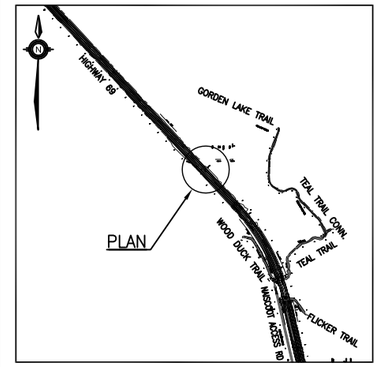
CONT No
WP No 5134-12-07

HIGHWAY 69 FOUR-LANING
NORTH SECTION
CULVERT 104
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MMM GROUP

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⊕ / ⊕	Culvert Report Borehole / Cone
⊕ / ⊕	Other Borehole / Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level During Drilling
▼	Water Level in Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BH15-03	186.4	5 057 522.1	234 080.3
BH15-04L	189.0	5 057 523.4	234 063.4
BH15-05	186.9	5 057 540.4	234 063.4
BH15-06R	185.4	5 057 552.1	234 068.6
BH15-07	187.0	5 057 547.8	234 056.6
BH15A-04L	185.3	5 057 554.3	234 079.8
BH15A-05R	186.2	5 057 583.4	234 096.5
C104-1	185.2	5 057 553.7	234 075.8
C104-2	189.8	5 057 566.9	234 096.5
C104-3	185.9	5 057 579.7	234 105.3
D15-02R	185.7	5 057 539.0	234 080.2
D15-03L	190.0	5 057 536.1	234 051.3
D15A-03L	186.2	5 057 535.9	234 096.8

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 41H-129

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	LRB	CHK	MRA	CODE	LOAD
DRAWN	MFA	CHK	LRB	SITE 44-604/C1	STRUCT

DATE AUG. 2014
DWG 1

FILENAME: H:\Drafting\13\5161\21\ted6121-Plan&Sections(Culverts).dwg
PLOTDATE: 9/22/2014 8:17 AM

Appendix B

Culvert 105 (Station 21+889 SBL)
Boreholes C105-1 to 3 and BH16-03
DCPTs D16-01R and D16-02L

Record of Borehole Sheets
Laboratory Test Results
Borehole Locations and Soil Strata Drawings

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C105-1 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 057 624.7 E 233 956.0 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Wash Boring COMPILED BY AN
DATUM Geodetic DATE 2011.03.12 - 2011.03.12 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
185.8	**Pond Surface**										
0.0 185.4	**ICE:** (350mm)										
0.4 184.9	**WATER**						185				
0.9 184.6	**PEAT** Very Soft Dark Brown Wet		1	SS	2						
1.2	Silty **CLAY**, trace sand to sandy Soft to Firm Grey Layer of sand (400mm) at 1.9m Occasional wood fibres		2	SS	5		184				
			3	SS	3		183				0 22 49 29
182.1			4	SS	3						
3.7	Gravelly **SAND**, trace silt Dense Grey Wet		5	SS	45		182				31 62 7 (SI+CL)
181.3											
4.5	END OF BOREHOLE AT 4.5m UPON REFUSAL ON PROBABLE BEDROCK.										

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

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

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C105-2 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 057 605.5 E 234 003.2 ORIGINATED BY ES

HWY 69 BOREHOLE TYPE Wash Boring COMPILED BY AN

DATUM Geodetic DATE 2011.03.12 - 2011.03.12 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
185.3	**Pond Surface**										
0.0	**ICE:** (225mm)										
185.2	**WATER:** (150mm)						185				
0.4	**PEAT**, fibrous Very Soft Dark Brown Wet		1	SS	0				1578		
183.8			2	SS	1		184				
1.5	Silty **CLAY**, some sand Very Soft Grey		3	SS	1		183				0 20 65 15
182.9											
2.4	**SAND**, some gravel to gravelly, trace to some silt and clay Compact Grey Wet		4	SS	29						17 69 14 (SI+CL)
182.0											
3.3	END OF BOREHOLE AT 3.3m UPON REFUSAL ON PROBABLE BEDROCK.										

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

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C105-3 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 057 589.5 E 234 042.3 ORIGINATED BY ES

HWY 69 BOREHOLE TYPE Wash Boring COMPILED BY AN

DATUM Geodetic DATE 2011.03.09 - 2011.03.09 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
185.8	**Pond Surface**										
0.0 185.4	**ICE:** (350mm)										
0.4 185.2	**WATER**										
185.1	**PEAT:** (50mm)										
0.7	Silty **CLAY**, trace to some sand Soft to Firm Brown/Grey		1	SS	3		185				
			2	SS	8		184				0 5 31 64
			1	TW			183	9.0			
	Very Soft		3	SS	0		182				0 13 54 33
181.1											
4.7	Gravelly **SAND** Grey Wet						181				
180.5			4	SS	100/						
5.3	END OF BOREHOLE AT 5.3m UPON REFUSAL ON PROBABLE BEDROCK.				0.125						

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

$15 \overset{20}{\oplus} 5$ $_{10}$ (%) STRAIN AT FAILURE

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH16-03 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Harrison Twp., Station 21+876 C/L, SBL ORIGINATED BY JM

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LG

DATUM Geodetic DATE 2009.02.08 - 2009.02.08 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
184.9	**Ground Surface**										
0.0	**ORGANICS:** (75mm)										
0.1	**SAND** and **SILT**, some clay Loose Grey Moist		1	SS	2				93		
			2	SS	5	▽	184				0 50 31 19
183.7											
1.2	Silty **CLAY**, some sand Soft to Firm Brown to Grey		3	SS	8		183				0 20 49 31
182.6											
2.3	END OF BOREHOLE AT 2.3m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT 1.2m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH AUGER CUTTINGS UPON COMPLETION.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No D16-01R 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Harrison Twp., Station 21+851 O/S 13.3R, SBL ORIGINATED BY JM

HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test (DCPT) COMPILED BY LG

DATUM Geodetic DATE 2009.02.08 - 2009.02.08 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
185.1	**Pond Surface**										
0.0	ICE AND WATER TO 0.3m DCPT started at 0.3m.						185				
							184				
							183				
							182				
							181				
							180				
178.6							179				
6.5	END OF DCPT AT 6.5m UPON REFUSAL ON PROBABLE BEDROCK.										

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

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

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No D16-02L 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Harrison Twp., Station 21+901 O/S 14.6L, SBL ORIGINATED BY JM

HWY 69 BOREHOLE TYPE Visual Assessment and Manual Excavation COMPILED BY LG

DATUM Geodetic DATE 2009.02.08 - 2009.02.08 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
185.6	**Ground Surface**										
0.0											
0.2	BEDROCK AT 0.2m.										

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

$\overset{20}{15\oplus 5}$ $\underset{10}{}$ (%) STRAIN AT FAILURE

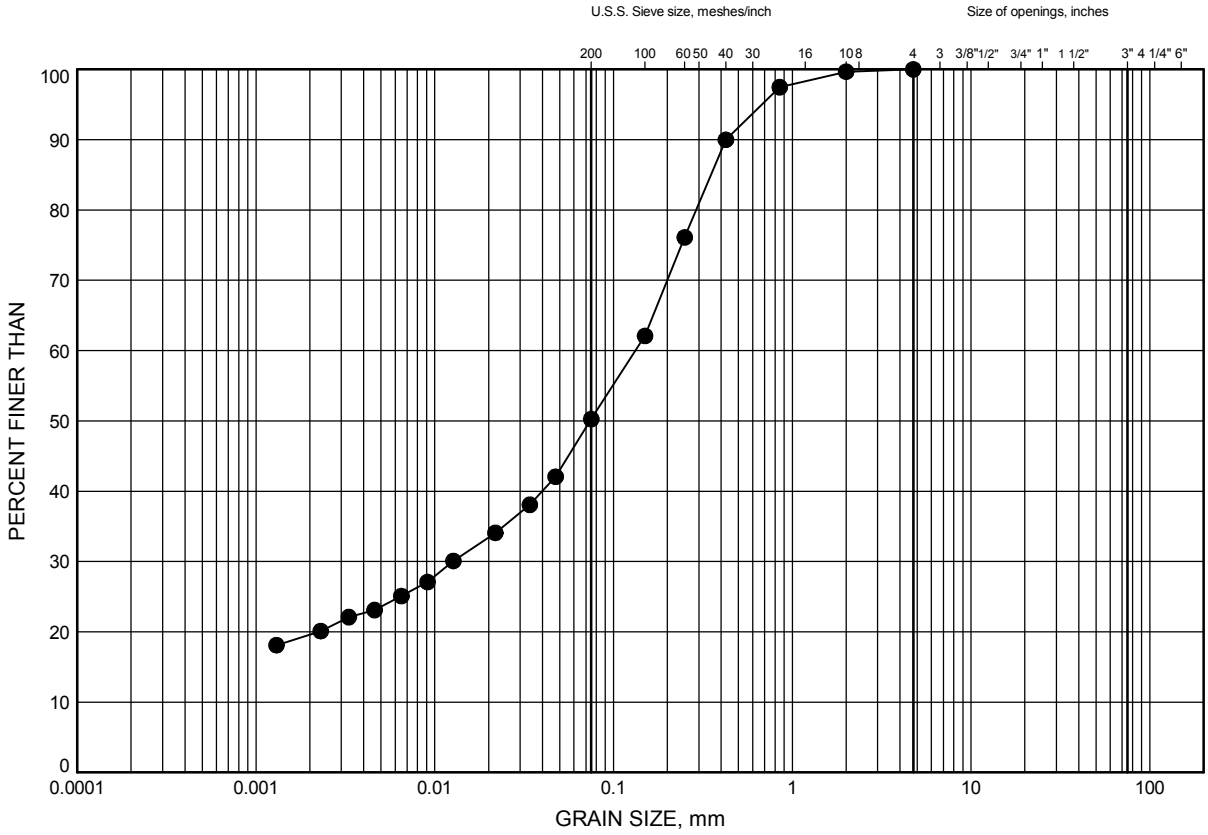
ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE B1

Sand and Silt



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH16-03	0.99	183.91

GRAIN SIZE DISTRIBUTION - THURBER 6121.GPJ 8/20/14

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

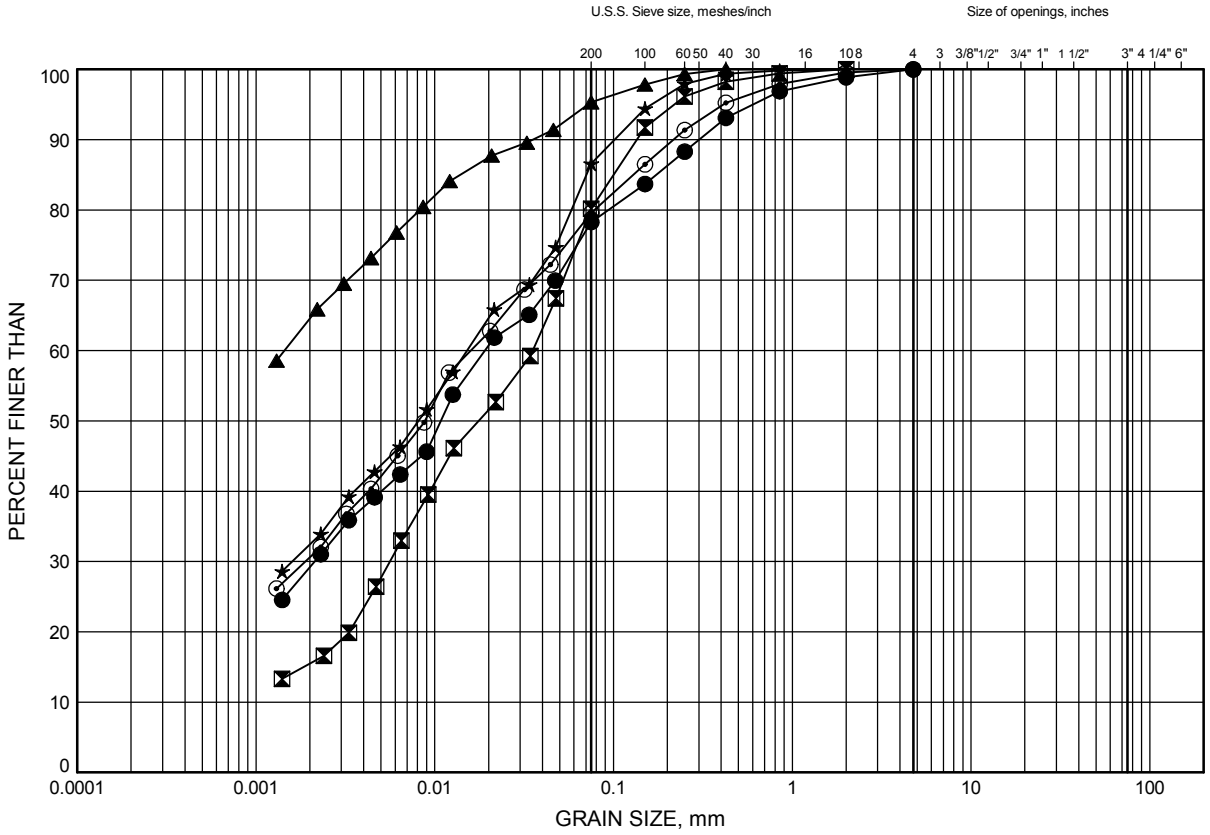
Chkd. MRA

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE B2

Silty Clay



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C105-1	2.72	183.08
⊠	C105-2	2.21	183.09
▲	C105-3	1.70	184.10
★	C105-3	3.99	181.81
⊙	BH16-03	1.83	183.07

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

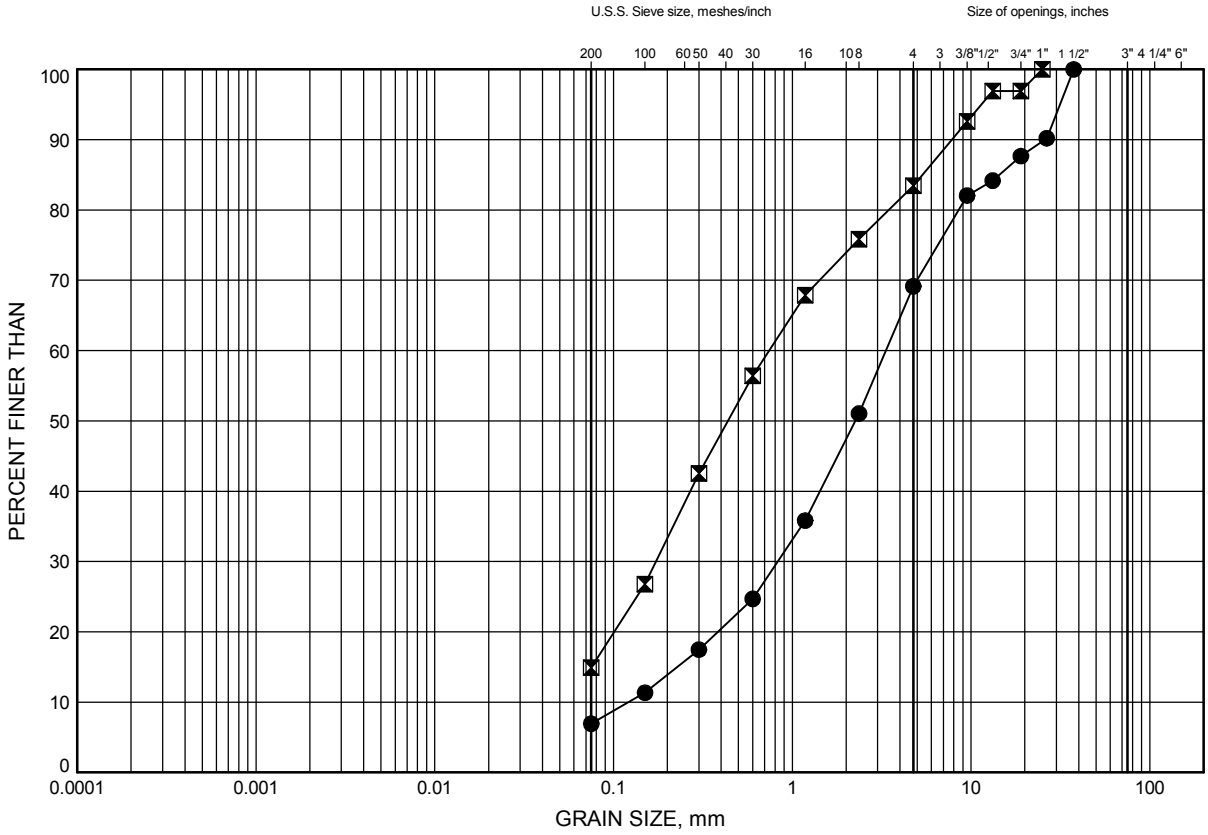
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE B3

Sand to Gravelly Sand



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C105-1	4.23	181.57
⊠	C105-2	2.96	182.34

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

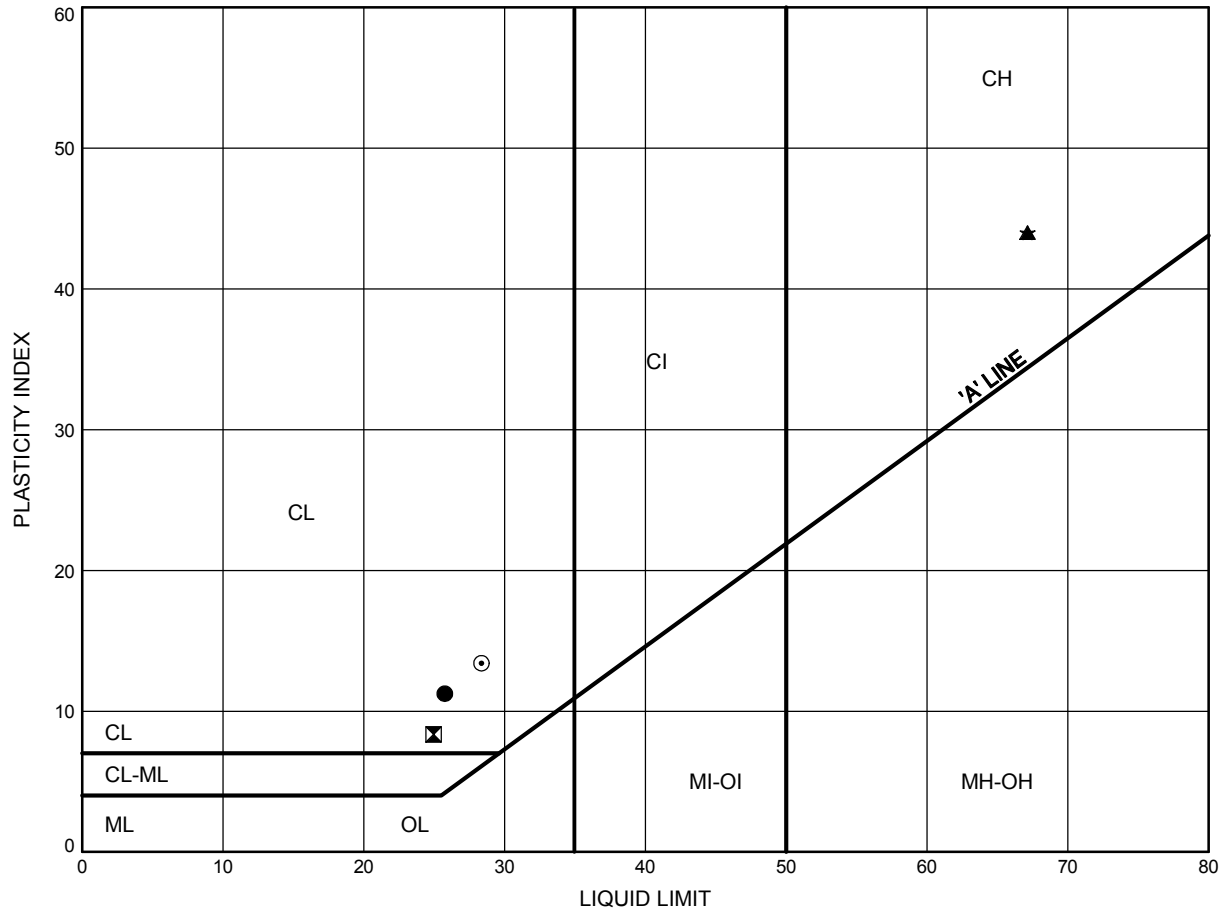
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

ATTERBERG LIMITS TEST RESULTS

FIGURE B4

Silty Clay



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C105-1	2.72	183.08
⊠	C105-2	2.21	183.09
▲	C105-3	1.70	184.10
★	C105-3	3.99	181.81
⊙	BH16-03	1.83	183.07

Date August 2014

GWP# 5294-08-00

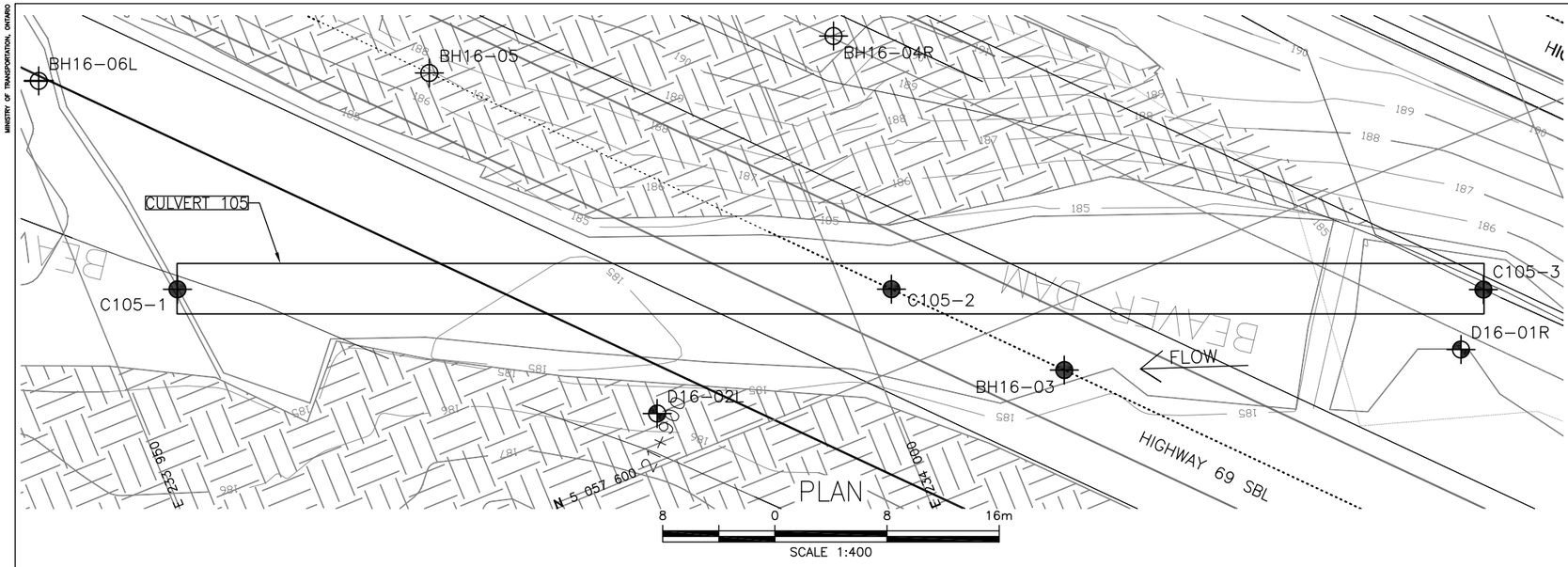
THURBER

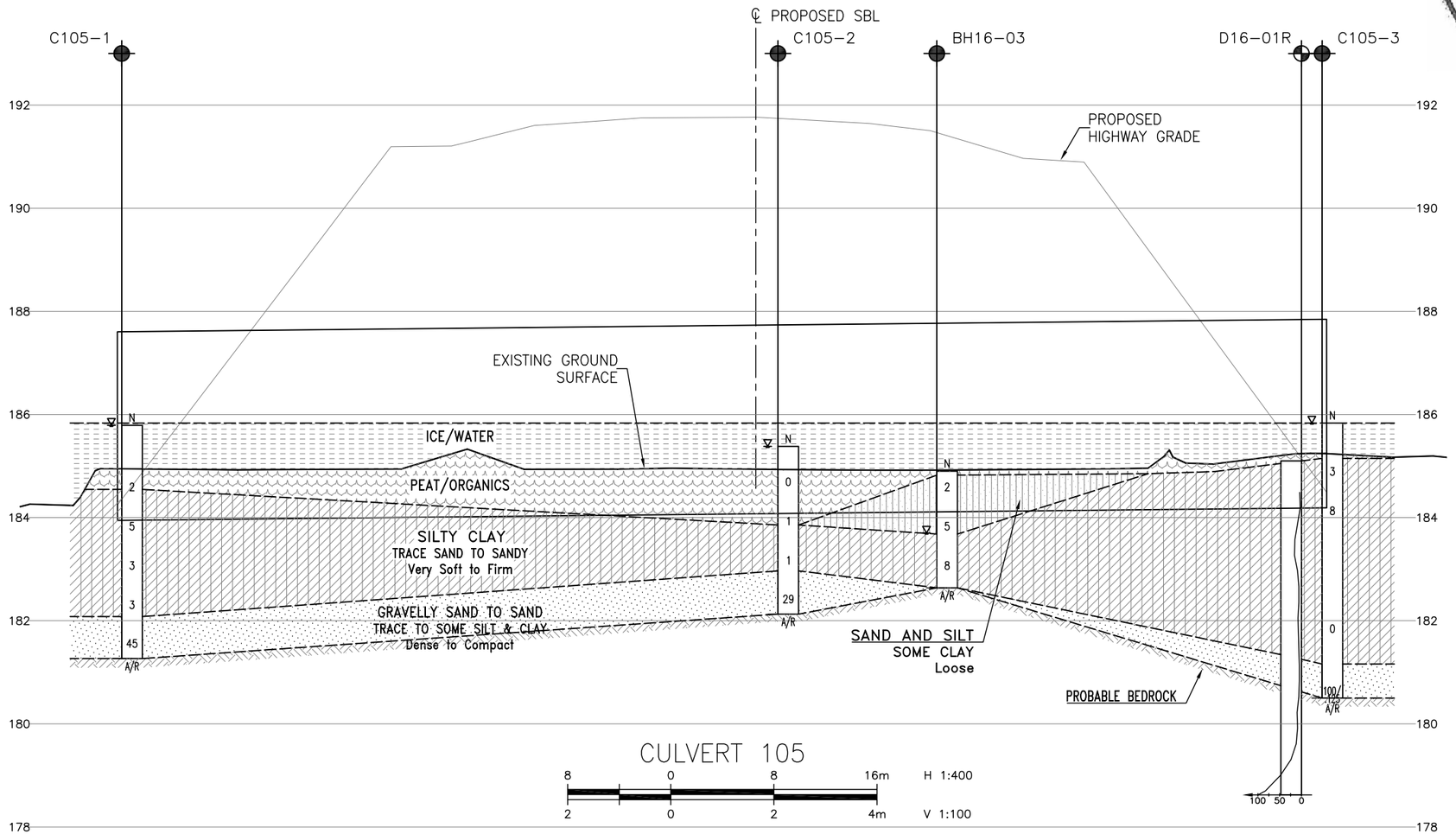
Prep'd MFA

Chkd. MRA

THURBALT 6121(CULVERTS).GPJ 8/20/14

MINISTRY OF TRANSPORTATION, ONTARIO





METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Aug 21/14
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Aug 21/14
PROVINCE OF ONTARIO

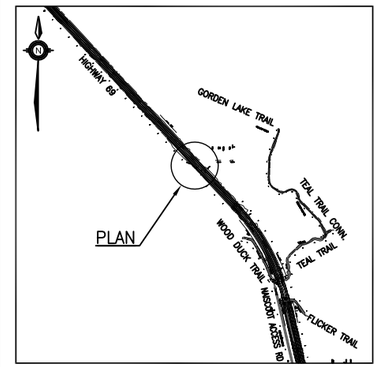
CONT No
WP No 5134-12-08

HIGHWAY 69 FOUR-LANING
NORTH SECTION
CULVERT 105
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MMM GROUP

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⊕/⊕	Culvert Report Borehole / Cone
⊕/⊕	Other Borehole / Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level During Drilling
▼	Water Level in Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BH16-03	184.9	5 057 595.5	234 012.4
BH16-04R	191.4	5 057 623.7	234 006.2
BH16-05	186.7	5 057 632.2	233 978.5
BH16-06L	184.5	5 057 642.2	233 952.5
C105-1	185.8	5 057 624.7	233 956.0
C105-2	185.3	5 057 605.5	234 003.2
C105-3	185.8	5 057 589.5	234 042.3
D16-01R	185.1	5 057 586.2	234 039.2
D16-02L	185.6	5 057 603.6	233 984.4

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 41H-129

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	LRB	CHK	MRA	CODE		LOAD	
DRAWN	MFA	CHK	LRB	SITE 44-604/C2	STRUCT	DWG	1

DATE AUG. 2014

FILENAME: H:\Drafting\19\5161\21\tech6121-PlanSections(Culverts).dwg
PLOTDATE: 8/22/2014 6:23 AM

Appendix C

Culvert 124 (Station 24+881 NBL)
and
Culvert 125 (Station 24+898 SBL)
Boreholes C124-1 to 3, C125-1 &2, and BH25-01
DCPTs C124-D1 and C125-D1 to D3

Record of Borehole Sheets
Laboratory Test Results
Borehole Locations and Soil Strata Drawings

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C124-1 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 059 835.0 E 232 014.2 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Continuous Split Spoon (50lb Hammer) COMPILED BY AN

DATUM Geodetic DATE 2012.06.19 - 2012.06.19 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
193.2	**Ground Surface**										
0.0	**PEAT**, fibrous Very Soft Black Wet		1	SS	0		193				
192.4											
0.8	END OF BOREHOLE AT 0.8m UPON REFUSAL ON PROBABLE BEDROCK. TRIED 3 LOCATIONS; REFUSAL AT 0.6m TO 0.9m. NOTE: 'N' VALUES HAVE BEEN CORRECTED TO ACCOUNT FOR A 50lb HAMMER.										

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

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

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C124-2 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 059 826.3 E 231 992.7 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers/HW/NQ COMPILED BY AN
DATUM Geodetic DATE 2012.06.20 - 2012.06.20 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.8	**Ground Surface**										
0.0	**ASPHALT:** (50mm)										
0.0	**SAND**, some gravel Dark Grey to Brown Damp (FILL)		1	GS							
196.8							197				
1.0	**ROCK FILL**		1	RUN			196				
			2	RUN			195				
			3	RUN			194				
	Peat (25mm thick) at 5.5m Dark Brown Wet						193				
191.4							192				
6.4	**PEAT**, fibrous Dark Brown Moist		4	RUN							
191.1							191				
6.7	**BEDROCK**, granitic gneiss, grey										
190.5											
7.3	END OF BOREHOLE AT 7.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.8m, CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C124-3 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 059 822.9 E 231 995.8 ORIGINATED BY ES

HWY 69 BOREHOLE TYPE Hollow Stem Augers/HQ COMPILED BY AN

DATUM Geodetic DATE 2012.06.23 - 2012.06.23 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.8	**Ground Surface**										
0.0 / 0.0	**ASPHALT:** (50mm)										
	SAND, some gravel Brown Damp (FILL)						197				
196.7 / 1.1	**ROCK FILL**		1	RUN			196				
			2	RUN			195				
							194				
192.9 / 4.9	**BEDROCK**, granitic gneiss, grey		3	RUN			193				
192.0 / 5.8	END OF BOREHOLE AT 5.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.1m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C124-D1 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 059 831.4 E 232 016.8 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2012.06.19 - 2012.06.19 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.5	**Ground Surface**										
0.0 / 193.0											
0.5	END OF DCPT AT 0.5m UPON REFUSAL ON PROBABLE BEDROCK. TRIED 3 LOCATIONS; REFUSAL AT 0.0m TO 0.5m.										

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

$\frac{20}{15 \quad 5}$ (%) STRAIN AT FAILURE
$\frac{}{10}$

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C125-1 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 059 821.1 E 231 980.0 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Continuous Split Spoon (50lb Hammer) COMPILED BY AN

DATUM Geodetic DATE 2012.06.19 - 2012.06.19 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
193.5	**Ground Surface**										
0.0	**PEAT**, fibrous Very Soft Black Wet		1	SS	1		193		209 ○		
192.8											
0.7	END OF BOREHOLE AT 0.7m UPON REFUSAL ON PROBABLE BEDROCK.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C125-2 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 059 808.9 E 231 939.1 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Continuous Split Spoon (50lb Hammer) COMPILED BY AN

DATUM Geodetic DATE 2012.06.19 - 2012.06.19 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.3	**Pond Surface**										
0.0	**WATER**						193				
192.2											
1.1	**PEAT**, fibrous										
191.9	Black						192		115		
1.4	Silty **CLAY**, trace sand		1	SS	4						
	Soft										
	Brown to Grey		2	SS	4						0 2 46 52
							191				
190.7	Occasional sand seams		3	SS	108/ 0.200						
2.6	END OF BOREHOLE AT 2.6m UPON REFUSAL ON PROBABLE BEDROCK.										

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

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C125-D1 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 059 817.7 E 231 982.2 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2012.06.19 - 2012.06.19 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
194.2	**Ground Surface**										
0.0							194				
193.6											
0.6	END OF DCPT AT 0.6m UPON REFUSAL ON PROBABLE BEDROCK.										

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

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C125-D2 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 059 806.7 E 231 941.1 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2012.06.19 - 2012.06.19 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.8	**Pond Surface**							20 40 60 80 100	20 40 60		
0.0 192.2	**WATER**										
0.6 190.4	Start DCPT at 0.6m						192 191				
2.4	END OF DCPT AT 2.4m UPON REFUSAL ON PROBABLE BEDROCK.										

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

$\overset{20}{15\oplus 5}$ $\underset{10}{}$ (%) STRAIN AT FAILURE

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C125-D3 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 059 812.1 E 231 960.6 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2012.06.19 - 2012.06.19 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
194.0	**Ground Surface**										
0.0 / 193.5											
0.5	END OF DCPT AT 0.5m UPON REFUSAL ON PROBABLE BEDROCK.										

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

$\overset{20}{15 \oplus 5}$ $\underset{10}{}$ (%) STRAIN AT FAILURE

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH25-01 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Harrison Twp., Station 24+901 C/L, SBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LG

DATUM Geodetic DATE 2009.02.07 - 2009.02.07 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.1	**Pond Surface**										
0.0	**ICE** and **WATER**						194				
192.7							193				
1.4	**PEAT** Very Soft		1	SS	0						
191.9							192				
2.2	Silty **CLAY**, sandy Very Soft Grey		2	SS	0				○		0 37 29 34
190.6			3	SS	0		191		○		
3.5	END OF BOREHOLE AT 3.5m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH HOLEPLUG AND AUGER CUTTINGS UPON COMPLETION.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

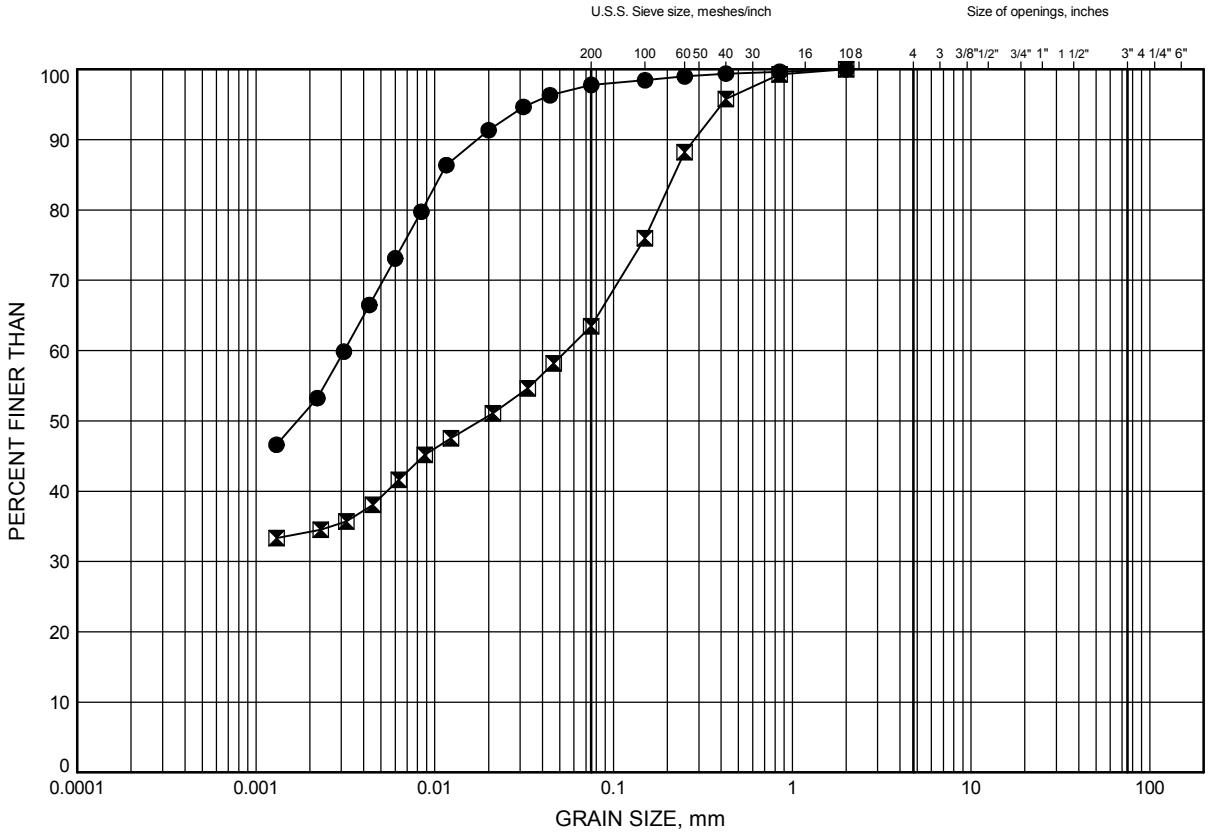
ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE C1

Silty Clay



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C125-2	1.98	191.32
⊠	BH25-01	2.59	191.51

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

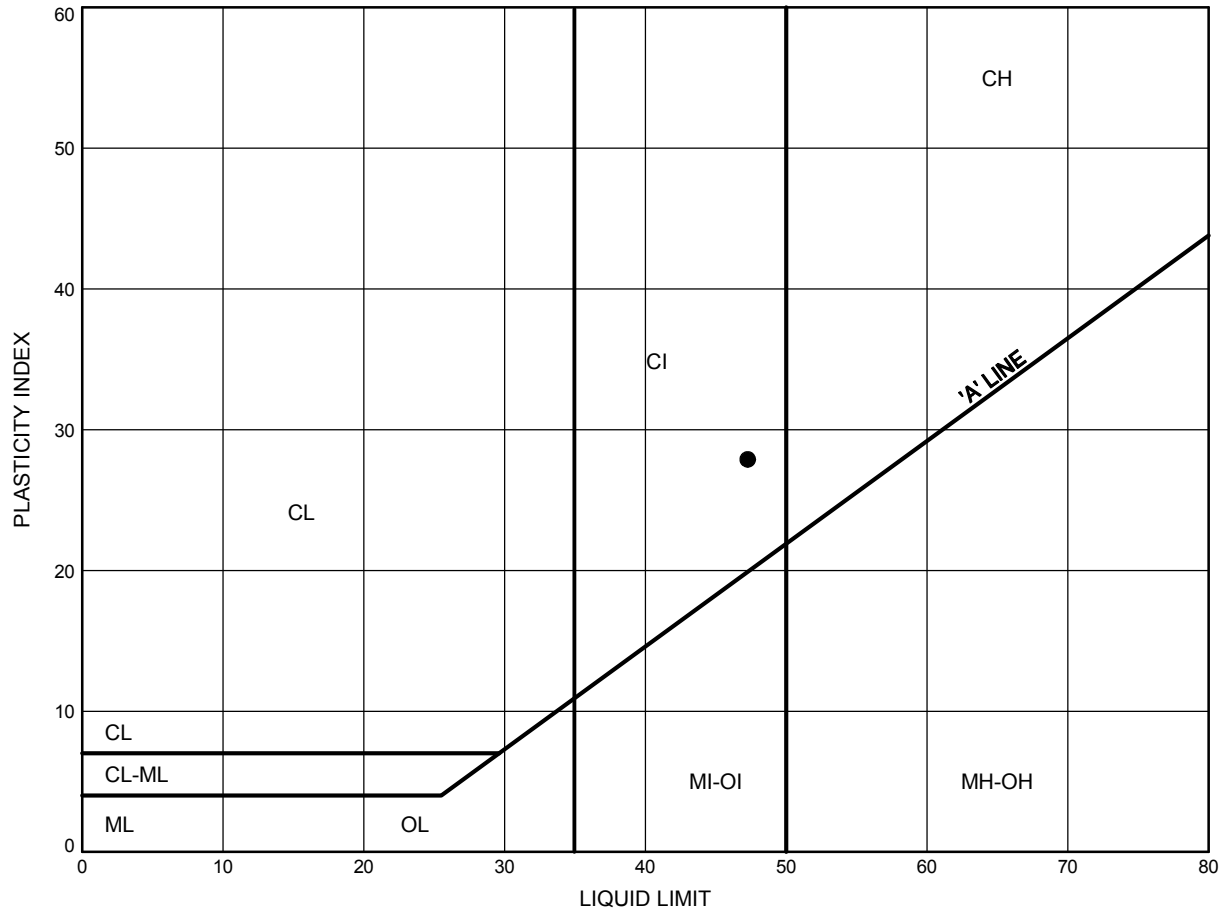
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

ATTERBERG LIMITS TEST RESULTS

FIGURE C2

Silty Clay



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C125-2	1.98	191.32

Date August 2014

GWP# 5294-08-00

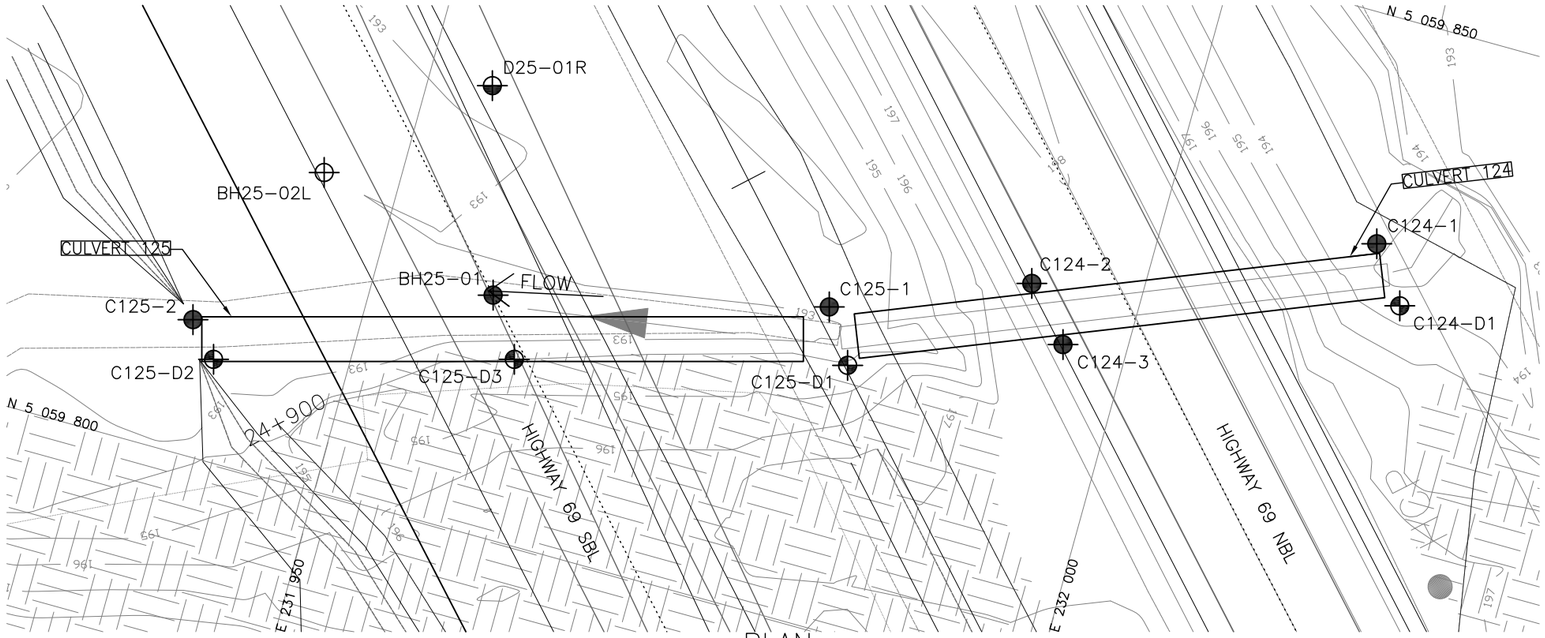
THURBER

Prep'd MFA

Chkd. MRA

THURBALT 6121(CULVERTS).GPJ 8/20/14

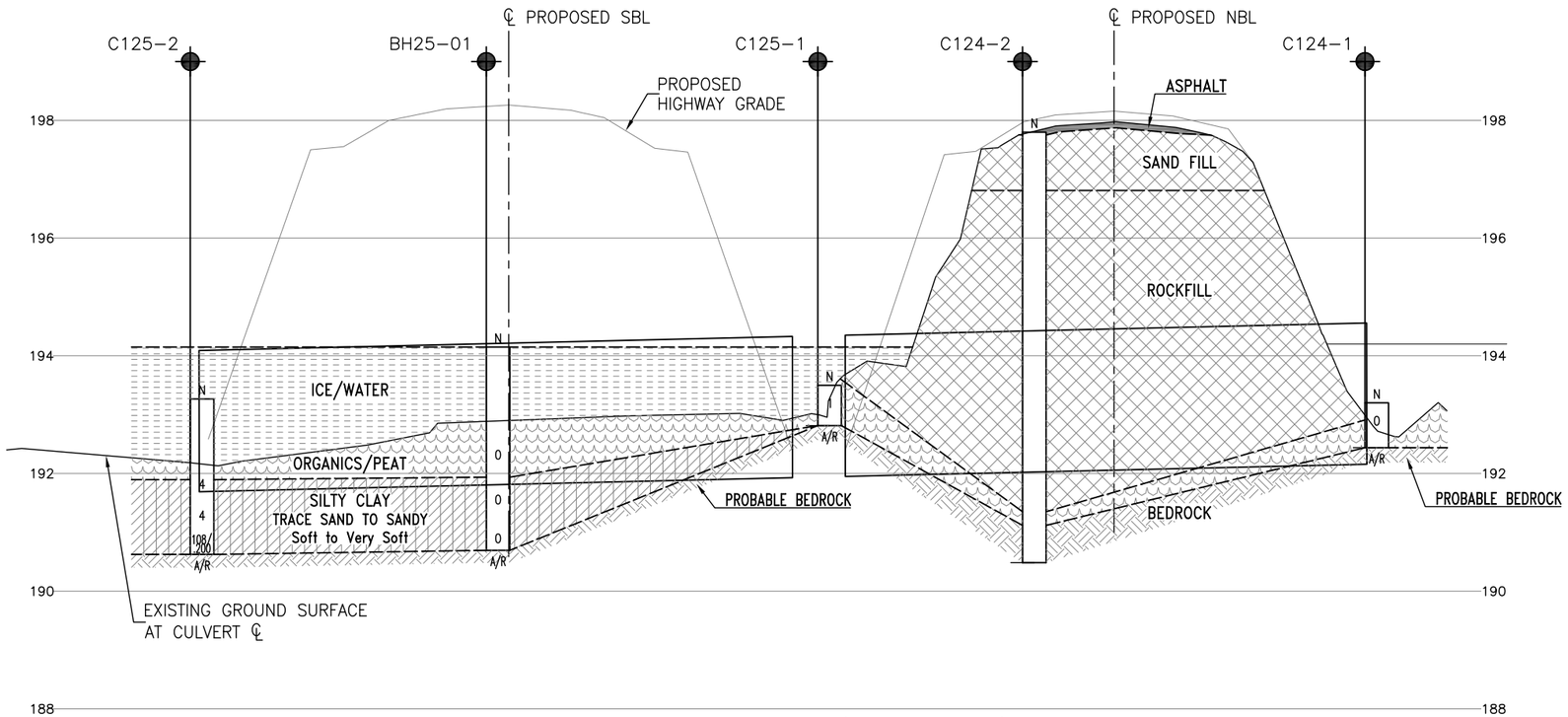
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

8 0 8 16m

SCALE 1:400



CULVERT 124 AND 125 (NORTH SIDE)

8 0 8 16m H 1:400

2 0 2 4m V 1:100

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Aug 21/14
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Aug 21/14
PROVINCE OF ONTARIO

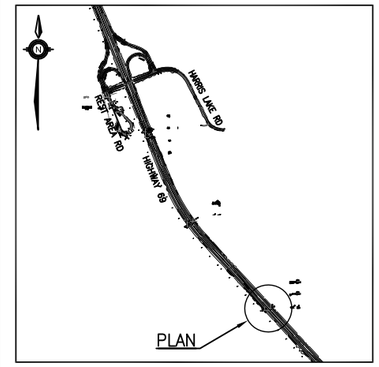
CONT No
WP No 5134-12-09/10

HIGHWAY 69 FOUR-LANING
NORTH SECTION
CULVERT 124 & 125 (NORTH SIDE)
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MMM GROUP

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⊕/⊕	Culvert Report Borehole / Cone
⊕/⊕	Other Borehole / Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▼	Water Level During Drilling
▼	Water Level in Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BH25-01	192.7	5 059 815.9	231 958.1
BH25-02L	193.0	5 059 820.8	231 945.0
C124-1	193.2	5 059 835.0	232 014.2
C124-2	197.8	5 059 826.3	231 992.7
C124-3	197.8	5 059 822.9	231 995.8
C124-D1	193.5	5 059 831.4	232 016.8
C125-1	193.5	5 059 821.1	231 980.0
C125-2	193.3	5 059 808.9	231 939.1
C125-D1	194.2	5 059 817.7	231 982.2
C125-D2	192.8	5 059 806.7	231 941.1
C125-D3	194.0	5 059 812.1	231 960.6
D25-01R	193.4	5 059 829.4	231 954.3

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 41H-129

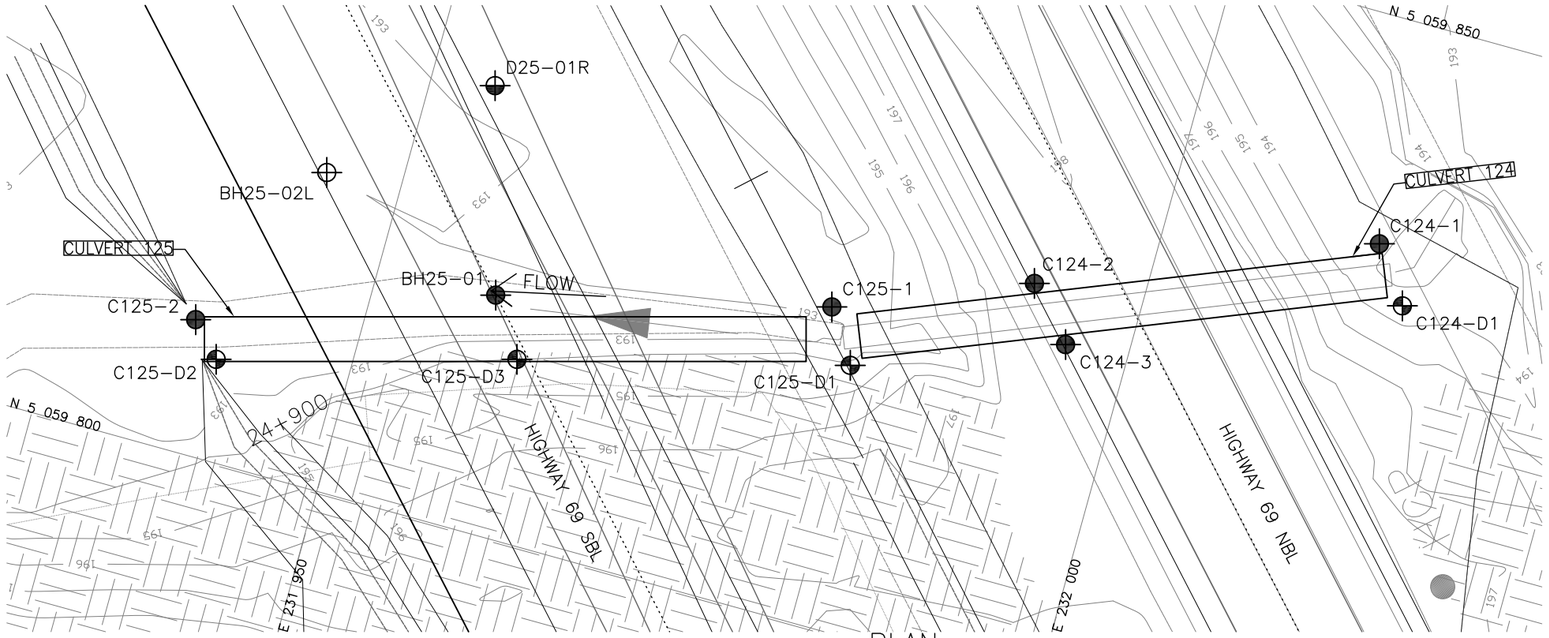
REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	LRB	CHK	MRA	CODE	LOAD
DRAWN	MFA	CHK	LRB	SITE 44-605/C1&C2	STRUCT

DATE AUG. 2014
DWG 1

FILENAME: H:\Drafting\13\5161\21\ted6121-Plan&Sections(Culverts).dwg
PLOTDATE: 9/22/2014 9:24 AM

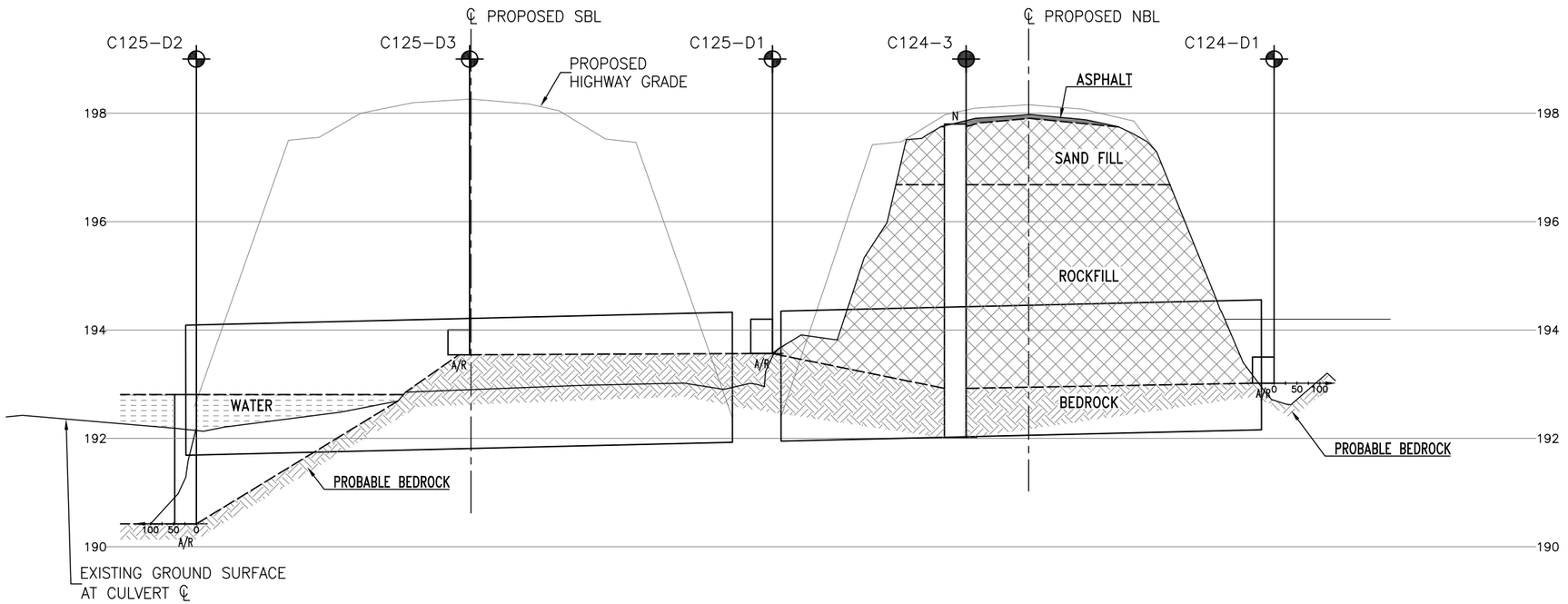
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

8 0 8 16m

SCALE 1:400



CULVERT 124 AND 125 (SOUTH SIDE)

8 0 8 16m H 1:400

2 0 2 4m V 1:100

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Aug 21/14
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Aug 21/14
PROVINCE OF ONTARIO

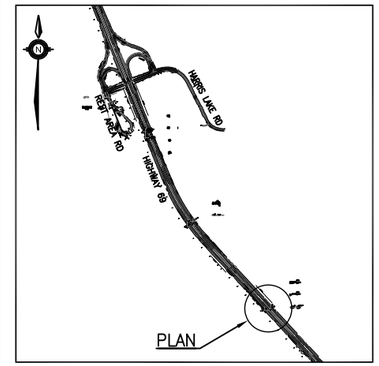
CONT No
WP No 5134-12-09/10

HIGHWAY 69 FOUR-LANING
NORTH SECTION
CULVERT 124 & 125 (SOUTH SIDE)
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MMM GROUP

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⊕/⊕	Culvert Report Borehole / Cone
⊕/⊕	Other Borehole / Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▼	Water Level During Drilling
▼	Water Level in Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BH25-01	192.7	5 059 815.9	231 958.1
BH25-02L	193.0	5 059 820.8	231 945.0
C124-1	193.2	5 059 835.0	232 014.2
C124-2	197.8	5 059 826.3	231 992.7
C124-3	197.8	5 059 822.9	231 995.8
C124-D1	193.5	5 059 831.4	232 016.8
C125-1	193.5	5 059 821.1	231 980.0
C125-2	193.3	5 059 808.9	231 939.1
C125-D1	194.2	5 059 817.7	231 982.2
C125-D2	192.8	5 059 806.7	231 941.1
C125-D3	194.0	5 059 812.1	231 960.6
D25-01R	193.4	5 059 829.4	231 954.3

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 41H-129

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	LRB	CHK	MRA	CODE	LOAD
DRAWN	MFA	CHK	LRB	SITE 44-605/C1&C2	STRUCT

DATE AUG. 2014
DWG 2

FILENAME: H:\Drafting\13\5161\21\ted6121-Plan&Sections(Culverts).dwg
PLOTDATE: 9/22/2014 9:25 AM

Appendix D

Culvert 200 (Station10+415 NBL)
and
Culvert 201 (Station 10+416 SBL)
Boreholes C200-1 and BH28-07/08R/09 and BH29-05/06L/07
DCPTs D28-04L and D29-03R

Record of Borehole Sheets
Laboratory Test Results
Borehole Locations and Soil Strata Drawings

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C200-1 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 060 548.7 E 231 342.5 ORIGINATED BY ES/GM
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.06.14 - 2012.06.14 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.7	**Ground Surface**										
0.0	**ASPHALT:** (40mm)										
0.0	**SAND**, some gravel Brown Dry (FILL)		1	GS					○		
196.6							197				
1.1	**ROCK FILL**		1	RUN							
							196				
							195				
			2	RUN							
193.4							194				
4.3	**PEAT** Dark Brown										
193.0	Wet		1	SS	2		193		270 ○		
4.7	Silty **CLAY**, trace sand, occasional wood fibres Soft Wet Grey								83 ○		
			2	SS	3				○		0 3 77 20
191.9							192				
5.8	Silty **SAND**, trace gravel Loose Grey/Brown Wet		3	SS	8				○		
191.1			4	SS	50/ 0.075				○		
6.6	END OF BOREHOLE AT 6.6m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 5.8m, CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.										

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH28-07 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 10+400 C/L, NBL ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.10.28 - 2008.10.28 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.4	**Ground Surface**										
0.0	**ASPHALT** (50mm)		1	AS							
0.0	**SAND**, some gravel, occasional rock fill fragments Brown Moist (FILL)						197		○		
196.5											
0.9	END OF BOREHOLE AT 0.9m ON PROBABLE ROCK FILL. BOREHOLE DRY UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH28-08R 1 OF 2 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 10+412.5 O/S 6.6R, NBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.10.06 - 2008.10.06 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
195.1	**Ground Surface**						195				
0.0	Silty **CLAY**, some sand to sandy, occasional topsoil, occasional peaty organics Very Soft Brown		1	SS	2						
			2	SS	1		194	3.0			0 20 50 30
			3	SS	1		193	3.0			
192.9											
2.2	**SAND** and **SILT**, trace clay, occasional peaty organics Very Loose Grey Moist		4	SS	4						0 64 28 8
	Layer of clay (600mm)		5	SS	1		192				
	wet						191				
190.8											
4.3	Silty **CLAY**, some sand to sandy, trace gravel Very Soft Grey		6	SS	2		190	2.0			
			7	SS	1		189				1 21 59 19
187.5							188				
7.6	END OF BOREHOLE AT 7.6m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT 5.2m UPON COMPLETION OF DRILLING. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct 29/08 0.1 195.0 Jan 14/09 0.5 194.6 Feb 19/09 0.9 194.2 Apr 21/09 Ground Surface Jun 04/09 Ground Surface Aug 17/09 Ground Surface										

Continued Next Page

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

$\frac{20}{15 \cdot 10 \cdot 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH28-08R 2 OF 2 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 10+412.5 O/S 6.6R, NBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.10.06 - 2008.10.06 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Aug 25/09 Ground Surface Oct 27/09 Ground Surface Nov 20/09 Ground Surface										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH28-09 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 10+425 C/L, NBL ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.10.28 - 2008.10.28 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.2	**Ground Surface**										
0.0	**ASPHALT** (50mm)										
0.0	**SAND** and **GRAVEL**, trace silt, trace clay, occasional rock fill fragments Compact Brown Moist (FILL)		1	AS			196		○		
			1	SS	17		195				35 56 9 (SI+CL)
194.8											
1.4	END OF BOREHOLE AT 1.4m UPON AUGER REFUSAL ON PROBABLE ROCK FILL. BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 0.2m, THEN ASPHALT TO THE SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
$\frac{}{10}$

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH29-05 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 10+400 C/L, SBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.09.25 - 2008.09.25 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
195.0	**Ground Surface**										
0.0	**PEAT**, fibrous Dark Brown (50mm)		1	SS	2				○		
	SAND and **SILT**, trace clay, with peaty organics Very Loose Brown to Grey Moist		2	SS	3		194		○		
	Compact Wet		3	SS	12		193		○		0 51 40 9
192.6											
2.4	Silty **CLAY**, some sand Very Soft Grey		4	SS	2				⊢○		0 11 67 22
			1	TW	PH		192				
191.3											
3.7			5	SS					○		
191.2	Gravelly **SAND**, occasional cobbles Grey Wet										
3.8	END OF BOREHOLE AT 3.8m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE DRY UPON COMPLETION OF DRILLING. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
Oct 29/08	1.2	193.8
Jan 15/09	0.2	194.8
Feb 19/09	Frozen at Surface	
Apr 21/09	0.4	194.6
Jun 04/09	0.4	194.6
Aug 17/09	0.6	194.4
Aug 25/09	0.6	194.4
Oct 27/09	0.6	194.4
Nov 20/09	0.9	194.1

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

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

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH29-06L 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 10+412.5 O/S 9.5L, SBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.09.25 - 2008.09.25 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.4	**Ground Surface**										
0.0	**PEAT**, fibrous (25mm)										
	Silty **CLAY**, mixed with peaty organics, sandy, trace gravel Very Soft Brown to Grey		1	SS	1		194				
			2	SS	2				102		1 20 55 24
	Trace sand Firm Grey		3	SS	6		193				0 3 35 62
191.8						▽	192	4.0			
2.6	Silty **SAND**, some gravel, some clay Grey Wet		4	SS	50/						
191.1											
3.3	END OF BOREHOLE (SAMPLER BOUNCING) AT 3.3m ON PROBABLE BEDROCK. WATER LEVEL AT 2.5m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH GROUT AND HOLEPLUG TO SURFACE.				.000						

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH29-07 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 10+425 C/L, SBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.09.25 - 2008.09.25 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.6	**Ground Surface**										
0.0	**PEAT**, fibrous (25mm)										
	Silty **SAND**, mixed with peaty organics Very Loose Dark Brown to Grey Moist		1	SS	1		194				
			2	SS	4						
	Layer of grey silty clay (300mm) at 1.2m					▽					0 11 69 20
193.0			3	SS	50/.150		193				
1.6	END OF BOREHOLE (SAMPLER BOUNCING) AT 1.6m ON PROBABLE BEDROCK. WATER LEVEL AT 1.5m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH AUGER CUTTINGS AND HOLEPLUG TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
$\frac{}{10}$

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No D28-04L 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 10+412.5 O/S 6.6L, NBL ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test (DCPT) COMPILED BY AN

DATUM Geodetic DATE 2008.10.28 - 2008.10.28 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
197.9	**Ground Surface**										
0.0	**ASPHALT** (50mm)										
0.0	**SAND**, some gravel, occasional rock fill fragments Brown Moist (FILL) Auger to 0.9m		1	AS					○		
197.0											
0.9	AUGER REFUSAL AT 0.9m ON PROBABLE ROCK FILL.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

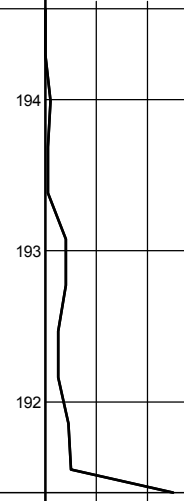
RECORD OF BOREHOLE No D29-03R 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 10+412.5 O/S 9.5R, SBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test (DCPT) COMPILED BY AN

DATUM Geodetic DATE 2008.09.25 - 2008.09.25 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
194.6	**Ground Surface**										
0.0	DCPT from surface.										
191.4											
3.2	END OF DCPT AT 3.2m UPON REFUSAL ON PROBABLE BEDROCK.										



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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

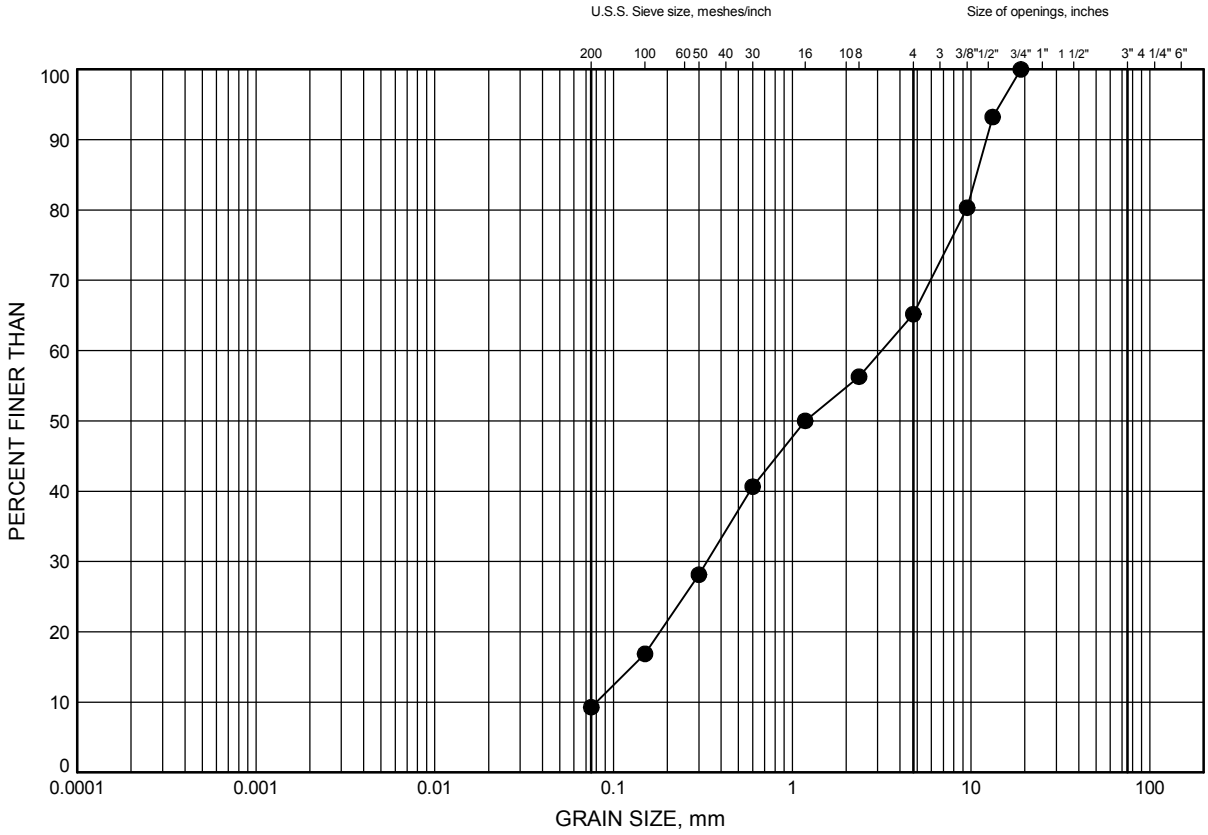
ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE D1

Sand and Gravel Fill



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH28-09	1.07	195.13

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

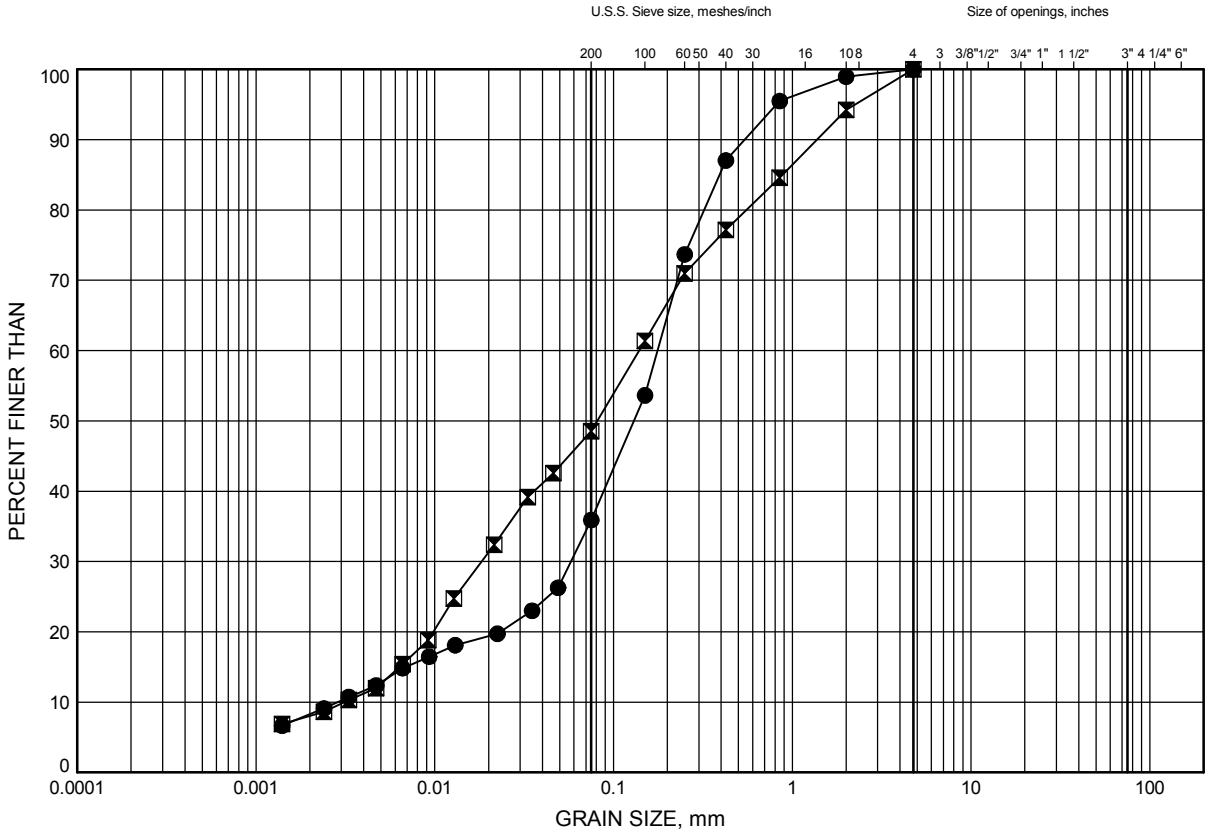
GRAIN SIZE DISTRIBUTION - THURBER 6121.GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE D2

Silt and Sand



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH28-08R	2.59	192.51
⊠	BH29-05	1.83	193.17

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

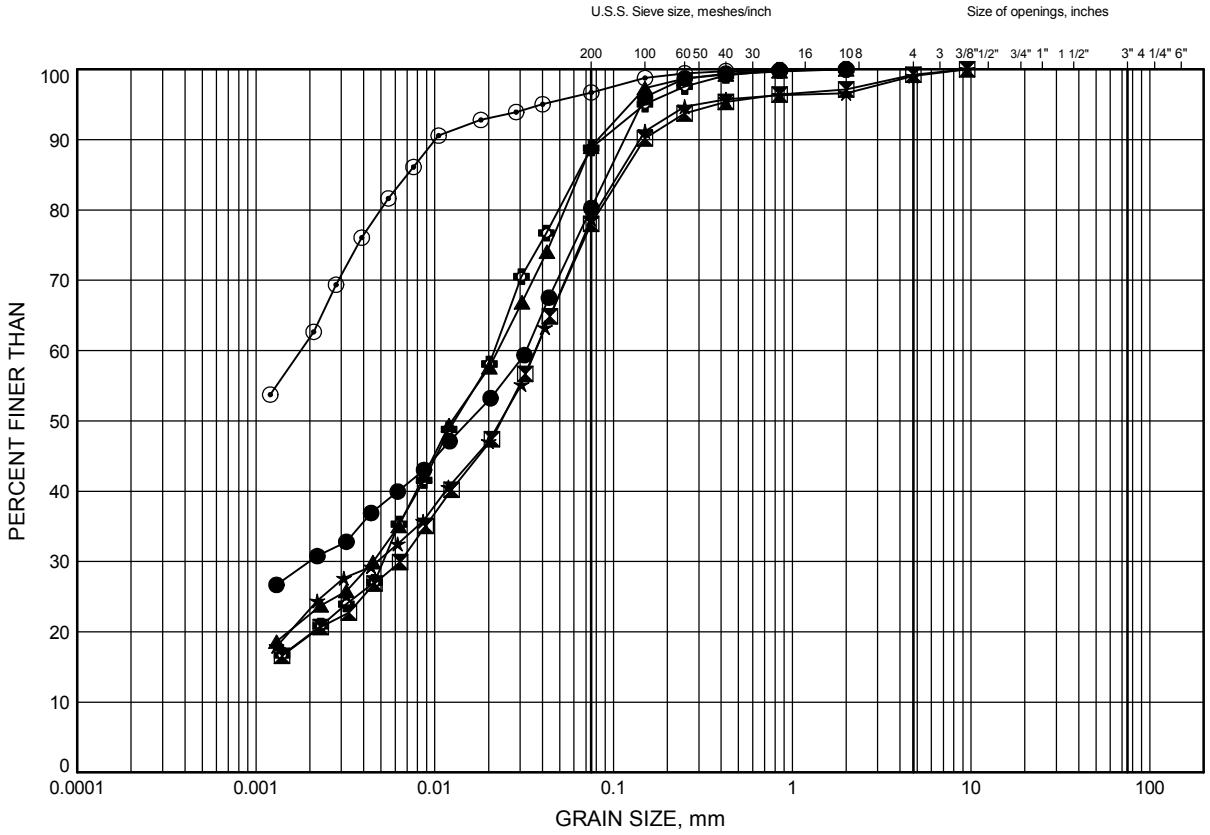
GRAIN SIZE DISTRIBUTION - THURBER 6121.GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE D3

Silty Clay



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH28-08R	1.07	194.03
⊠	BH28-08R	6.40	188.70
▲	BH29-05	2.59	192.41
★	BH29-06L	1.07	193.33
⊙	BH29-06L	1.98	192.42
✿	BH29-07	1.30	193.30

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

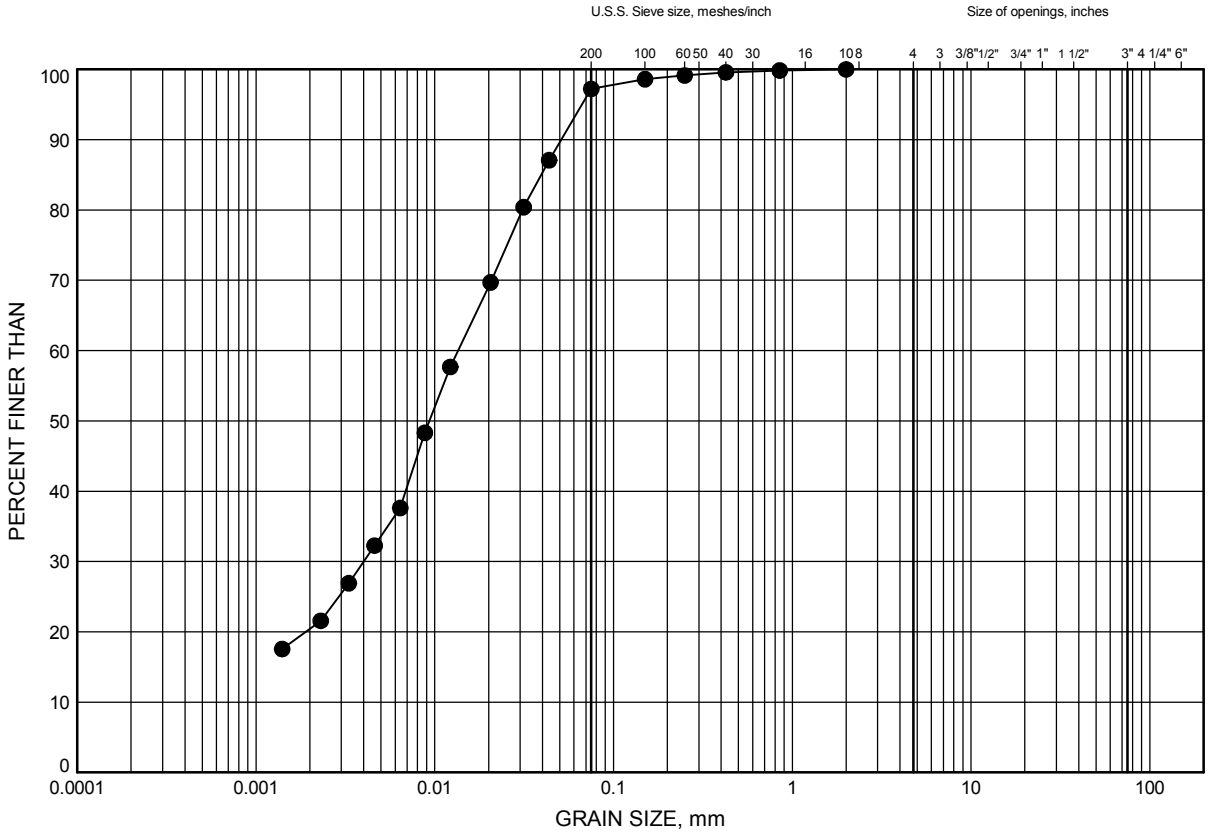
GRAIN SIZE DISTRIBUTION - THURBER 6121.GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE D4

Silty Clay



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C200-1	5.49	192.21

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

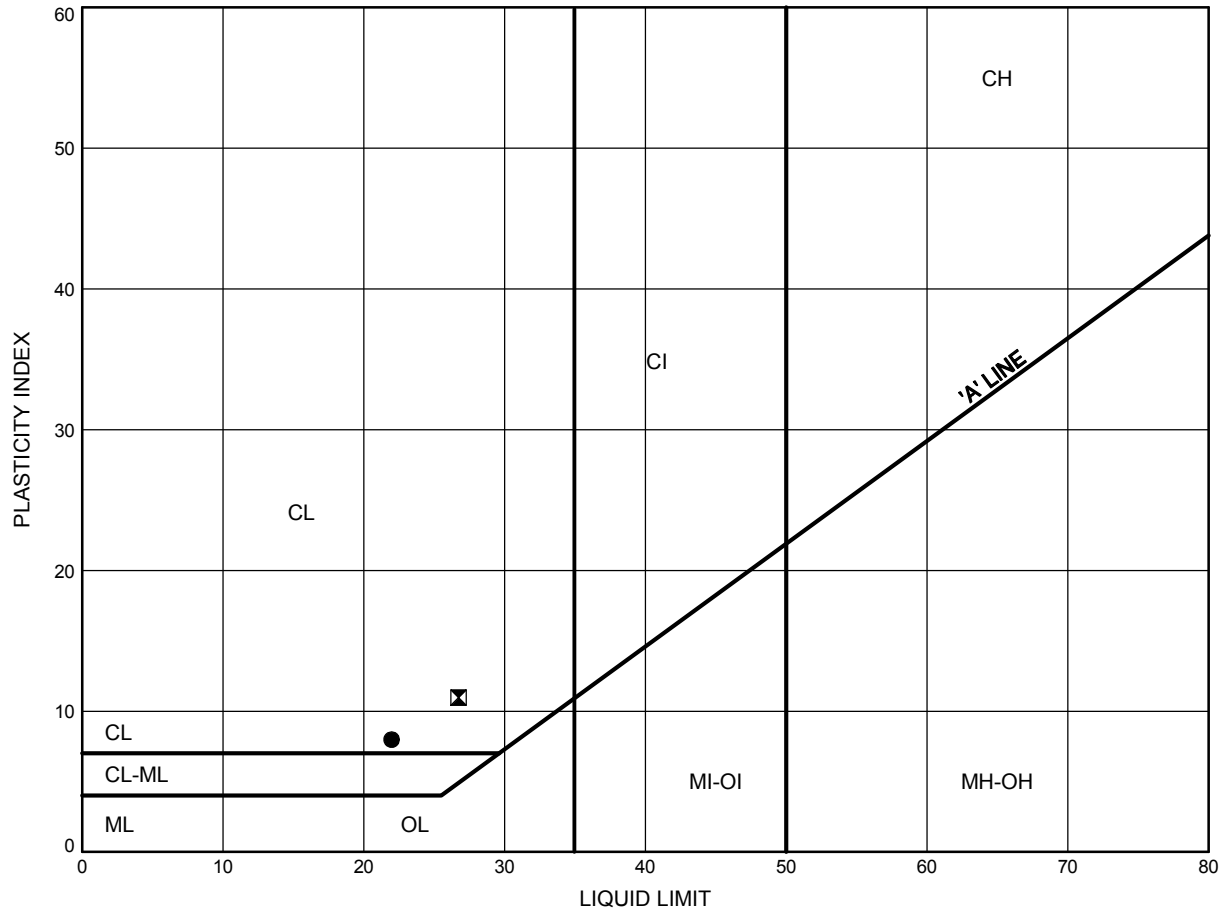
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

ATTERBERG LIMITS TEST RESULTS

FIGURE D5

Silty Clay



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH28-08R	6.40	188.70
⊠	BH29-05	2.59	192.41

Date August 2014

GWP# 5294-08-00

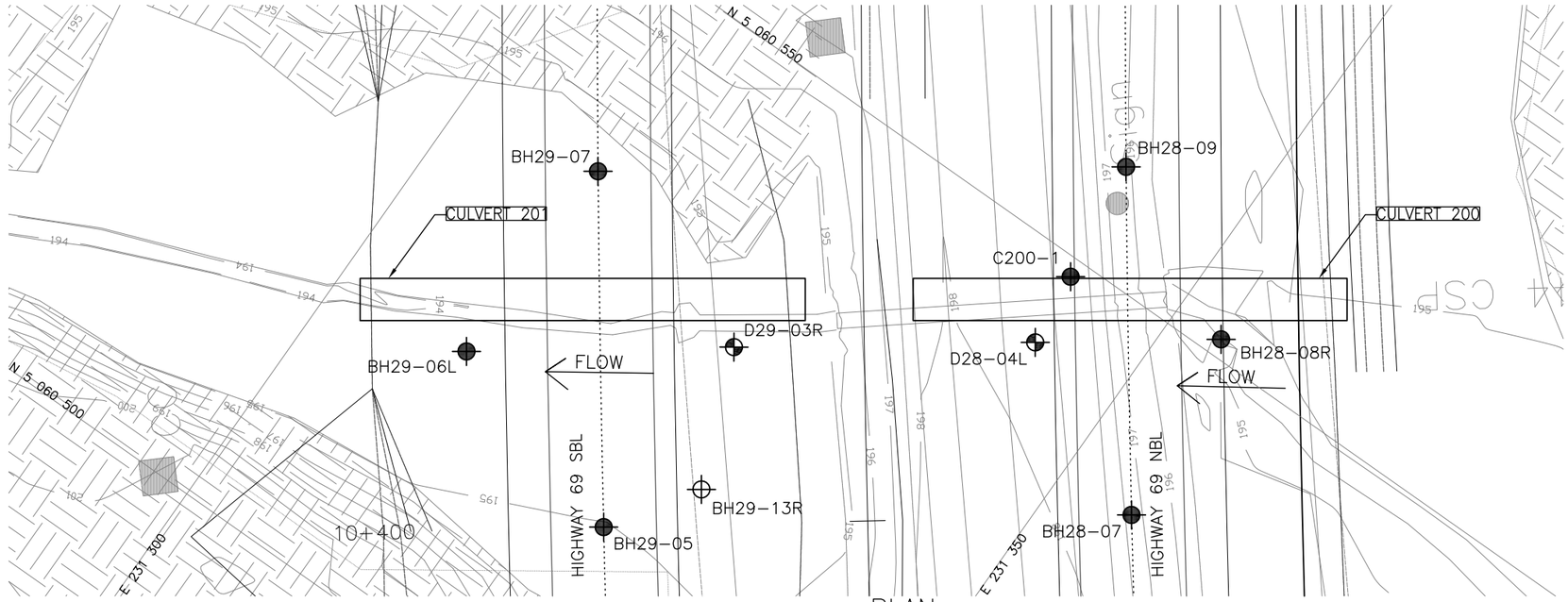
THURBER

Prep'd MFA

Chkd. MRA

THURBALT 6121.GPJ 8/20/14

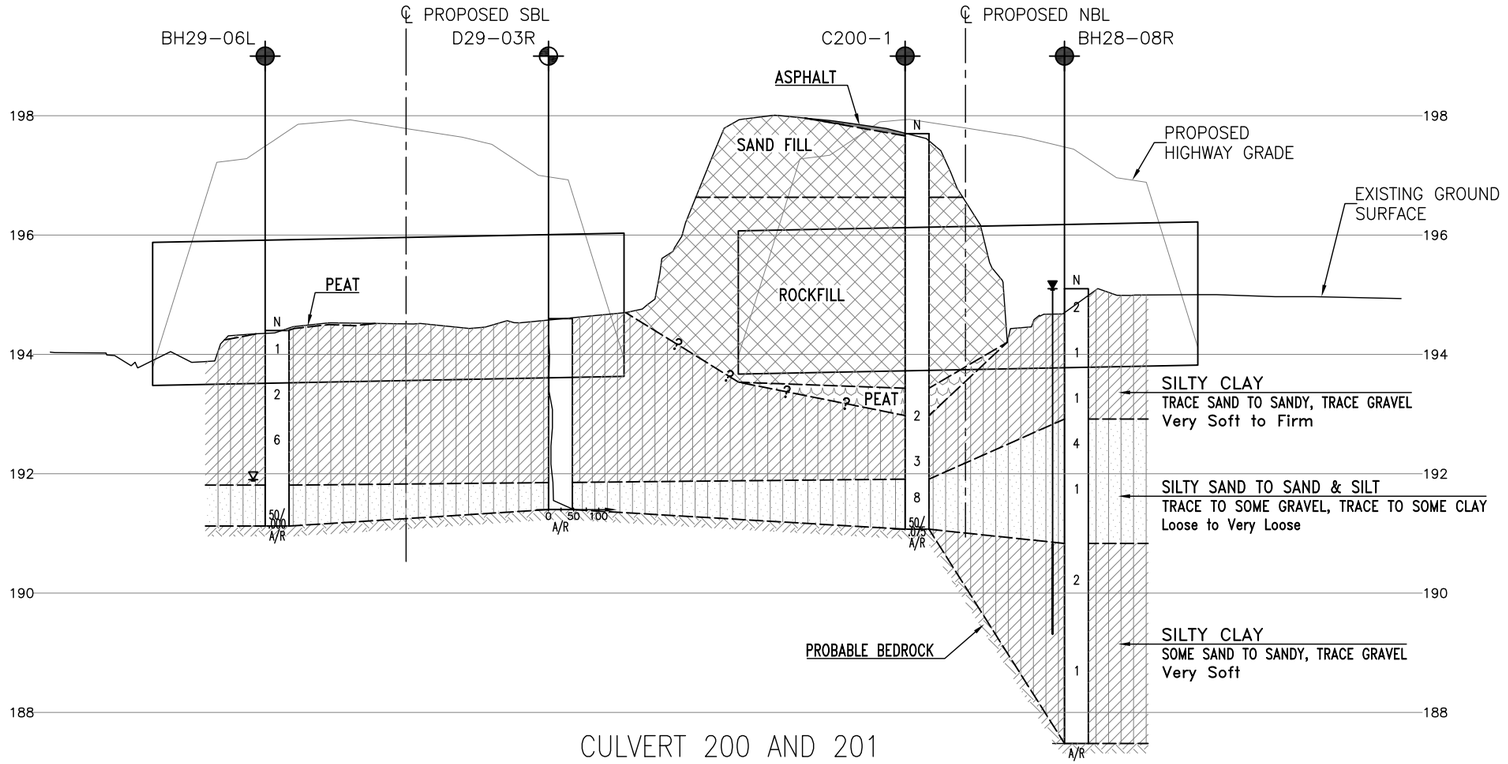
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

8 0 8 16m

SCALE 1:400



CULVERT 200 AND 201

8 0 8 16m H 1:400

2 0 2 4m V 1:100

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Aug 21/14
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Aug 21/14
PROVINCE OF ONTARIO

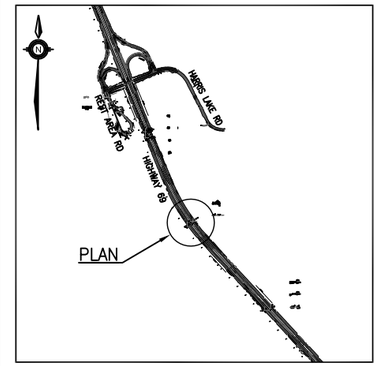
CONT No
WP No 5134-12-11/12

HIGHWAY 69 FOUR-LANING
NORTH SECTION
CULVERT 200 AND 201
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MMM GROUP

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⊕ / ⊕	Culvert Report Borehole / Cone
⊕ / ⊕	Other Borehole / Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level During Drilling
▼	Water Level in Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BH28-07	197.4	5 060 537.4	231 355.7
BH28-08R	195.1	5 060 551.3	231 353.8
BH28-09	196.2	5 060 557.4	231 341.2
BH29-05	195.0	5 060 515.1	231 325.6
BH29-06L	194.4	5 060 519.7	231 310.4
BH29-07	194.6	5 060 535.6	231 310.7
BH29-13R	194.6	5 060 521.3	231 329.7
C200-1	197.7	5 060 548.7	231 342.5
D28-04L	197.9	5 060 543.5	231 343.1
D29-03R	194.6	5 060 530.9	231 325.8

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 41H-129

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	LRB	CHK	MRA	CODE	LOAD
DRAWN	MFA	CHK	LRB	SITE 44-606/C1&C2	STRUCT

DATE AUG. 2014
DWG 1

FILENAME: H:\Drafting\13\5161\21\ted6121-Plan&Sections(Culverts).dwg
PLOTDATE: 9/22/2014 9:27 AM

Appendix E

Culvert 209 (Station 10+108 Rest Area Road)
Boreholes BH34-08R/09/10L

Record of Borehole Sheets
Laboratory Test Results
Borehole Locations and Soil Strata Drawings

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH34-08R 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Service Rd. Tie-in, Station 10+112.5 O/S 14.9R ORIGINATED BY LG

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2009.01.30 - 2009.01.30 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
191.3	**Pond Surface**										
0.0	**ICE** and **WATER**						191				
189.8							190				
1.5	END OF BOREHOLE (SAMPLER BOUNCING) AT 1.5m UPON AUGER REFUSAL ON PROBABLE BEDROCK.										

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

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH34-09 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Service Rd. Tie-in, Station 10+100 C/L ORIGINATED BY LG

HWY 69 BOREHOLE TYPE Visual Assessment and Manual Excavation COMPILED BY AN

DATUM Geodetic DATE 2009.01.30 - 2009.01.30 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
191.9	**Ground Surface**										
0.0	BEDROCK AT SURFACE.										

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

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH34-10L 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Service Rd. Tie-in, Station 10+112.5 O/S 14.9L ORIGINATED BY LG

HWY 69 BOREHOLE TYPE Visual Assessment and Manual Excavation COMPILED BY AN

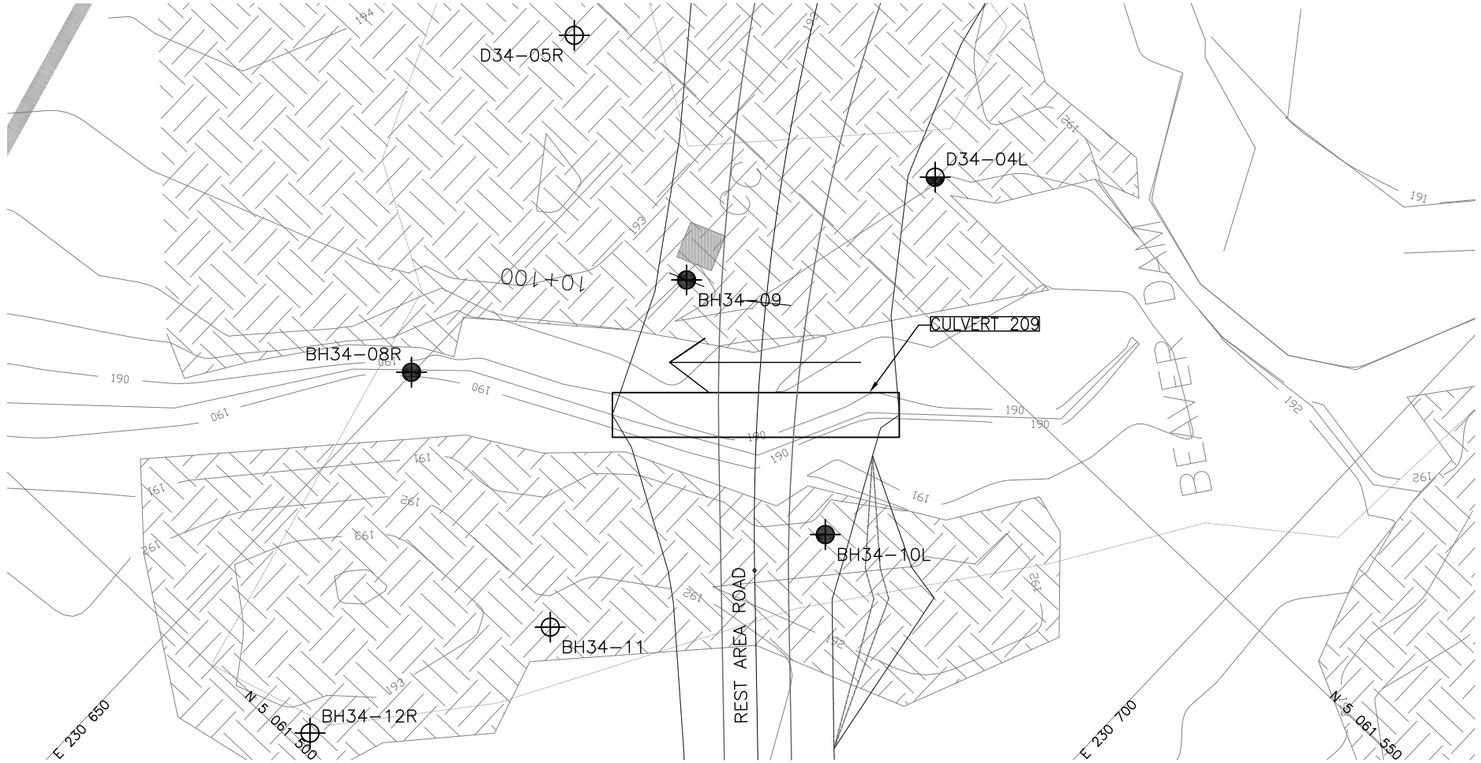
DATUM Geodetic DATE 2009.01.30 - 2009.01.30 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
191.3	**Ground Surface**										
0.0	BEDROCK AT SURFACE.										

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

15 20 10 5 (%) STRAIN AT FAILURE

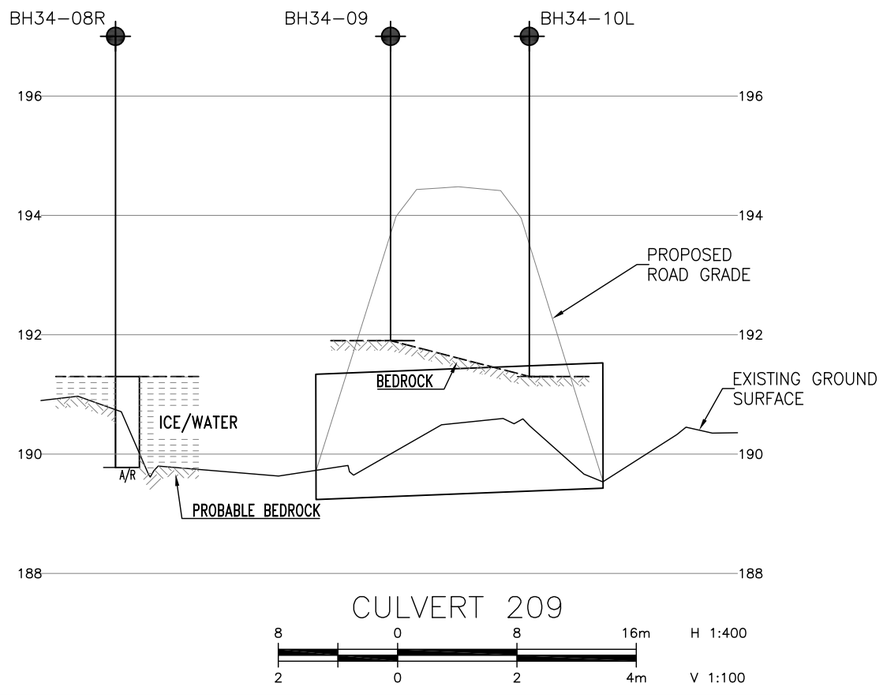
ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14



PLAN

8 0 8 16m

SCALE 1:400



CULVERT 209

8 0 8 16m H 1:400

2 0 2 4m V 1:100

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Aug 21/14
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Aug 21/14
PROVINCE OF ONTARIO

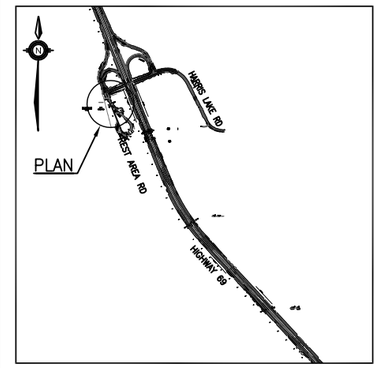
CONT No
WP No 5134-12-13

HIGHWAY 69 FOUR-LANING
NORTH SECTION
CULVERT 209
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MMM GROUP

THURBER ENGINEERING LTD.



KEYPLAN

	LEGEND
⊕/⊕	Culvert Report Borehole / Cone
⊕/⊕	Other Borehole / Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
⧗	Water Level During Drilling
⧗	Water Level in Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BH34-08R	191.3	5 061 523.5	230 649.9
BH34-09	191.9	5 061 540.7	230 659.1
BH34-10L	191.3	5 061 534.7	230 677.6
BH34-11	192.3	5 061 517.5	230 668.4
BH34-12R	192.8	5 061 501.3	230 661.6
D34-04L	192.2	5 061 557.1	230 666.4
D34-05R	193.7	5 061 547.4	230 642.3

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 41H-129

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	LRB	CHK	MRA	CODE		LOAD	DATE AUG. 2014
DRAWN	MFA	CHK	LRB	SITE 44-607/C		STRUCT	DWG 1

FILENAME: H:\Drafting\19\5161\21\ed6121-Plan&Sections(Culverts).dwg
PLOTDATE: 8/22/2014 9:28 AM

Appendix F

Culvert 221 (Station 12+711 NBL)
and
Culvert 222 (Station 12+717 SBL)
Boreholes C221-1 to 3 and C222-1 & 2

Record of Borehole Sheets
Laboratory Test Results
Borehole Locations and Soil Strata Drawings

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C221-1 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 062 655.3 E 230 460.0 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE A Rods/Probe COMPILED BY AN

DATUM Geodetic DATE 2012.05.24 - 2012.05.24 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 20 40 60 80 100 (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
199.4	**Ground Surface**										
0.0	**PEAT** Black Wet						199				
198.6											
0.8	END OF BOREHOLE AT 0.8m UPON REFUSAL ON PROBABLE BEDROCK.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C221-2 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 062 651.5 E 230 444.0 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE A Rods/Probe COMPILED BY AN

DATUM Geodetic DATE 2012.05.24 - 2012.05.24 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 20 40 60 80 100 (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
199.8	**Ground Surface**										
0.0	**PEAT** Black Wet										
199.3											
0.5	END OF BOREHOLE AT 0.5m UPON REFUSAL ON PROBABLE BEDROCK.										

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

$\overset{20}{15 \oplus 5}$ $\underset{10}{}$ (%) STRAIN AT FAILURE

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C221-3 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 062 647.1 E 230 425.9 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE A Rods/Probe COMPILED BY AN

DATUM Geodetic DATE 2012.05.24 - 2012.05.24 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
200.1	**Ground Surface**										
0.0 / 199.8	**PEAT** Black Wet						200				
0.3	END OF BOREHOLE AT 0.3m UPON REFUSAL ON PROBABLE BEDROCK.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C222-1 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 062 644.9 E 230 401.2 ORIGINATED BY ES

HWY 69 BOREHOLE TYPE Hollow Stem Augers/NW/NQ COMPILED BY AN

DATUM Geodetic DATE 2012.07.04 - 2012.07.04 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
203.2	**Ground Surface**										
0.0	**ASPHALT:** (40mm)						203				
0.0	**SAND**, some gravel Dark Brown to Brown Damp (FILL)		1	GS					○		
202.7											
0.5	**ROCK FILL**		1	RUN			202				
			2	RUN							
			3	RUN			201				
							200				
198.9			4	RUN			199				
4.3	**BEDROCK**, granitic gneiss, reddish grey										RUN #5 TCR=100%
			5	RUN			198				
197.3											
5.9	END OF BOREHOLE AT 5.9m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.2m, CUTTINGS TO 0.07m, THEN ASPHALT TO SURFACE.										

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

$\frac{20}{15 \quad 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C222-2 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 062 639.0 E 230 391.1 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE A Rods/Probe COMPILED BY AN

DATUM Geodetic DATE 2012.05.24 - 2012.05.24 CHECKED BY LRB

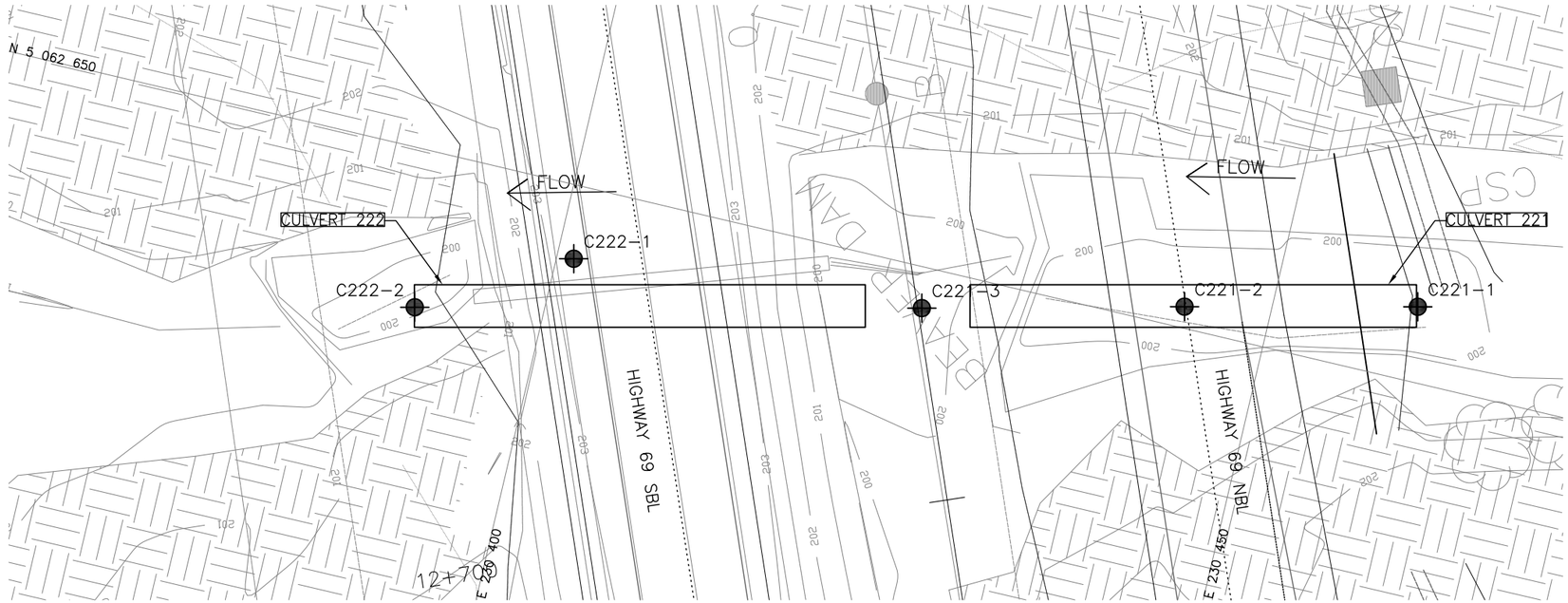
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
198.9	**Ground Surface**										
0.0 / 198.6	**PEAT**, mixed with sand										
0.3	END OF BOREHOLE AT 0.3m UPON REFUSAL ON PROBABLE BEDROCK.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

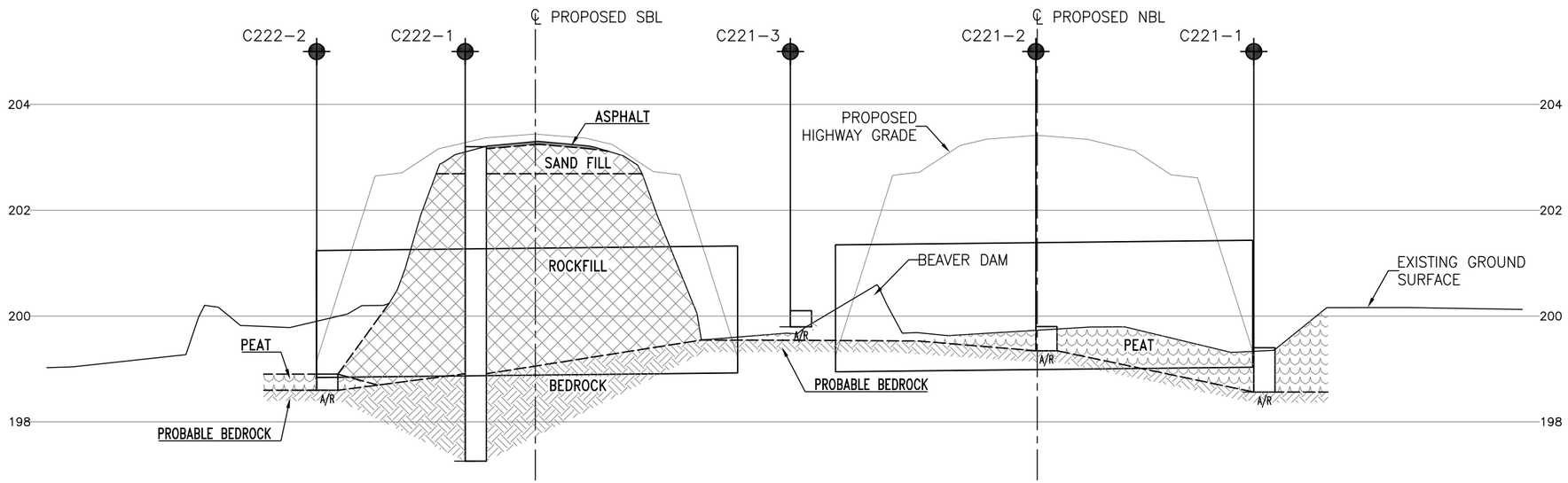
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

8 0 8 16m

SCALE 1:400



CULVERT 221 AND 222

8 0 8 16m H 1:400

2 0 2 4m V 1:100

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Aug 21/14
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Aug 21/14
PROVINCE OF ONTARIO

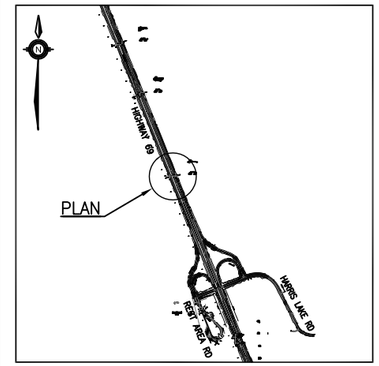
CONT No
WP No 5134–12–14/15

HIGHWAY 69 FOUR–LANING
NORTH SECTION
CULVERT 221 AND 222
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MMM GROUP

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⊕ / ⊕	Culvert Report Borehole / Cone
⊕ / ⊕	Other Borehole / Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▼	Water Level During Drilling
▼	Water Level in Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
C221–1	199.4	5 062 655.3	230 460.0
C221–2	199.8	5 062 651.5	230 444.0
C221–3	200.1	5 062 647.1	230 425.9
C222–1	203.2	5 062 644.9	230 401.2
C222–2	198.9	5 062 639.0	230 391.1

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 41H-129

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	LRB	CHK	MRA	CODE		LOAD	DATE AUG. 2014
DRAWN	MFA	CHK	LRB	SITE	44–608/C1&C2	STRUCT	DWG 1

FILENAME: H:\Drafting\13\5161\V21\ted6121–Plan&Sections(Culverts).dwg
PLOTDATE: 9/22/2014 9:29 AM

Appendix G

Culvert 226 (Station 13+452 NBL)
and
Culvert 227 (Station 13+452 SBL)
Boreholes C226-1 to 3 and C227-1 & 2

Record of Borehole Sheets
Laboratory Test Results
Borehole Locations and Soil Strata Drawings

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C226-1 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 063 344.5 E 230 179.9 ORIGINATED BY SLL
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.05.25 - 2012.05.25 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.5	**Ground Surface**										
0.0	**PEAT**										
0.2	Black Wet (150mm)		1	SS	2		197		○		
	SAND, trace silt Very Loose Brown		2	SS	3				○		0 7 66 27
196.4 1.1 196.2	Wet								○		
1.3	Silty **CLAY**, trace sand Soft Grey						196				
	Silty **SAND**, trace gravel Compact Grey Wet		3	SS	14				○		
			4	SS	24		195		○		
194.6											
2.9	END OF BOREHOLE AT 2.9m UPON AUGER REFUSAL ON PROBABLE BEDROCK. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun.05/12 0.4 197.1 Jun.21/12 0.4 197.1 JuL.05/12 0.5 197.0										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C226-2 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 063 339.0 E 230 166.4 ORIGINATED BY SLL
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.05.25 - 2012.05.25 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.3	**Ground Surface**										
0.0	**PEAT**, fibrous										
0.2	Black (175mm)		1	SS	1	▽	197				
	SAND, trace silt, trace gravel Very Loose to Loose Dark Brown to Brown Wet		2	SS	4						1 95 4 (SI+CL)
			3	SS	3		196				
			4	SS	7		195				
194.5	150mm silty clay seam at 2.6m										
2.8	Silty **SAND**, trace to some gravel Compact Brown Wet		5	SS	30		194				
	Occasional cobbles		6	SS	26		193				16 62 22 (SI+CL)
191.1			7	SS	100/		192				
6.2	END OF BOREHOLE AT 6.2m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE CAVED TO 3.2m AND WATER LEVEL AT 0.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.6m, THEN CUTTINGS TO SURFACE.				0.100						

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

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

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C226-3 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 063 333.9 E 230 153.6 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2012.05.24 - 2012.05.24 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.5	**Ground Surface**										
0.0	**PEAT**										
0.2	Black (150mm)		1	SS	8		197		○		
	SAND, trace silt, trace gravel Loose Brown Moist to Wet		2	SS	9	▽			○		
196.0							196				
1.5	Silty **CLAY** Firm Grey		3	SS	4				○		
195.3							195				
2.2	Silty **SAND**, trace gravel Compact Grey Wet		4	SS	19				○		2 74 24 (SI+CL)
			5	SS	28		194		○		
			6	SS	18		193		○		
191.9							192				
5.6	END OF BOREHOLE AT 5.6m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN TO 1.6m AND WATER LEVEL AT 1.5m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.15m, THEN CUTTINGS TO SURFACE.										

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

$15 \oplus^{20}_{10} 5$ (%) STRAIN AT FAILURE

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C227-1 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 063 325.4 E 230 126.2 ORIGINATED BY ES

HWY 69 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2012.07.04 - 2012.07.04 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
199.5	**Ground Surface**										
0.0	**ASPHALT:** (50mm)										
0.0	**SAND**, some gravel Dark Brown Damp (FILL)		1	GS			199		○		
198.8											
0.7	**ROCK FILL**		1	RUN			198				
196.4							197				
3.1	**SAND**, trace gravel, occasional cobbles Compact Brown Wet		2	SS	17		196		○		
195.3			3	SS	9		195		○ ○		
4.2	Silty **CLAY**, some sand Stiff Grey										
194.9											
4.6	Gravelly **SAND**, some silt and clay, occasional cobbles Compact Grey Wet		4	SS	23		194		○		
193.4			5	SS	14				○		23 64 13 (SI+CL)
6.1	**SAND**, trace gravel, occasional cobbles Compact Grey Wet		6	SS	28		193		○		
192.3											
7.2	**BEDROCK**, granitic gneiss, reddish grey		2	RUN			192				RUN #2 TCR=100%
191.7											
7.8	END OF BOREHOLE AT 7.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.9m, CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.										

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C227-2 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 063 319.1 E 230 117.3 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Continuous Split Spoon (50lb Hammer) COMPILED BY AN

DATUM Geodetic DATE 2012.06.21 - 2012.06.21 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.3	**Ground Surface**										
0.0	**PEAT:** (100mm)										
0.1	Black										
	Silty **SAND**, some gravel, trace clay Very Loose to Compact Grey Wet		1	SS	2		196				
			2	SS	7						
			3	SS	13		195				12 57 24 7
			4	SS	15		194				
193.7			5	SS	50/						
2.6	END OF BOREHOLE AT 2.6m UPON REFUSAL ON PROBABLE BEDROCK. BOREHOLE CAVED TO 1.9m, AND WATER LEVEL AT 0.05m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.1m, THEN CUTTINGS TO SURFACE. NOTE: 'N' VALUES HAVE BEEN CORRECTED TO ACCOUNT FOR A 50lb HAMMER.				0.025						

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

$\frac{20}{15 \quad 5}$ (%) STRAIN AT FAILURE
$\quad 10$

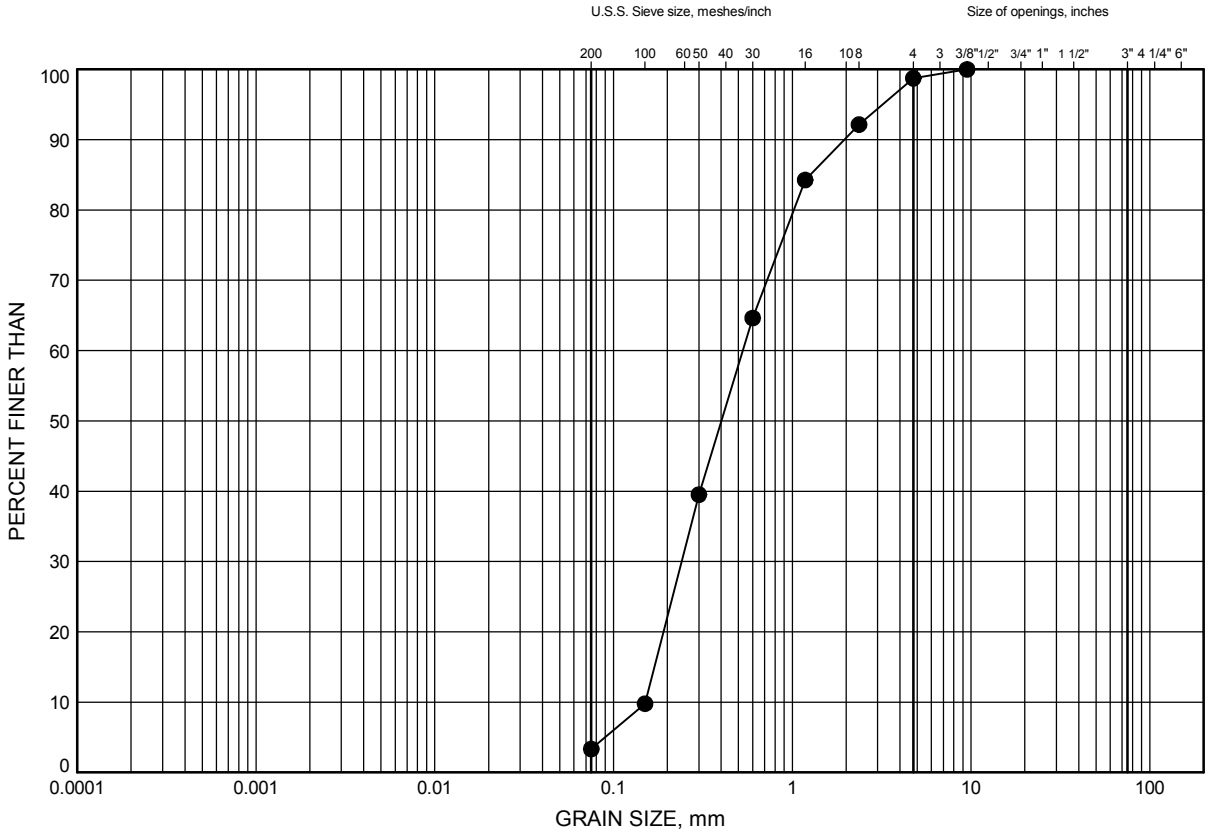
ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE G1

Sand



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C226-2	1.07	196.23

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

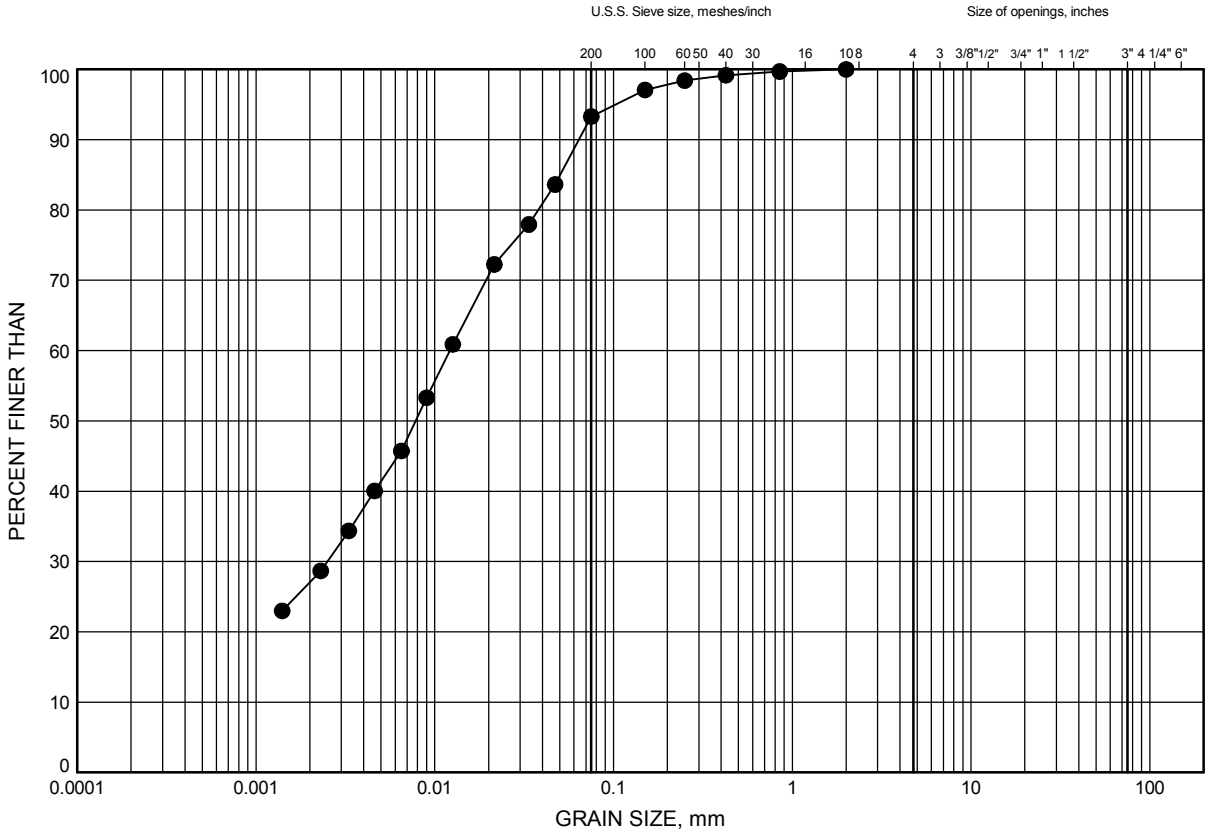
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE G2

Silty Clay



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C226-1	1.22	196.28

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

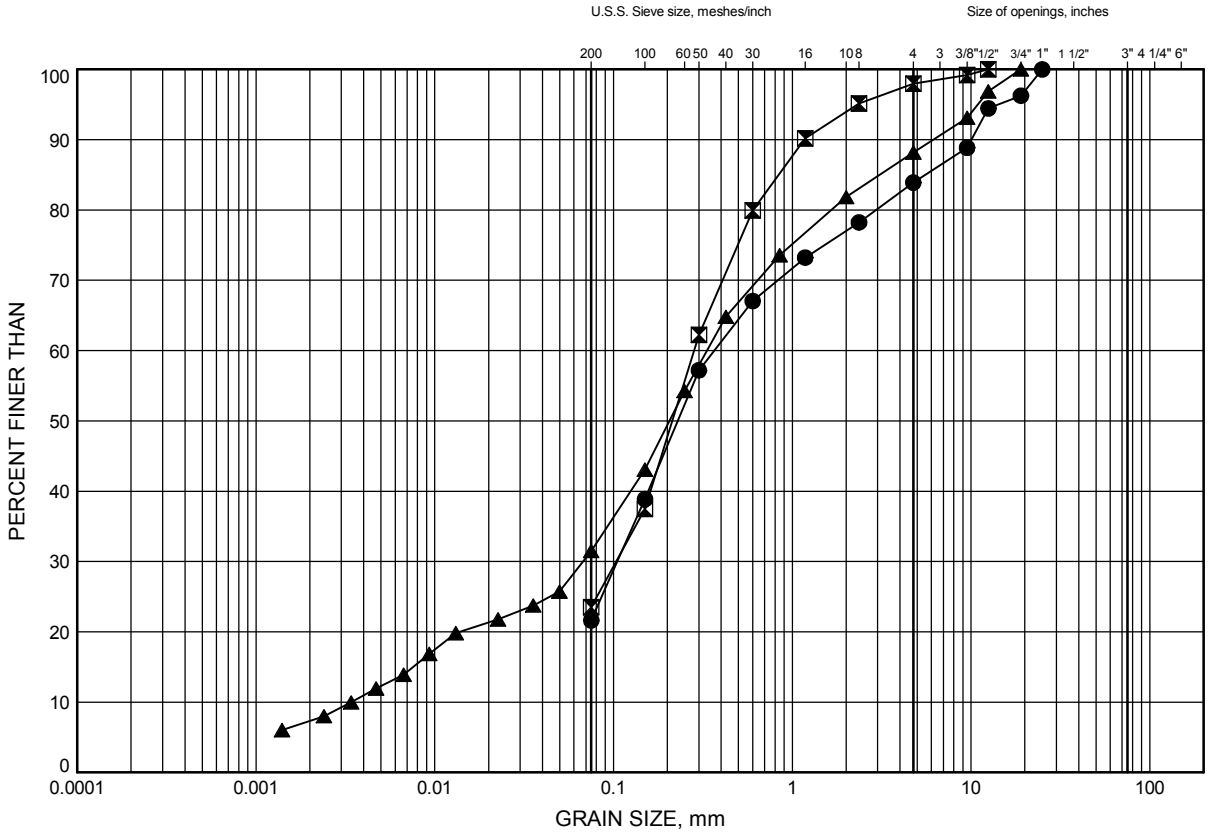
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE G3

Silty Sand



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C226-2	4.88	192.42
⊠	C226-3	2.59	194.91
▲	C227-2	1.52	194.78

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

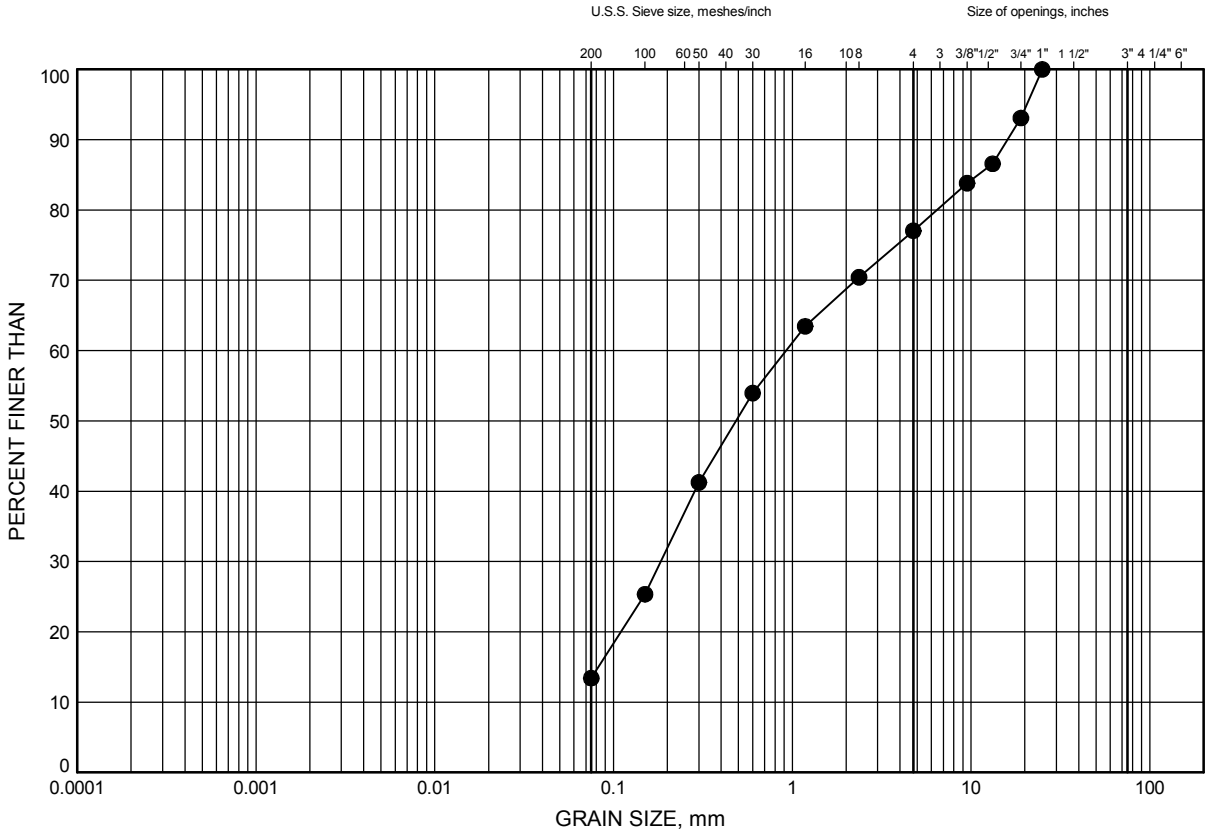
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE G4

Gravelly Sand



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C227-1	5.79	193.71

Date August 2014

GWP# 5294-08-00

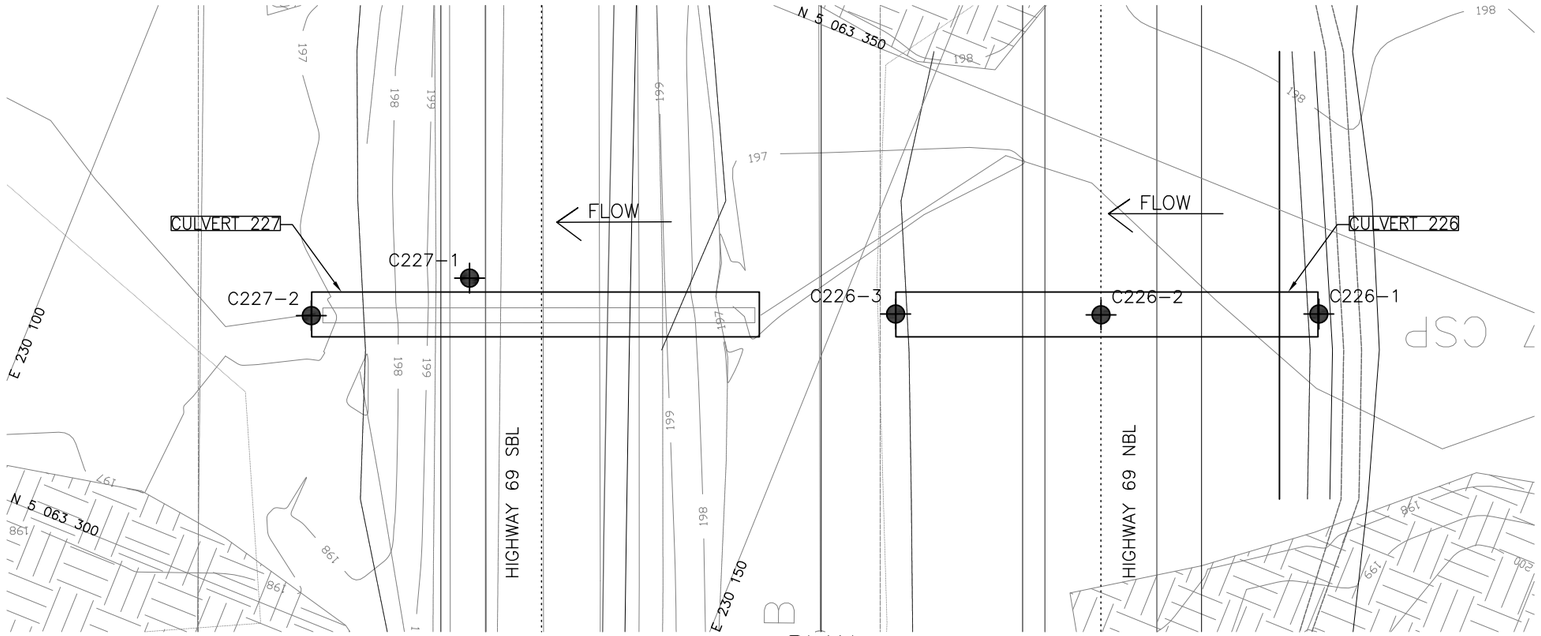
THURBER

Prep'd MFA

Chkd. MRA

GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

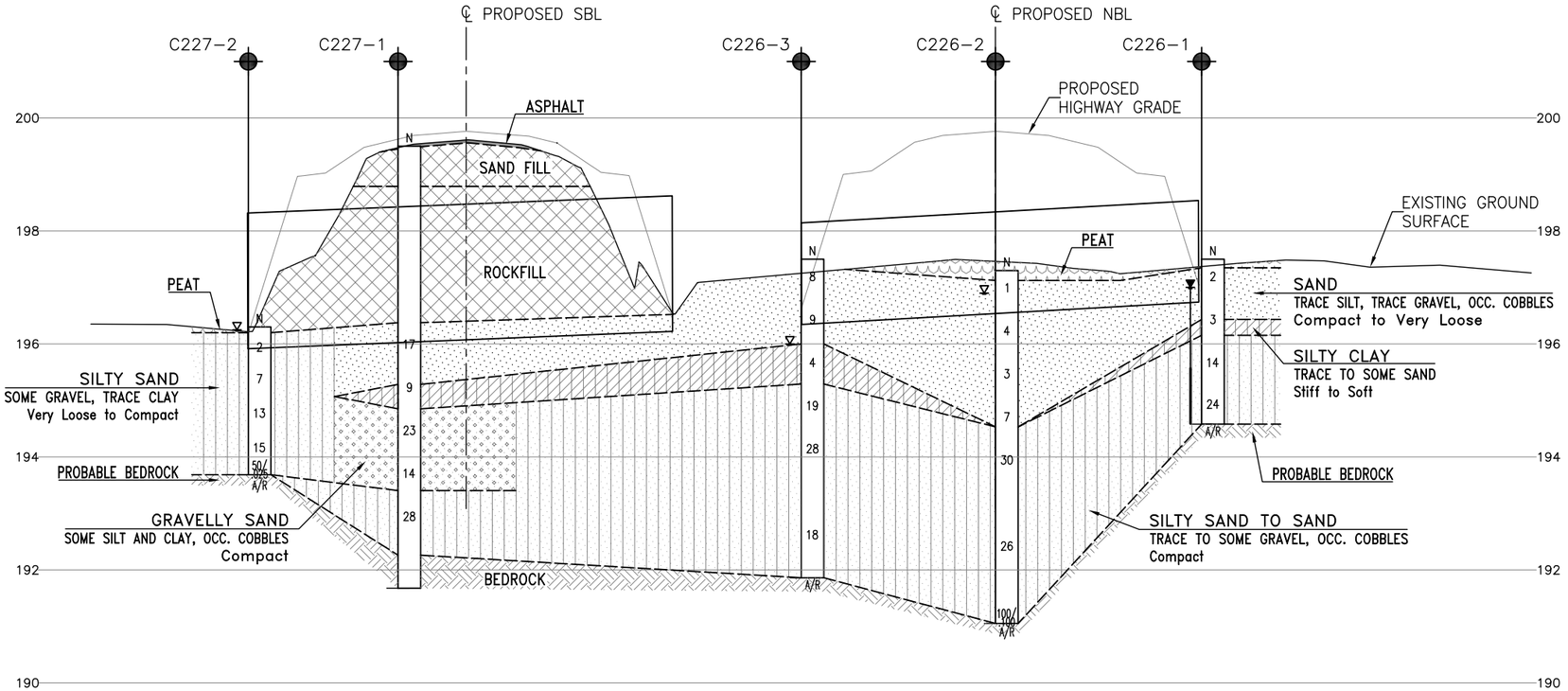
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

8 0 8 16m

SCALE 1:400



CULVERT 226 AND 227

8 0 8 16m H 1:400

2 0 2 4m V 1:100

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Aug 21/14
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Aug 21/14
PROVINCE OF ONTARIO

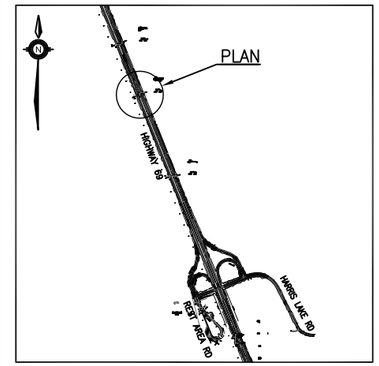
CONT No
WP No 5134-12-16/17

HIGHWAY 69 FOUR-LANING
NORTH SECTION
CULVERT 226 AND 227
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MMM GROUP

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⊕/⊕	Culvert Report Borehole / Cone
⊕/⊕	Other Borehole / Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level During Drilling
▼	Water Level in Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
C226-1	197.5	5 063 344.5	230 179.9
C226-2	197.3	5 063 339.0	230 166.4
C226-3	197.5	5 063 333.9	230 153.6
C227-1	199.5	5 063 325.4	230 126.2
C227-2	196.3	5 063 319.1	230 117.3

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 41H-129

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	LRB	CHK	MRA	CODE		LOAD	DATE AUG. 2014
DRAWN	MFA	CHK	LRB	SITE	44-609/C1&C2	STRUCT	DWG 1

FILENAME: H:\Drafting\13\5161\21\ted6121-Plan&Sections(Culverts).dwg
PLOTDATE: 9/22/2014 8:51 AM

Appendix H

Culvert 230 (Station 13+914 NBL)
and
Culvert 231 (Station 13+914 SBL)
Boreholes BH45-02/03L/04 and C231-1 to 3
DCPT D45-01R

Record of Borehole Sheets
Laboratory Test Results
Borehole Locations and Soil Strata Drawings

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C231-1 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 063 758.7 E 229 971.4 ORIGINATED BY SLL
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.05.25 - 2012.05.25 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.4	**Ground Surface**										
0.0	**ORGANICS**, with roots and rootlets:										
0.2	(150mm)		1	SS	5		193				
	SAND, mixed with rock fill (FILL)					▽					
192.0							192				
1.4	Silty **CLAY**, with occasional sand seams Stiff to Very Soft Brown		2	SS	9						
			3	SS	2		191				0 0 46 54
	Grey		4	SS	1		190	3.0			
188.1			5	SS	0		189				
5.3	**SAND**, trace silt Very Dense Grey Wet						188				
187.4			6	SS	100/ 0.075						
6.0	END OF BOREHOLE AT 6.0m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN TO 4.6m AND WATER LEVEL AT 0.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOELPLUG TO 1.0m, THEN CUTTINGS TO SURFACE.										

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

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

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C231-2 1 OF 2 METRIC

GWP# 5294-08-00 LOCATION N 5 063 751.7 E 229 954.1 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2012.07.03 - 2012.07.03 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
195.0	**Ground Surface**										
0.0	**ASPHALT:** (50mm)										
0.0	**SAND** and **GRAVEL**, trace silt, occasional cobbles Dense to Compact Dark Brown to Brown Damp (FILL)		1	GS							
			1	SS	38		194				57 35 8 (SI+CL)
			2	SS	22		193				
192.7											
2.3	**ROCK FILL**, with sand and gravel zones		1	RUN							
			2	RUN			192				
			3	SS	19						
			3	RUN			191				
			4	SS	16		190				
			4	RUN			189				
188.2			5	SS	7						
6.8	Silty **CLAY**, trace sand Firm to Very Soft Grey		6	SS	100/0.125		188				
			7	SS	1		187				0 2 34 64
			8	SS	1		186				

Continued Next Page

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

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C231-2 2 OF 2 METRIC

GWP# 5294-08-00 LOCATION N 5 063 751.7 E 229 954.1 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2012.07.03 - 2012.07.03 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
184.2											
10.8	**SILT** and **SAND**, some clay Compact Grey Moist		9	SS	16		184		○		0 40 48 12
183.5											
11.5	Sandy **GRAVEL** Compact to Very Dense Grey Wet		10	SS	27		183		○		
182.3			11	SS	71				○		
12.7	END OF BOREHOLE AT 12.7m UPON REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.9m, CUTTINGS TO 0.15m, THEN ASPHALT TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C231-3 1 OF 2 METRIC

GWP# 5294-08-00 LOCATION N 5 063 747.7 E 229 944.4 ORIGINATED BY SLL
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.05.24 - 2012.05.24 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES
193.3	**Ground Surface**				
0.0	Silty **CLAY**, some sand, trace gravel, with roots and rootlets, occasional cobbles Stiff Dark brown (FILL)		1	SS	10
			2	SS	50/ 0.125
191.8					
1.5	**PEAT**, fibrous, with clay seams Soft Wet		3	SS	3
190.6			4	SS	3
2.7	Silty **CLAY**, trace sand Very Soft Grey to Brown		5	SS	1
			6	SS	1
			1	ST	
			7	SS	0
183.9			8	SS	9
9.4	**SAND**, some silt and clay, trace gravel Loose to Dense				

GROUND WATER CONDITIONS

ELEVATION SCALE: 193, 192, 191, 190, 189, 188, 187, 186, 185, 184

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

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

3.0
4.0

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
20 40 60

89

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
0	3	74	23

Continued Next Page

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C231-3 2 OF 2 METRIC

GWP# 5294-08-00 LOCATION N 5 063 747.7 E 229 944.4 ORIGINATED BY SLL
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.05.24 - 2012.05.24 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Grey Moist to Wet						183				
			9	SS	33				○		12 72 16 (SI+CL)
							182				
	Coarse grained		10	SS	36		181		○		
179.9							180				
13.4	END OF BOREHOLE AT 13.4m UPON REFUSAL ON PROBABLE BEDROCK. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun.05/12 0.1* 193.4 Jun.21/12 0.1* 193.4 Jul.05/12 At Surface * ARTESIAN CONDITION										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH45-02 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 13+900 C/L, NBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.09.09 - 2008.09.09 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.8	**Ground Surface**										
0.0	**ORGANICS:** (25mm)		1	SS	1				○		
192.2	Silty **SAND** Very Loose Brown Moist										
0.6	Silty **CLAY**, trace sand, decayed wood fragments Soft Grey		2	SS	4	▽	192		○		0 8 45 47
191.3											
191.5	Silty **SAND**		3	SS	1/				○		
1.7	Grey Wet				.125						
	END OF BOREHOLE (SAMPLER BOUNCING) AT 1.7m UPON PROBABLE BEDROCK. WATER LEVEL AT 0.9m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH45-03L 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 13+912.5 O/S 9.0L, NBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.09.09 - 2008.09.09 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.7	**Ground Surface**										
0.0	**ORGANICS**, peaty, fibrous: (50mm)										
0.0	Silty **SAND**, some clay Very Loose Grey Moist		1	SS	3	▽			○		
192.1											
0.6	Silty **CLAY**, trace sand, decayed wood fragments, occasional rootlets Very Soft to Soft Grey		2	SS	3		192		○		
			3	SS	2		191	7.0 +	○ — ○ — ○		0 4 34 62
							190				
189.5			4	SS	50/				○		
3.2	END OF BOREHOLE AT 3.2m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT 0.3m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.				.125						

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

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

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH45-04 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 13+925 C/L, NBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.09.09 - 2008.09.09 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.6	**Ground Surface**										
0.0 / 191.8	**ORGANICS:**, peaty: (800mm)		1	SS	0	▽	192				
0.8	Silty **CLAY**, trace to some sand Very Soft Grey		2	SS	2						0 5 67 28
			3	SS	1		191				
189.2			4	SS	50/.000		190				0 18 39 43
3.4	END OF BOREHOLE (SAMPLER BOUNCING) AT 3.4m ON PROBABLE BEDROCK. WATER LEVEL AT 0.3m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH GROUT AND HOLEPLUG TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No D45-01R 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 13+912.5 O/S 9.0R, NBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test (DCPT) COMPILED BY AN

DATUM Geodetic DATE 2008.09.09 - 2008.09.09 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
192.6	**Ground Surface**										
0.0	DCPT from surface.						192 / 191 / 190				
189.3											
3.3	END OF DCPT AT 3.25m UPON REFUSAL ON PROBABLE BEDROCK.										

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

$\oplus^{20}_{15\ 10\ 5}$ (%) STRAIN AT FAILURE

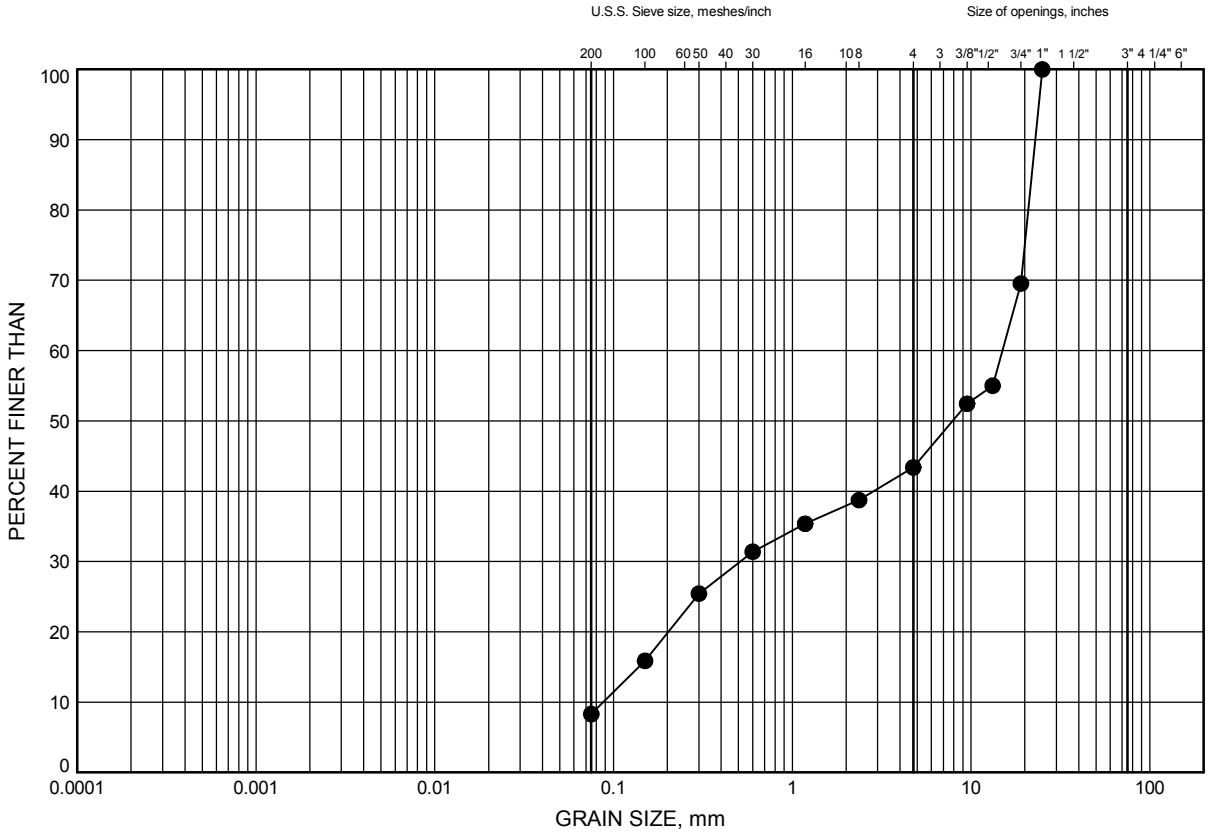
ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE H1

Sand and Gravel Fill



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C231-2	1.07	193.93

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

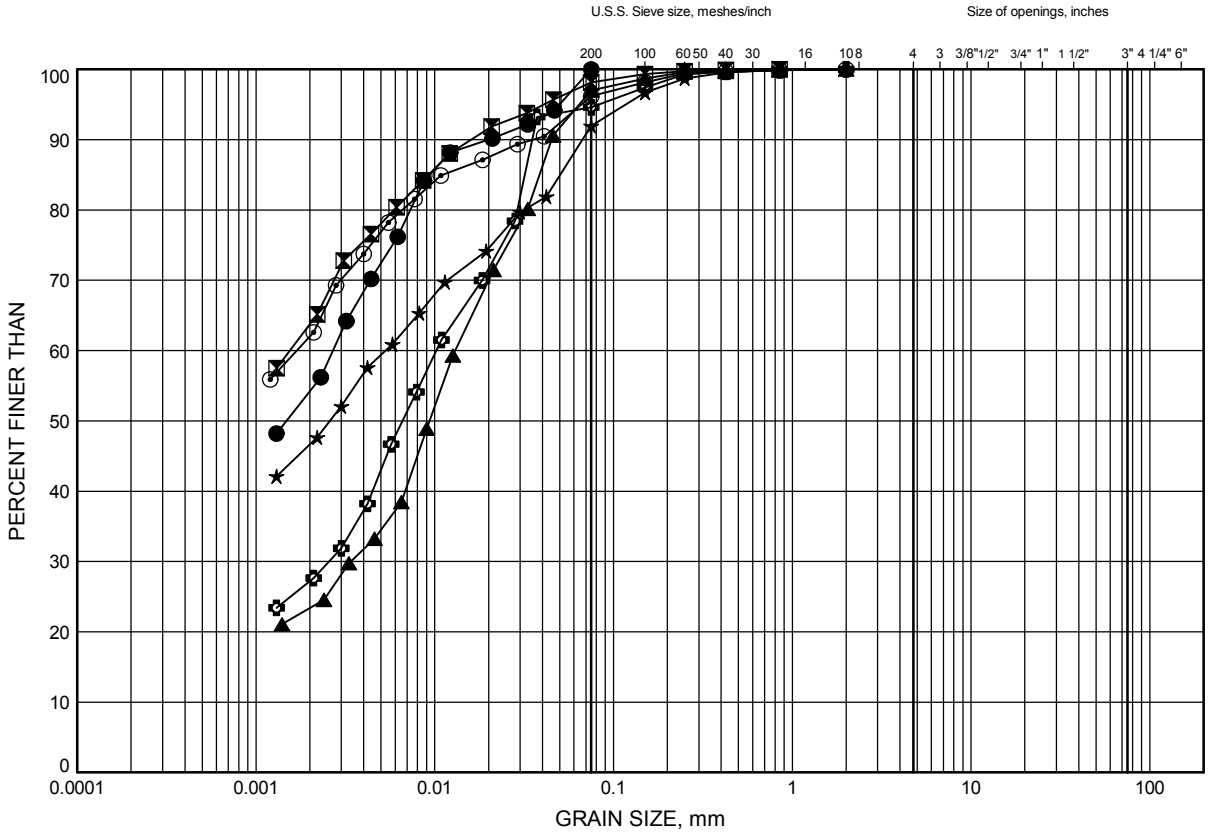
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE H2

Silty Clay



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C231-1	2.59	190.81
⊠	C231-2	8.53	186.47
▲	C231-3	3.35	189.95
★	BH45-02	1.07	191.73
⊙	BH45-03L	1.83	190.87
✿	BH45-04	1.07	191.53

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

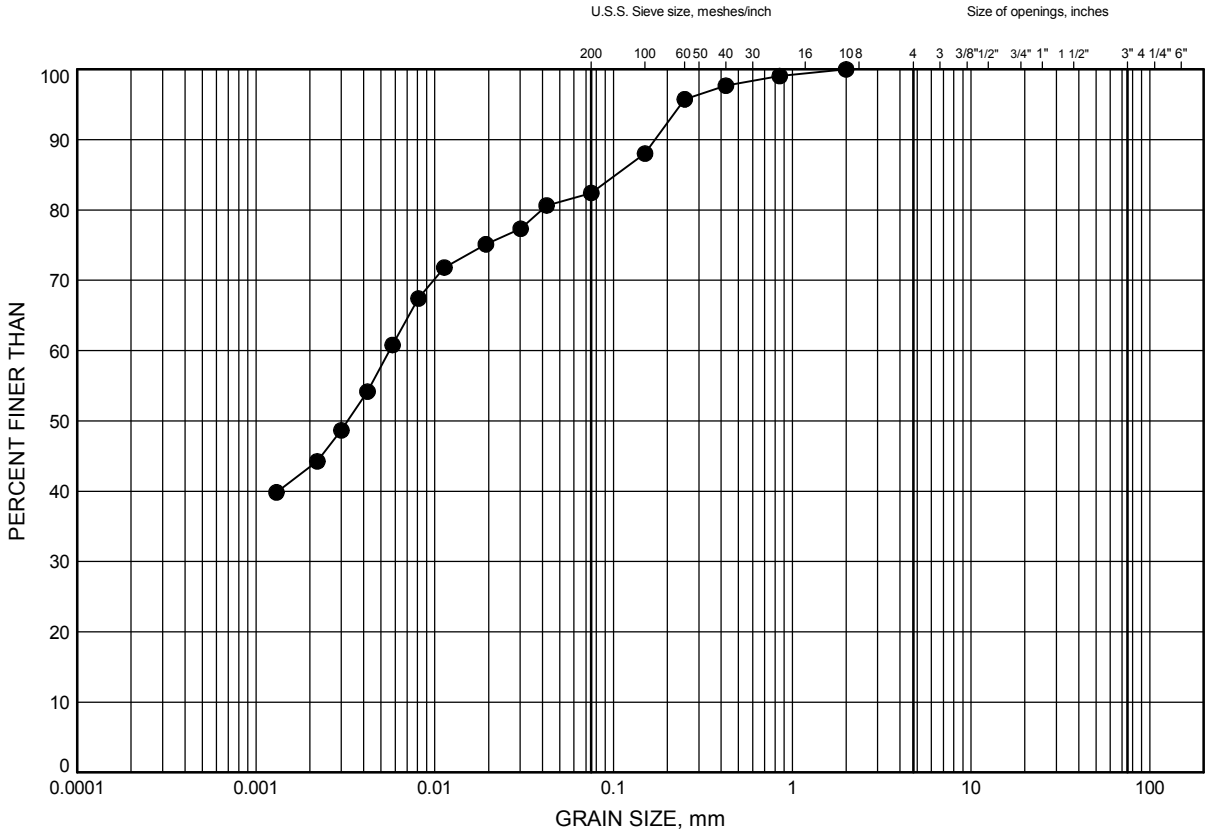
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE H3

Silty Clay



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH45-04	3.20	189.40

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

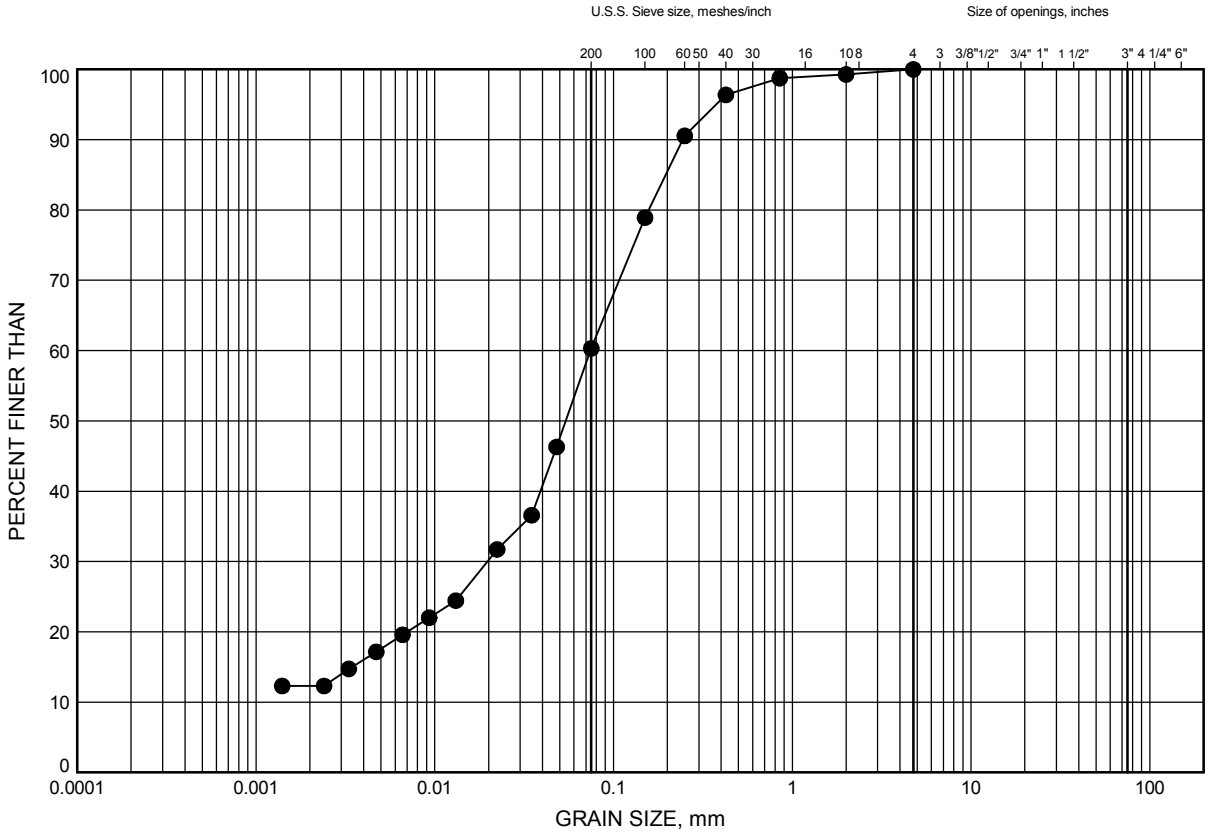
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE H4

Silt and Sand



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C231-2	10.87	184.13

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

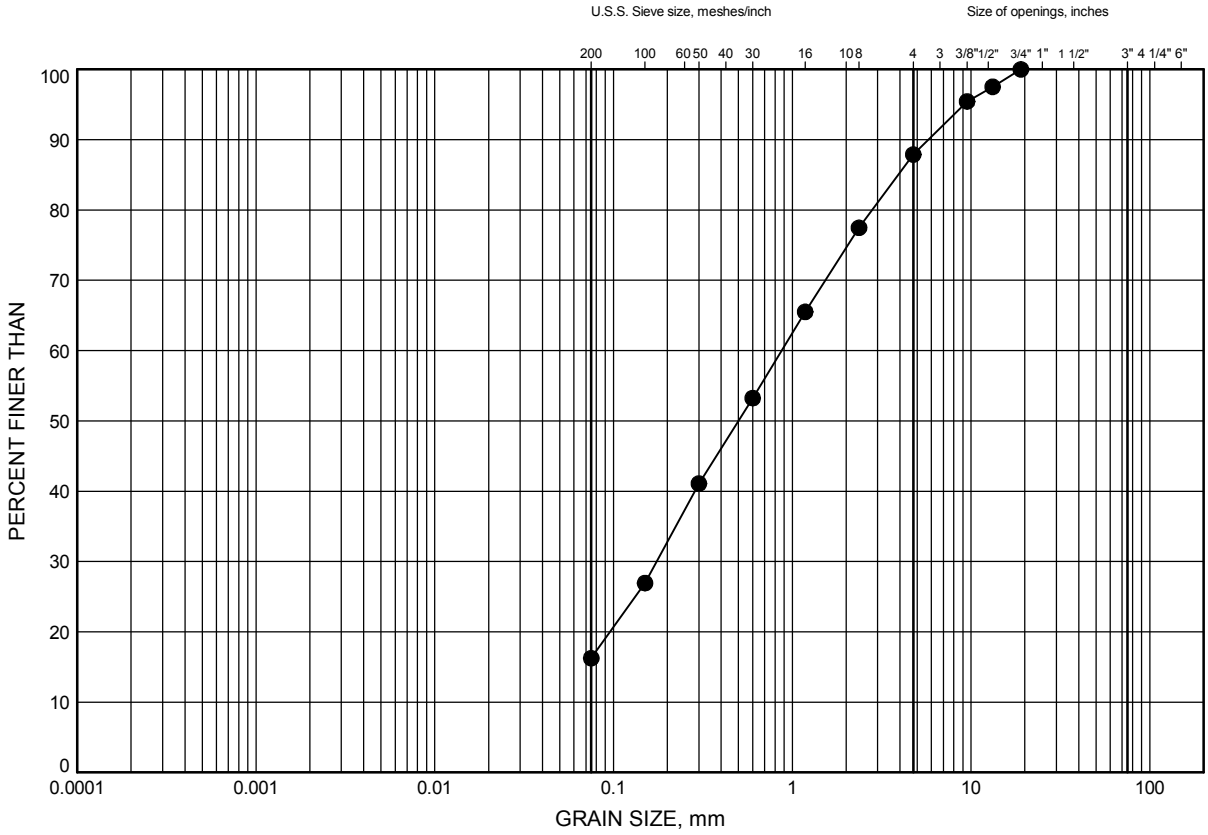
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE H5

Sand



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C231-3	10.97	182.33

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

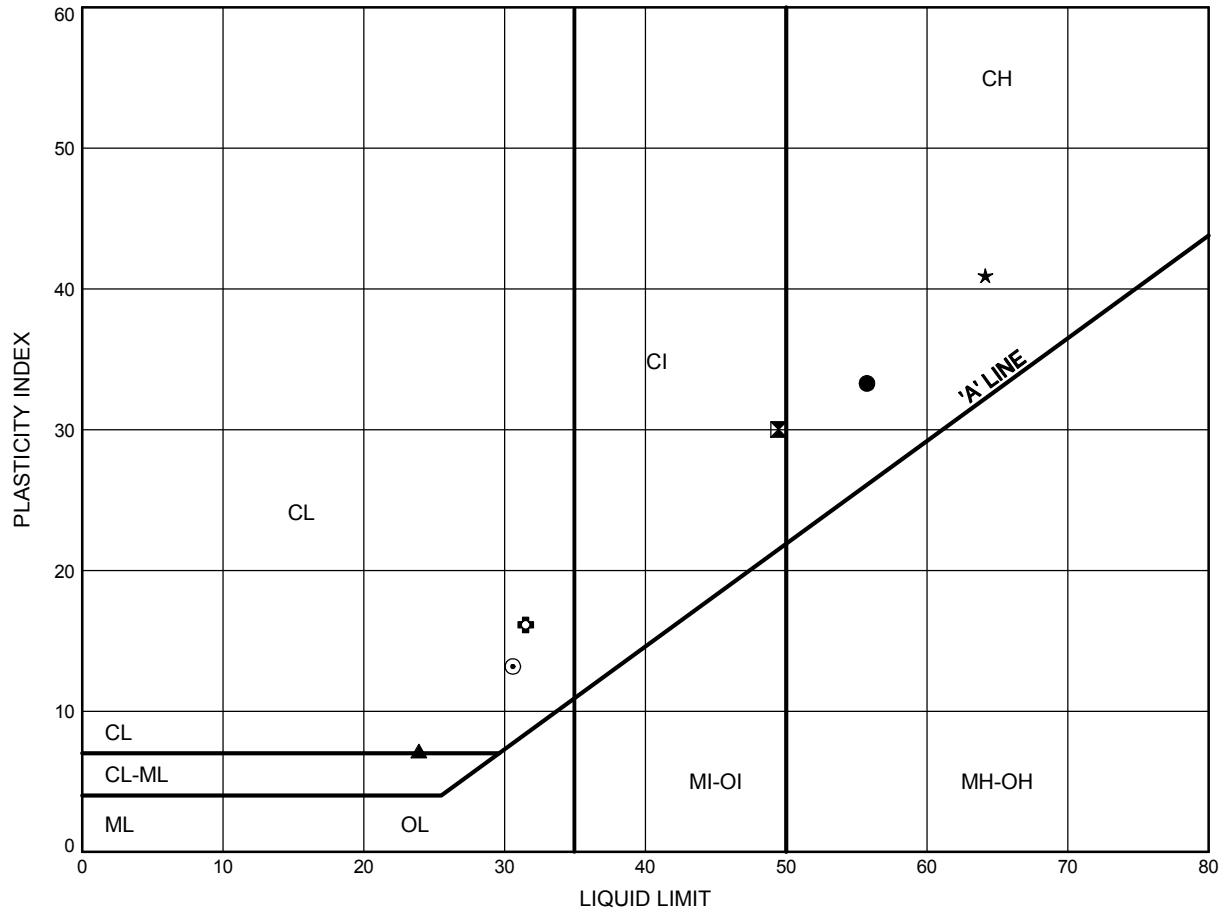
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

ATTERBERG LIMITS TEST RESULTS

FIGURE H6

Silty Clay



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C231-1	2.59	190.81
⊠	C231-2	8.53	186.47
▲	C231-3	3.35	189.95
★	BH45-03L	1.83	190.87
⊙	BH45-04	1.07	191.53
✿	BH45-04	3.20	189.40

Date August 2014

GWP# 5294-08-00

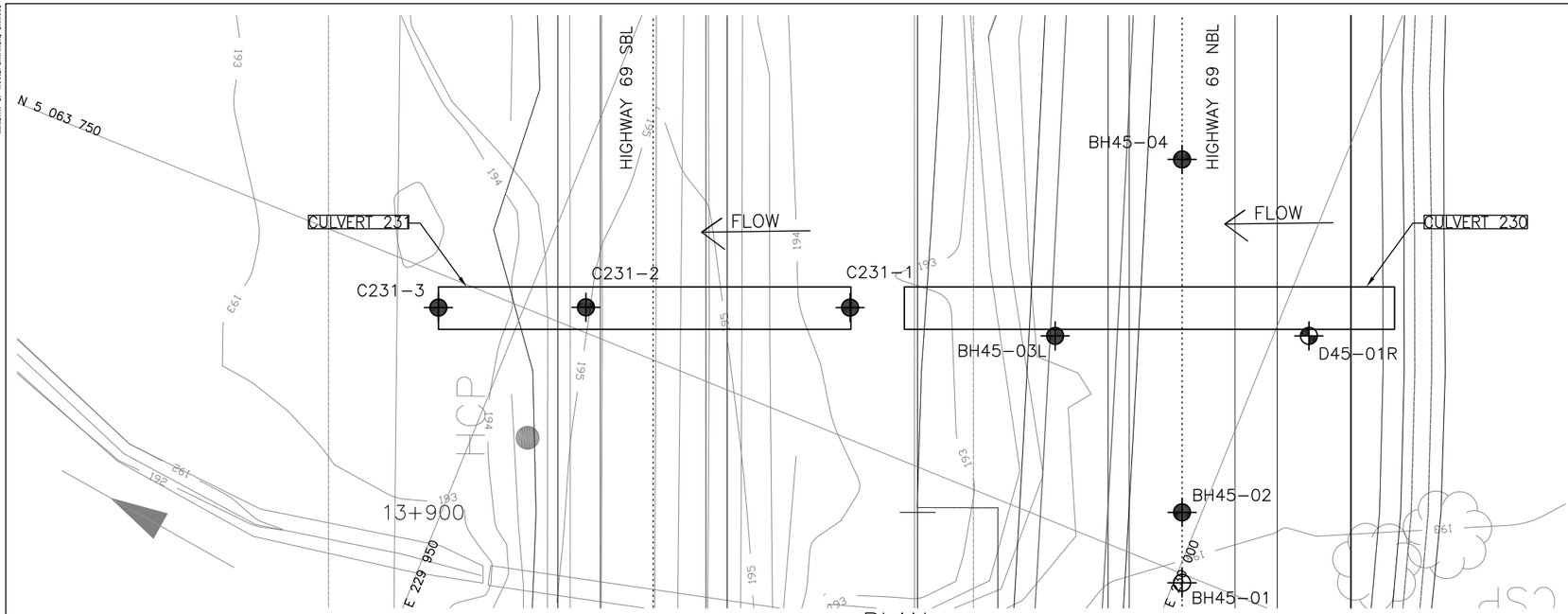
THURBER

Prep'd MFA

Chkd. MRA

THURBALT 6121(CULVERTS).GPJ 8/20/14

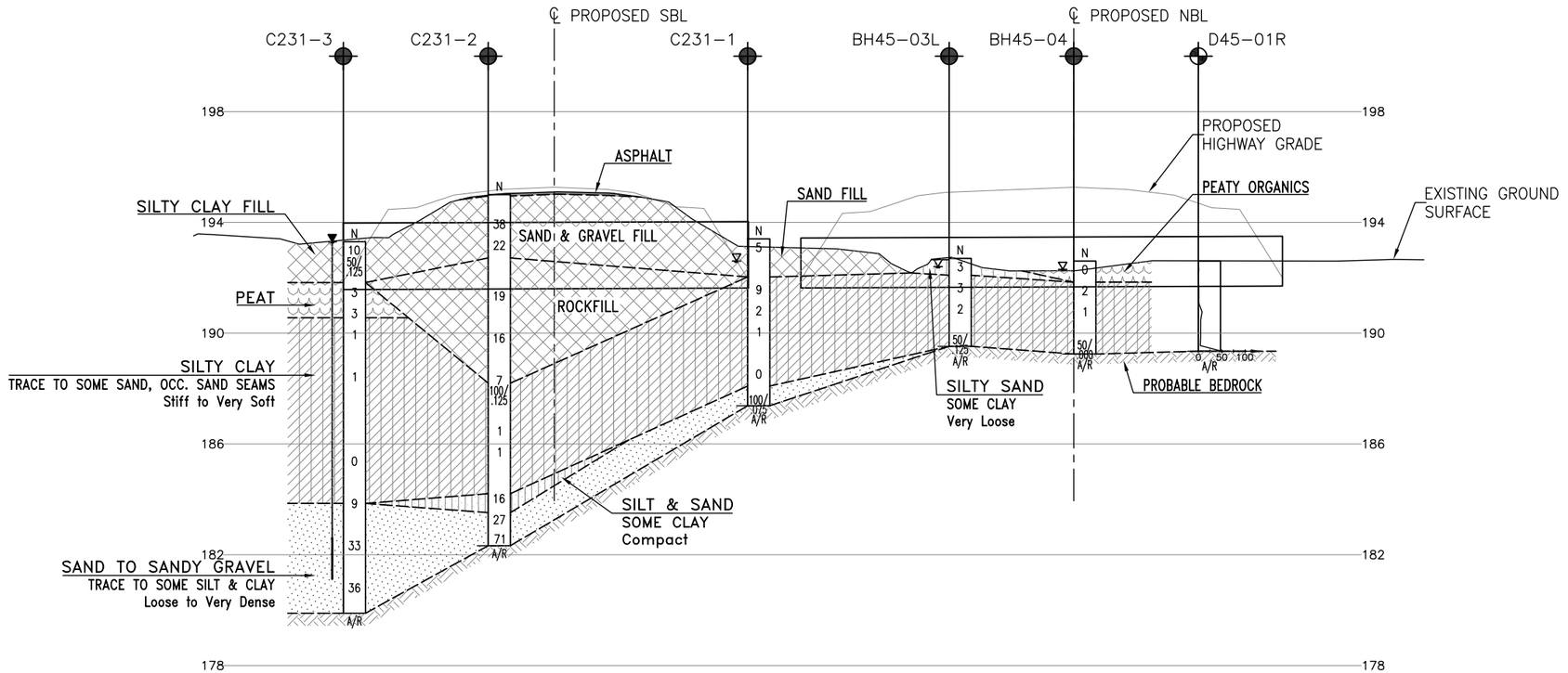
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

8 0 8 16m

SCALE 1:400



CULVERT 230 AND 231

8 0 8 16m H 1:400

4 0 4 8m V 1:200

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Aug 21/14
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Aug 21/14
PROVINCE OF ONTARIO

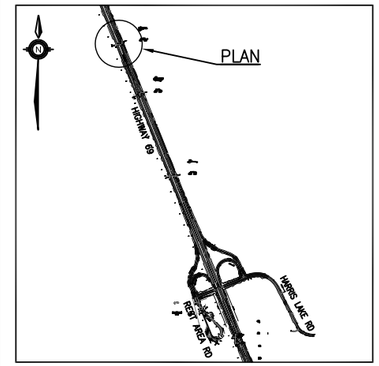
CONT No
WP No 5134-12-18/19

HIGHWAY 69 FOUR-LANING
NORTH SECTION
CULVERT 230 AND 231
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MMM GROUP

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⊕/⊕	Culvert Report Borehole / Cone
⊕/⊕	Other Borehole / Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
⧩	Water Level During Drilling
⧩	Water Level in Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BH45-01	193.1	5 063 749.4	230 000.6
BH45-02	192.8	5 063 754.0	229 998.7
BH45-03L	192.7	5 063 762.3	229 985.7
BH45-04	192.6	5 063 777.2	229 989.3
C231-1	193.4	5 063 758.7	229 971.4
C231-2	195.0	5 063 751.7	229 954.1
C231-3	193.3	5 063 747.7	229 944.4
D45-01R	192.6	5 063 769.0	230 002.4

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 41H-129

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	LRB	CHK	MRA	CODE		LOAD	DATE AUG. 2014
DRAWN	MFA	CHK	LRB	SITE 44-610/C1&C2		STRUCT	DWG 1

FILENAME: H:\Drafting\13\5161\21\ted6121-Plan&Sections(Culverts).dwg
PLOTDATE: 9/22/2014 8:32 AM

Appendix I

Culvert 234 (Station 14+507 NBL)
and
Culvert 235 (Station 14+515 SBL)
Boreholes BH47-04/05R/06 and C235-1 to 3
DCPT D47-02L

Record of Borehole Sheets
Laboratory Test Results
Borehole Locations and Soil Strata Drawings

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C235-1 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 064 313.0 E 229 750.4 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2012.05.24 - 2012.05.24 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.8	**Ground Surface**										
0.0	**PEAT**, black										
0.2	Wet (200mm)		1	SS	1						
	SAND, trace to some silt		2	SS	100/						
194.0	Very Loose						194				
0.8	Brown Wet				0.150						
	END OF BOREHOLE AT 0.8m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH CUTTINGS TO SURFACE. TIRED THREE DIFFERENT LOCATIONS WITH PROBE ROD - REFUSAL AT 0.8m TO 1.0m.										

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

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

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C235-2 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 064 309.6 E 229 731.4 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers/NW/NQ COMPILED BY AN
DATUM Geodetic DATE 2012.07.05 - 2012.07.05 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.9	**Ground Surface**										
0.0	**ASPHALT:** (50mm)										
0.0	**SAND**, some gravel Dark Brown Damp (FILL)		1	GS					○		
196.2											
0.7	**ROCK FILL**		1	RUN			196				RUN #2 TCR=88%
195.0							195				
1.9	**BEDROCK**, granitic gneiss, reddish grey		2	RUN			194				
193.7											
3.2	END OF BOREHOLE AT 3.2m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.3m, CUTTINGS TO 0.15m, THEN ASPHALT TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C235-3 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 064 308.7 E 229 718.4 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2012.05.24 - 2012.05.24 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.8	**Ground Surface**										
0.0 194.5	**PEAT**, with sand Black		1	SS	100/ 0.150						
0.3	END OF BOREHOLE AT 0.3m UPON AUGER REFUSAL ON PROBABLE BEDROCK. MOVED 1.5m SOUTH - REFUSAL AT 0.8m.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH47-04 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 14+490 C/L, NBL ORIGINATED BY WB
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2008.09.10 - 2008.09.10 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.8	**Ground Surface**										
0.0 / 0.0	**ORGANICS:** (50mm) Brown Wet		1	SS	1				579		
	Silty **CLAY**, trace sand, occasional peaty organics Very Stiff Brown		2	SS	24		194				0 4 28 68
			3	SS	29		193				
192.2			4	SS	8						
2.6	**SAND**, trace silt, trace clay Loose Grey Moist						192				0 88 12 (SI+CL)
190.5							191				
4.3 / 190.2	**SAND** and **GRAVEL** Grey		5	SS	50/						
4.6	END OF BOREHOLE AT 4.6m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT SURFACE UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH GROUT AND HOLEPLUG TO SURFACE.				.150						

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

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

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH47-05R 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 14+502.5 O/S 7.2R, NBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.09.11 - 2008.09.11 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.7	**Ground Surface**										
0.0	**ORGANICS**, peaty Very Soft to Soft Brown Wet		1	SS	2						
193.8	A layer of grey sandy silt (200mm)						194				
0.9	Silty **CLAY**, trace sand Very Soft to Soft Grey		2	SS	3						
			3	SS	1		193				0 1 47 52
191.5							192				
3.2	END OF BOREHOLE AT 3.2m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT SURFACE UPON COMPLETION OF DRILLING. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
Sep 24/08	Ground Surface	
Oct 29/08	0.3	194.4
Jan 16/09	Frozen at Surface	
Feb 19/09	0.2	194.5
Apr 21/09	Ground Surface	
Jun 05/09	Ground Surface	
Aug 17/09	Ground Surface	
Aug 25/09	Ground Surface	
Oct 27/09	Ground Surface	
Nov 20/09	Ground Surface	

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH47-06 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 14+515 C/L, NBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.09.11 - 2008.09.11 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.9	**Ground Surface**										
0.0	Silty **CLAY**, trace sand, oxidized staining Soft to Firm Grey		1	SS	1				○		
	Occasional peaty organics		2	SS	6		194		○		0 7 53 40
193.2			3	SS	52/				○		
1.7	END OF BOREHOLE (SAMPLER BOUNCING) AT 1.7m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT SURFACE UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WIH AUGER CUTTINGS AND HOLEPLUG TO SURFACE.				.200						

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

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No D47-02L 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 14+502.5 O/S 7.2L, NBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test (DCPT) COMPILED BY AN

DATUM Geodetic DATE 2008.09.10 - 2008.09.10 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
194.7	**Ground Surface**										
0.0	Auger to 1.5m. DCPT starts from 1.5m.						194				
193.0							193				
1.7	END OF DCPT AT 1.7m UPON REFUSAL ON PROBABLE BEDROCK.										

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

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

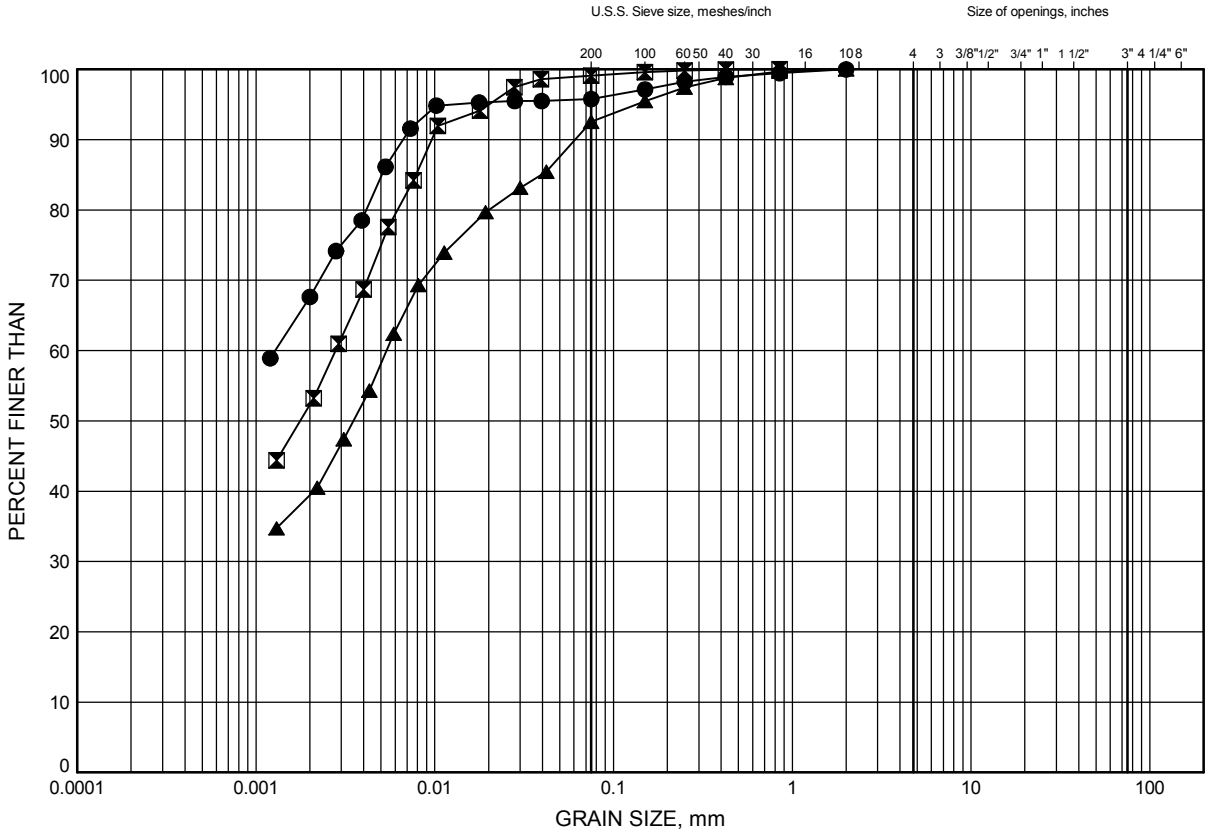
ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE I1

Silty Clay



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH47-04	1.07	193.73
⊠	BH47-05R	2.59	192.11
▲	BH47-06	1.07	193.83

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

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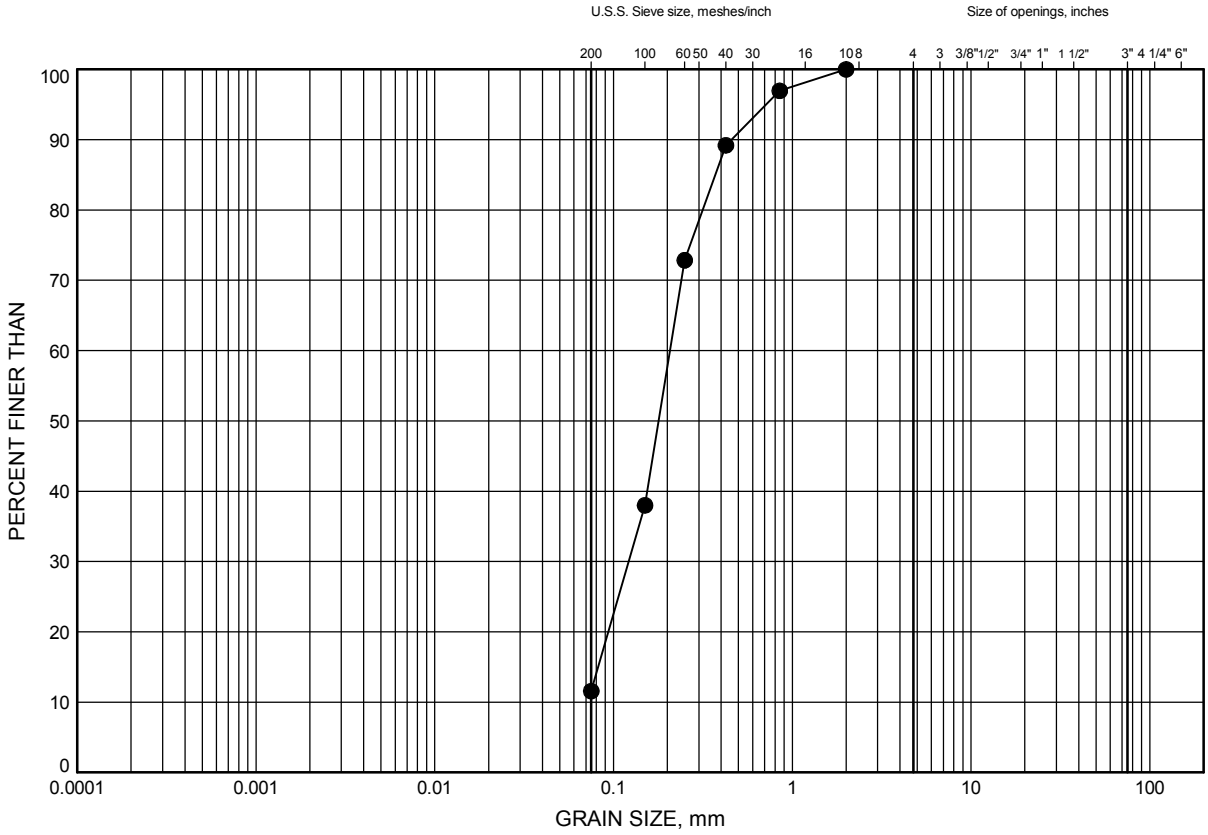
GRAIN SIZE DISTRIBUTION - THURBER 6121.GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE I2

Sand



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH47-04	2.74	192.06

Date August 2014

GWP# 5294-08-00

THURBER

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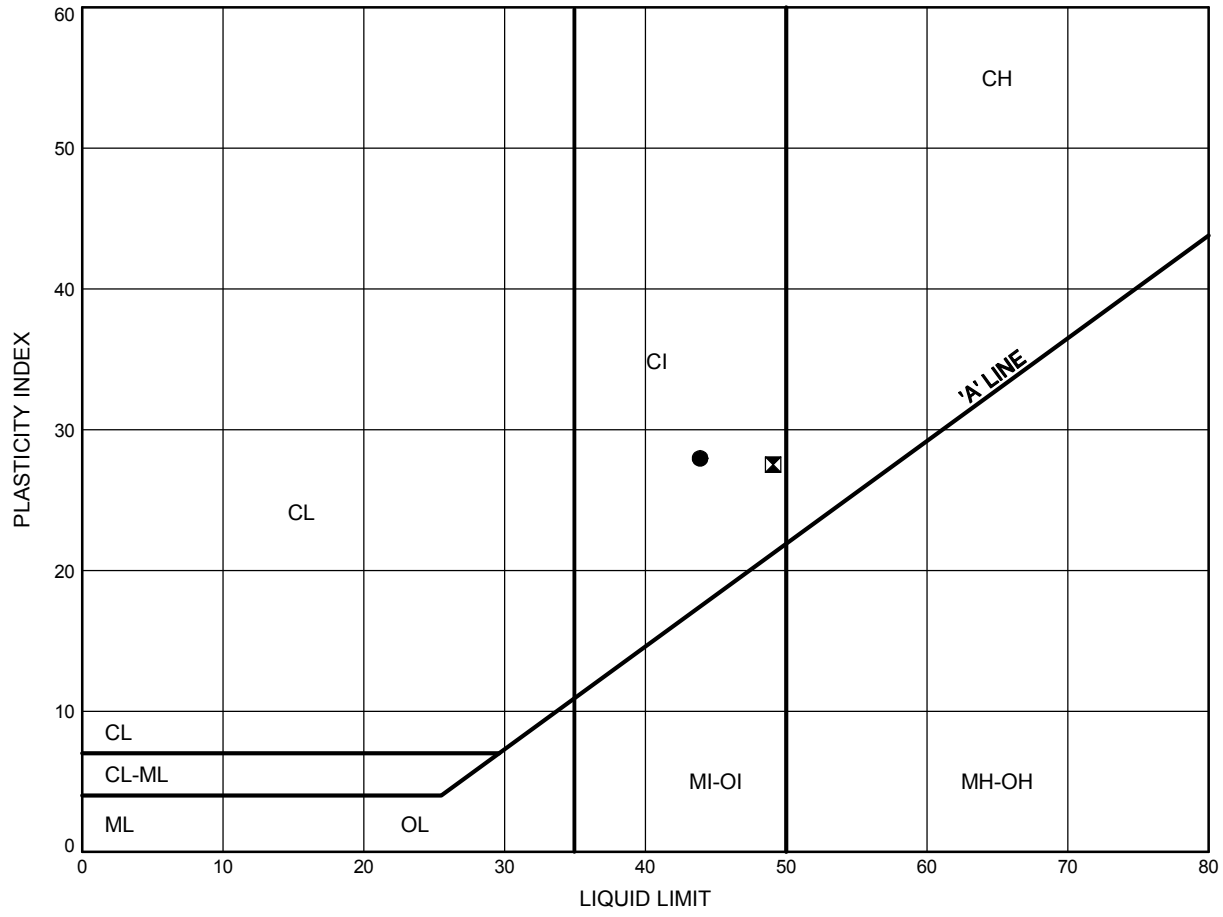
GRAIN SIZE DISTRIBUTION - THURBER 6121.GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

ATTERBERG LIMITS TEST RESULTS

FIGURE I3

Silty Clay



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH47-05R	2.59	192.11
⊠	BH47-06	1.07	193.83

Date August 2014

GWP# 5294-08-00

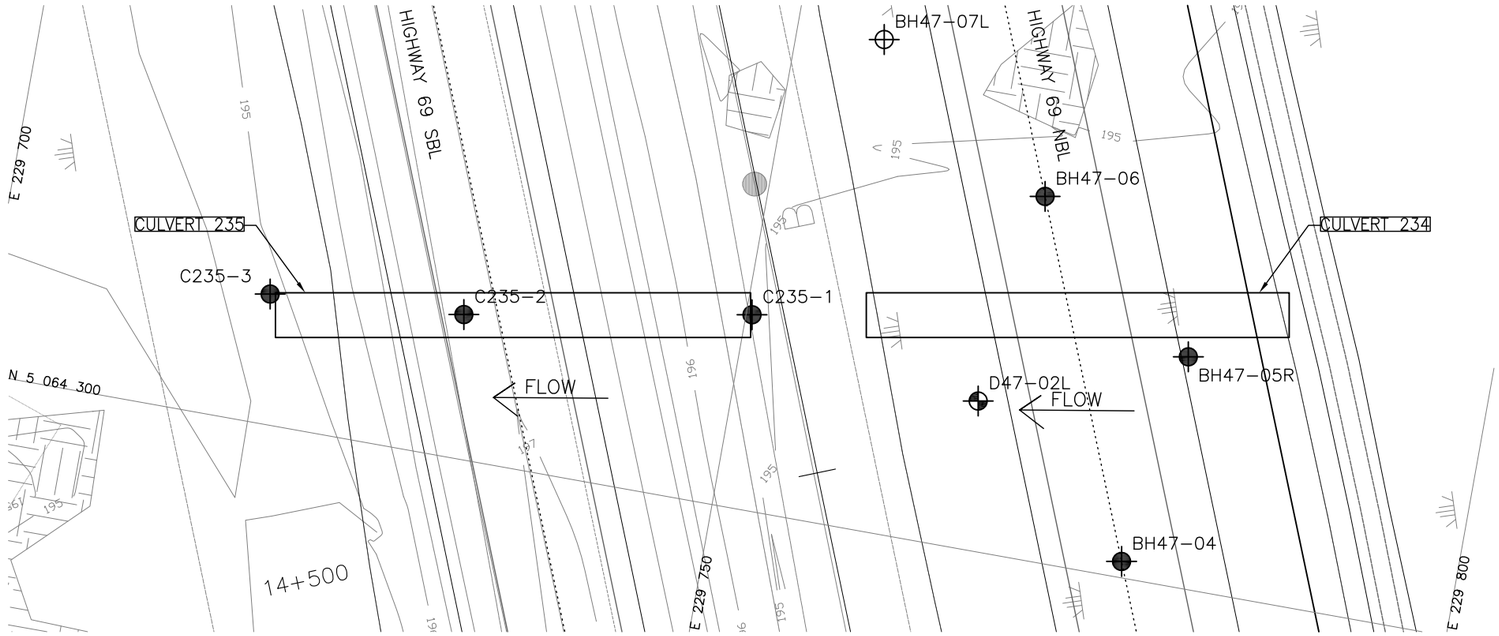
THURBER

Prep'd MFA

Chkd. MRA

THURBALT 6121.GPJ 8/20/14

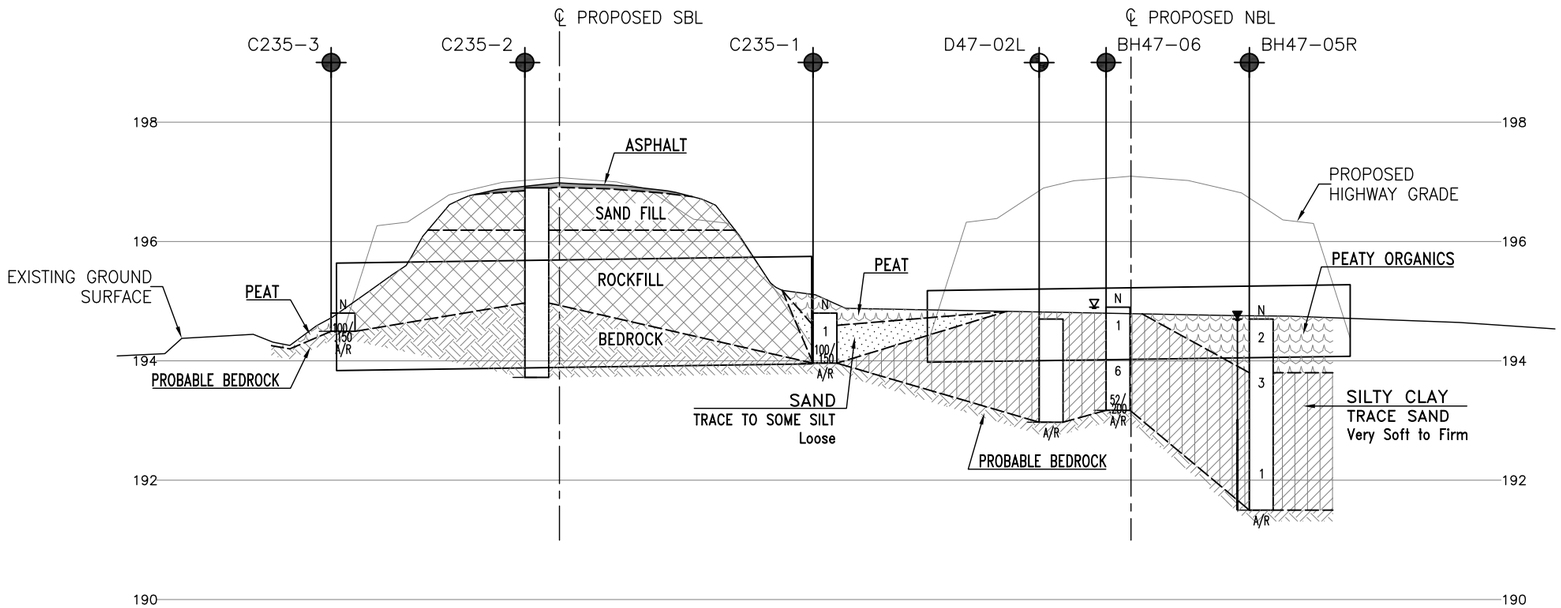
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

8 0 8 16m

SCALE 1:400



CULVERT 234 AND 235

8 0 8 16m H 1:400

2 0 2 4m V 1:100

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Aug 21/14
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Aug 21/14
PROVINCE OF ONTARIO

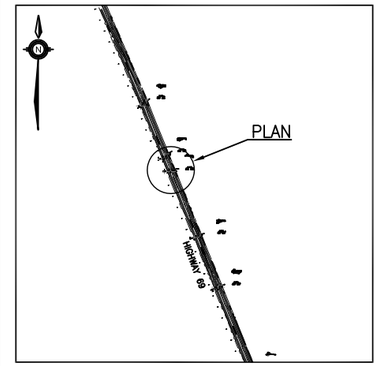
CONT No
WP No 5134-12-20/21

HIGHWAY 69 FOUR-LANING
NORTH SECTION
CULVERT 234 AND 235
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MMM GROUP

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⊕ / ⊕	Culvert Report Borehole / Cone
⊕ / ⊕	Other Borehole / Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level During Drilling
▼	Water Level in Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BH47-04	194.8	5 064 301.1	229 777.7
BH47-05R	194.7	5 064 315.4	229 779.7
BH47-06	194.9	5 064 324.3	229 768.3
BH47-07L	195.1	5 064 332.7	229 755.9
C235-1	194.8	5 064 313.0	229 750.4
C235-2	196.9	5 064 309.6	229 731.4
C235-3	194.8	5 064 308.7	229 718.4
D47-02L	194.7	5 064 310.0	229 766.3

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 41H-129

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	LRB	CHK	MRA	CODE		LOAD	DATE AUG. 2014
DRAWN	MFA	CHK	LRB	SITE	44-611/C1&C2	STRUCT	DWG 1

FILENAME: H:\Drafting\13\5161\21\ted6121-Plan&Sections(Culverts).dwg
PLOTDATE: 9/22/2014 8:33 AM

Appendix J

Culvert 236 (Station 14+644 NBL)
and
Culvert 237 (Station 14+636 SBL)
Boreholes BH47A-01/02L/03 and C237-1 to 3
DCPT C236-D1

Record of Borehole Sheets
Laboratory Test Results
Borehole Locations and Soil Strata Drawings

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C237-1 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 064 432.1 E 229 704.5 ORIGINATED BY SLL
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.05.23 - 2012.05.23 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.9	**Ground Surface**										
0.0 194.5	**PEAT**, with sand Black		1	SS	5		194		○		
0.4	**SAND**, topsoil stained Loose Brown Moist		2	SS	4	▽			○		
193.6							193		○		
1.3	Silty **CLAY**, mottled Stiff Brown		3	SS	8				○		
192.7							192		○		14 53 33 (SI+CL)
2.2	Silty **SAND**, trace to some gravel, occasional cobbles Compact to Loose Grey Wet		4	SS	27				○		
			5	SS	5		191		○		
			6	SS	15		190		○		
189.6											
5.3	END OF BOREHOLE AT 5.3m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN TO 1.2m AND WATER LEVEL AT 1.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.3m, THEN CUTTINGS TO SURFACE.										

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

$15 \oplus^{20}_{10} 5$ (%) STRAIN AT FAILURE

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C237-2 1 OF 2 METRIC

GWP# 5294-08-00 LOCATION N 5 064 421.6 E 229 686.5 ORIGINATED BY ES

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2012.07.05 - 2012.07.05 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.7	**Ground Surface**										
0.0	**ASPHALT:** (50mm)										
0.0	**SAND**, some gravel Dark Brown Damp		1	GS							
196.0	(FILL)										
0.7	**SAND**, fine grained Compact Brown Damp		1	SS	10		196				
195.2	(FILL)										
1.5	**SILT** and **SAND**, trace clay Compact Grey Moist		2	SS	23		195				0 58 40 2
194.1			3	SS	4						0 6 46 48
2.6	Silty **CLAY**, trace sand, occasional oxide staining Firm Grey						194				
193.7											
3.0	**SAND**, fine grained Compact Grey		4	SS	18		193				
192.9	Wet										
3.8	**SAND**, trace to some gravel, trace silt and clay Loose to Compact Brown Wet		5	SS	10		192				
			6	SS	6		191				
			7	SS	8		190				
			8	SS	18		189				7 88 5 (SI+CL)
			9	SS	11		188				
							187				

Continued Next Page

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

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

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C237-2 2 OF 2 METRIC

GWP# 5294-08-00 LOCATION N 5 064 421.6 E 229 686.5 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.07.05 - 2012.07.05 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	SAND, trace gravel, occasional cobbles Dense Grey Moist						186		○		
			10	SS	32						
184.7							185				
12.0	END OF BOREHOLE AT 12.0m UPON REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 3.0m, CUTTINGS AND HOLEPLUG TO 0.15m, THEN ASPHALT TO SURFACE.		11	SS	100/ 0.0						

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
$\frac{}{10}$

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C237-3 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 064 414.4 E 229 675.9 ORIGINATED BY SLL
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.05.24 - 2012.05.24 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.3	**Ground Surface**										
0.0	**PEAT** Black (200mm)		1	SS	2		194				
193.9 0.4	**SAND**, with roots Very Loose Dark Brown Wet		2	SS	15		193				0 6 49 45
192.8 1.5	Silty **CLAY**, topsoil stained, trace sand seams Soft to Stiff Brown		3	SS	14		192				
	SAND, trace gravel, trace silt Compact Grey Wet		4	SS	15						
			5	SS	19		191				2 93 5 (SI+CL)
			6	SS	11		190				
							189				
			7	SS	12		188				
186.9							187				
7.4	END OF BOREHOLE AT 7.4m UPON AUGER REFUSAL ON PROBABLE BEDROCK. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
Jun.05/12	0.3	194.0
Jun.21/12	0.3	194.0
Jul.05/12	0.4	193.9

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

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

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH47A-01 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 14+625 C/L, NBL ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Portable Split Spoon Sampling Equipment COMPILED BY AN

DATUM Geodetic DATE 2010.12.01 - 2010.12.01 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
195.4	**Ground Surface**										
0.0	**ORGANICS**, fibrous										
0.2	Silty **SAND**, trace clay Loose Brown		1	SS	5		195				
194.8											
0.6	Moist Silty **CLAY**, trace sand Very Stiff to Hard Brown		2	SS	22						0 2 46 52
			3	SS	33		194				
193.6											
1.8	END OF BOREHOLE (SAMPLER BOUNCING) AT 1.8m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.										

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

$\frac{20}{15 \quad 5}$ (%) STRAIN AT FAILURE
$\frac{10}{}$

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH47A-02L 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 14+637.5 O/S 11.0L, NBL ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Portable Split Spoon Sampling Equipment COMPILED BY AN

DATUM Geodetic DATE 2010.12.01 - 2010.12.01 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
195.1	**Ground Surface**										
0.0 194.5	**ORGANICS**, fibrous, with sand Soft		1	SS	2	▽	195				
0.6 194.0	**SAND**, some silt to silty, some clay		2	SS	7						0 61 28 11
1.1 193.3	Silty **CLAY**, trace sand seams Very Stiff Brown		3	SS	19		194				0 10 42 48
1.8 193.0	**SAND**, some silt to silty		4	SS	17		193				
2.1 192.7	Silty **CLAY**, trace sand seams Very Stiff Brown										
2.4	END OF BOREHOLE AT 2.4m DUE TO CAVE. BOREHOLE OPEN TO 1.8m AND WATER LEVEL AT 0.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.										

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

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH47A-03 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 14+650 C/L, NBL ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Portable Split Spoon Sampling Equipment COMPILED BY AN

DATUM Geodetic DATE 2010.12.01 - 2010.12.01 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
195.1	**Ground Surface**										
0.0	**ORGANICS**, fibrous: (100mm)						195				
0.1	**SAND**, trace silt Very Loose Brown Wet		1	SS	1						
194.5											
0.6	Silty **CLAY**, with some wet sand seams Firm Brown		2	SS	6	▽	194				0 18 46 36
193.9											
1.2	**SAND**, some silt Compact Brown Wet		3	SS	16						4 79 14 3
193.6											
1.5	Silty **CLAY**, with sand seams Very Stiff to Firm Brown		4	SS	7		193				
192.7											
2.4	END OF BOREHOLE AT 2.4m DUE TO CAVE. BOREHOLE OPEN TO 1.3m AND WATER LEVEL AT 1.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C236-D1 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 064 451.2 E 229 731.8 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2012.05.23 - 2012.05.23 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
195.1	**Ground Surface**							20 40 60 80 100	20 40 60		
0.0	Start DCPT from surface						195				
							194				
							193				
							192				
							191				
190.0											
5.1	END OF DCPT AT 5.1m UPON REFUSAL ON PROBABLE BEDROCK. HOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

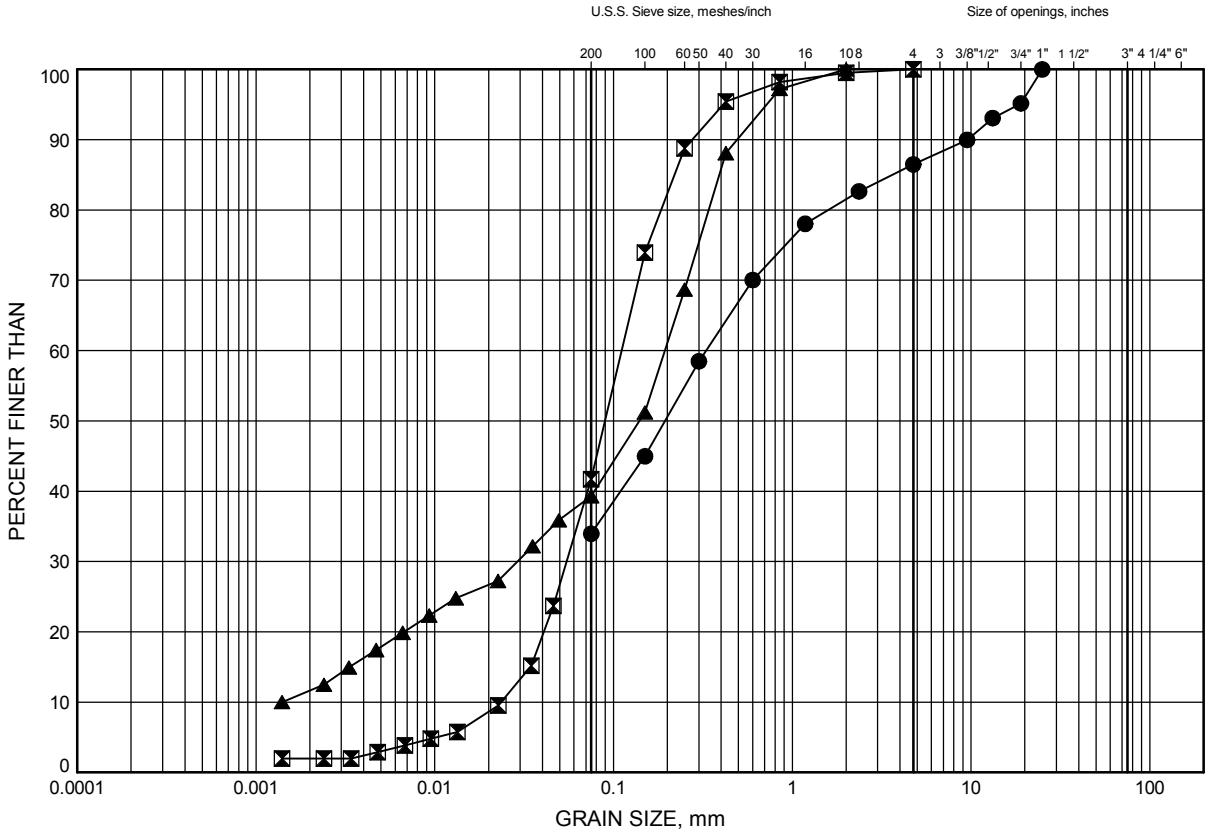
ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE J1

Silt and Sand to Silty Sand



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C237-1	2.59	192.31
⊠	C237-2	1.83	194.87
▲	BH47A-02L	0.91	194.19

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

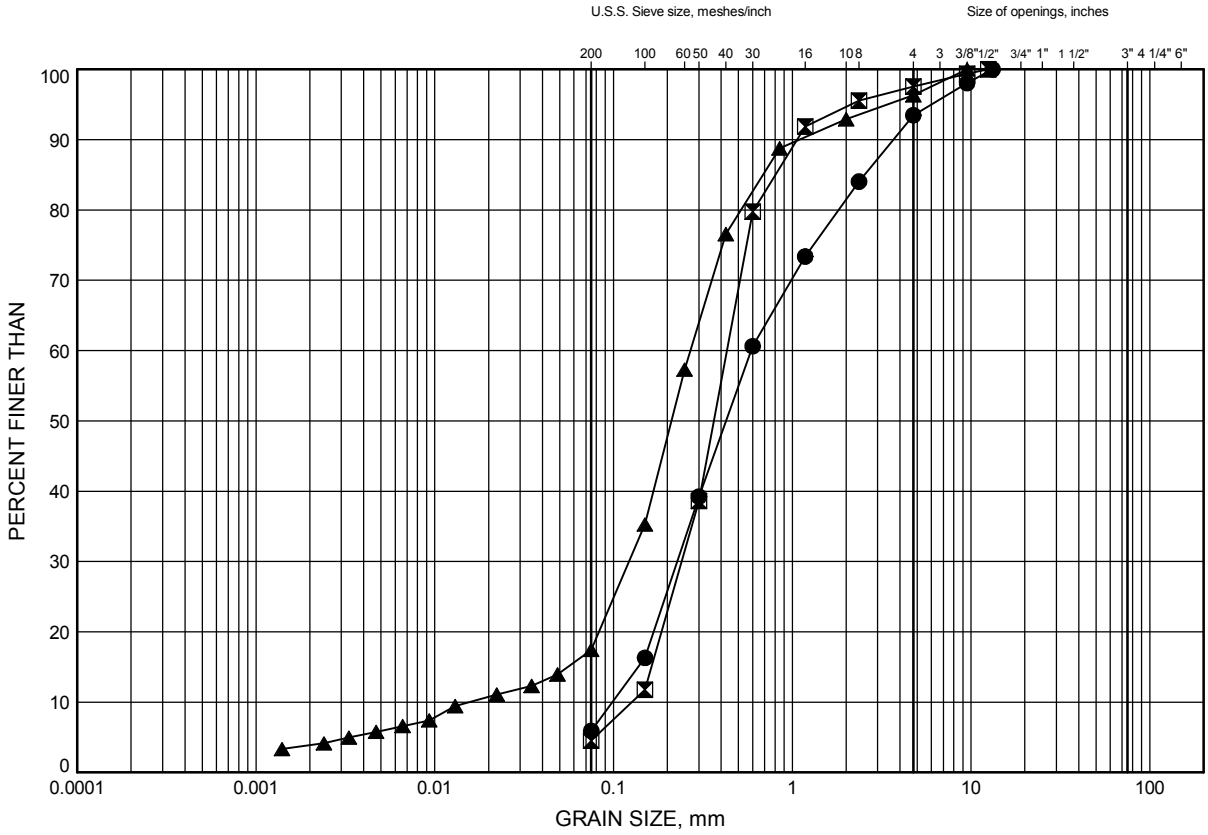
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE J2

Sand



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C237-2	7.92	188.78
⊠	C237-3	3.35	190.95
▲	BH47A-03	1.37	193.73

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

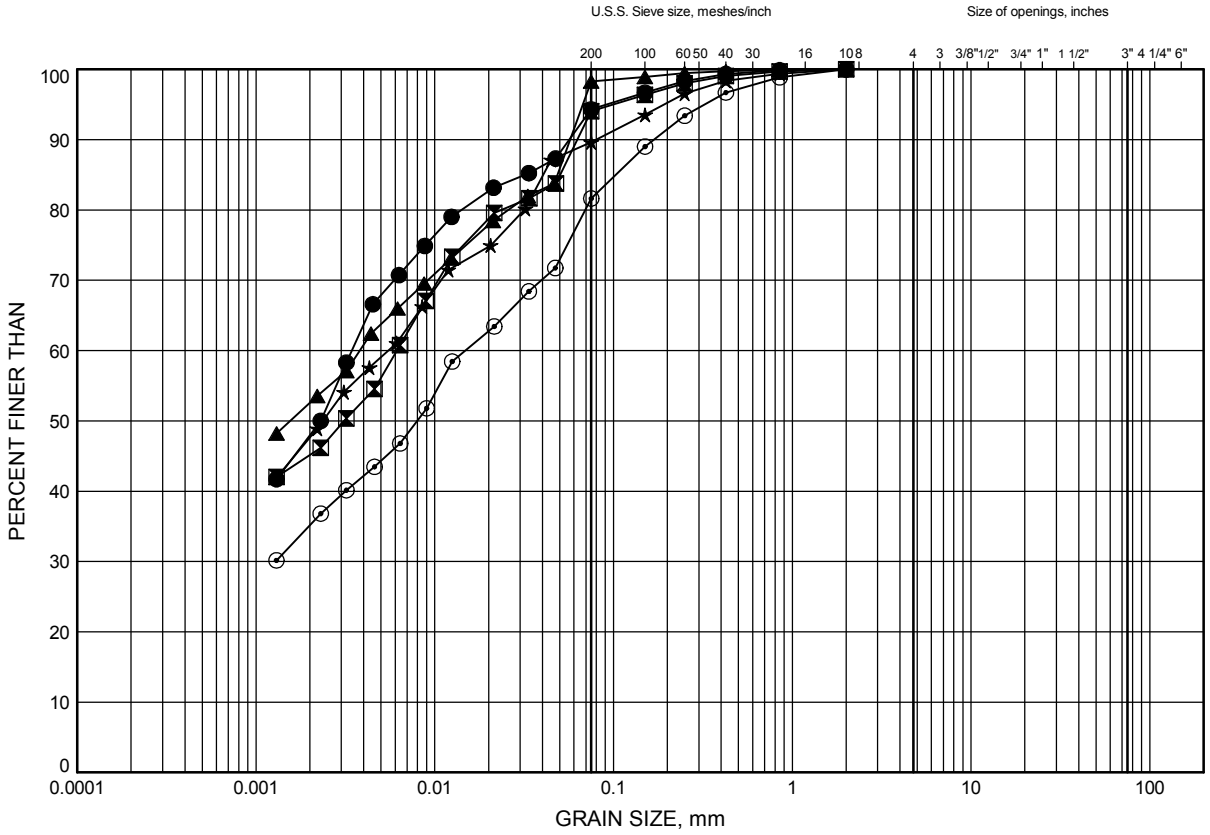
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE J3

Silty Clay



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C237-2	2.59	194.11
⊠	C237-3	1.07	193.23
▲	BH47A-01	0.91	194.49
★	BH47A-02L	1.52	193.58
⊙	BH47A-03	0.91	194.19

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

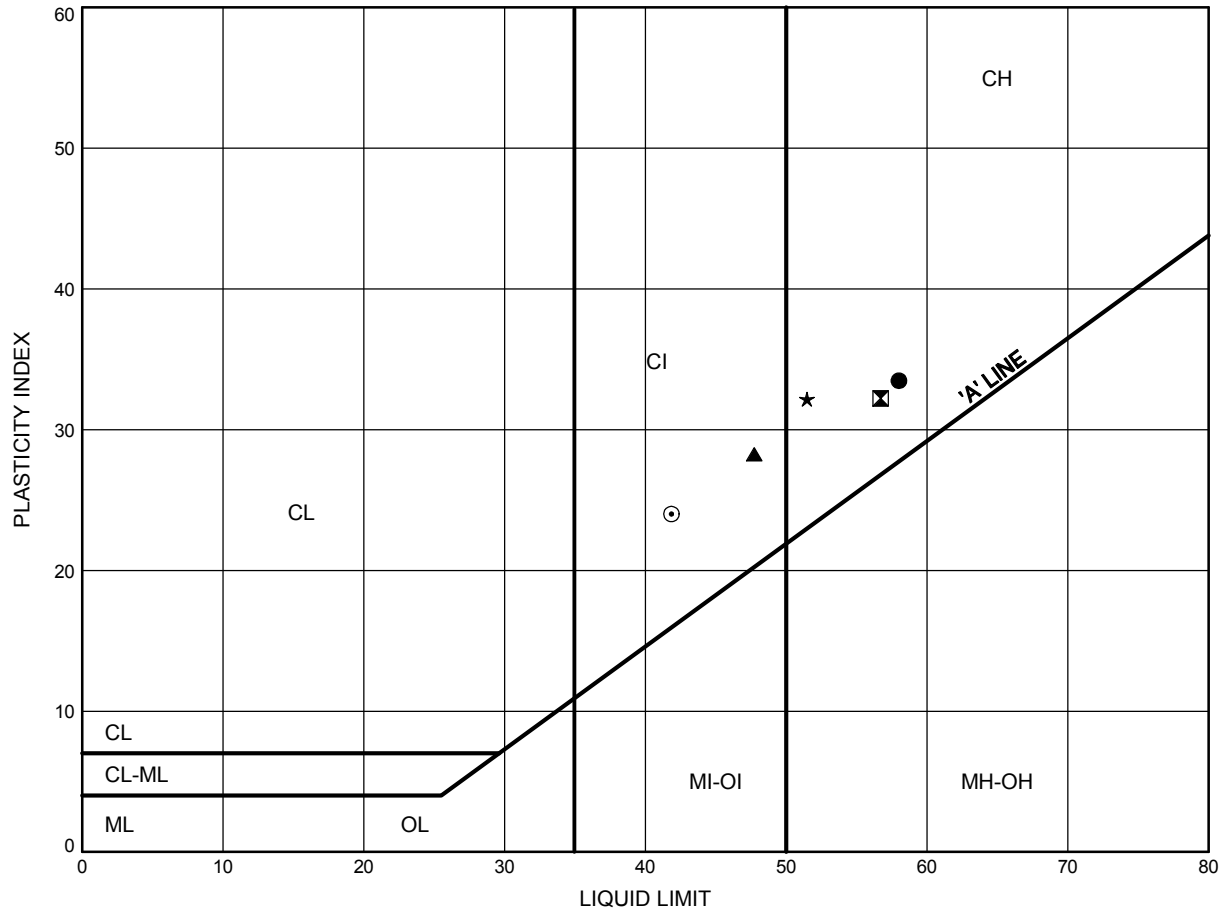
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

ATTERBERG LIMITS TEST RESULTS

FIGURE J4

Silty Clay



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C237-2	2.59	194.11
⊠	C237-3	1.07	193.23
▲	BH47A-01	0.91	194.49
★	BH47A-02L	1.52	193.58
⊙	BH47A-03	0.91	194.19

Date August 2014

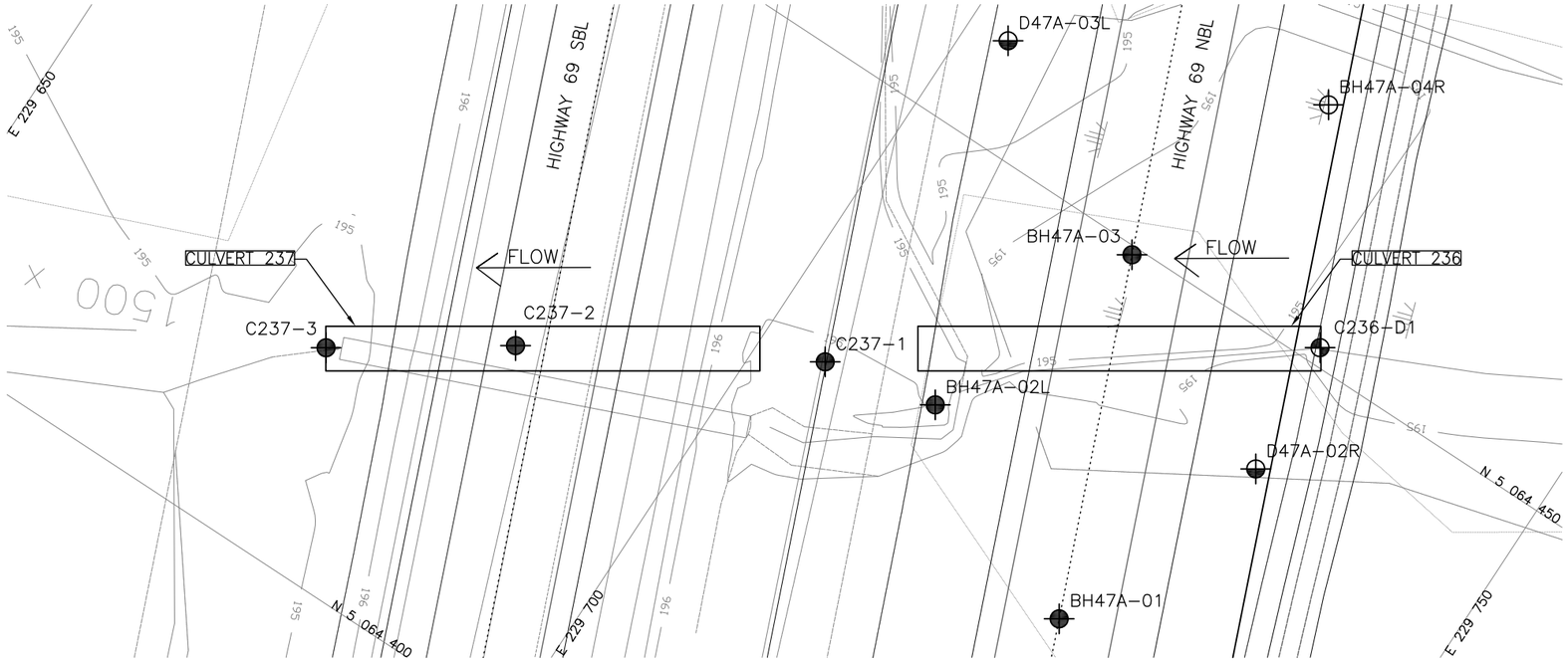
GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

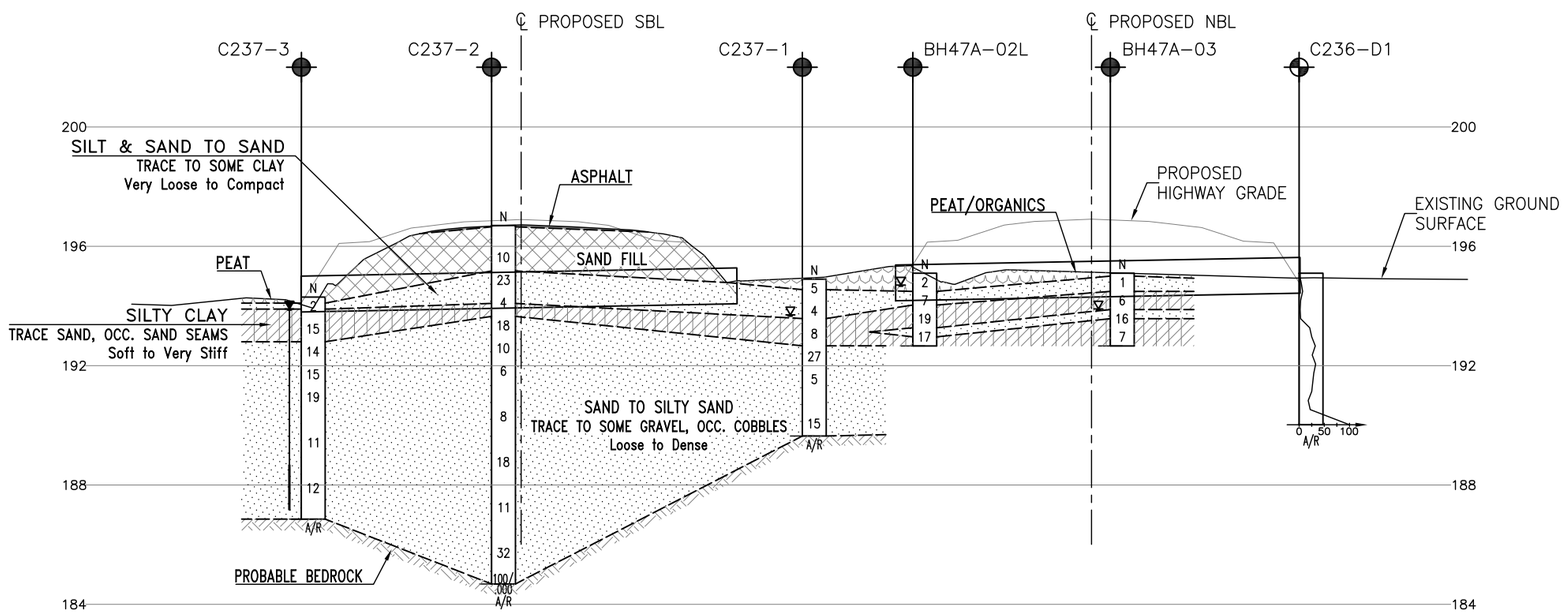
THURBALT 6121(CULVERTS).GPJ 8/20/14



PLAN

8 0 8 16m

SCALE 1:400



CULVERT 236 AND 237

8 0 8 16m H 1:400

4 0 4 8m V 1:200

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Aug 21/14
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Aug 21/14
PROVINCE OF ONTARIO

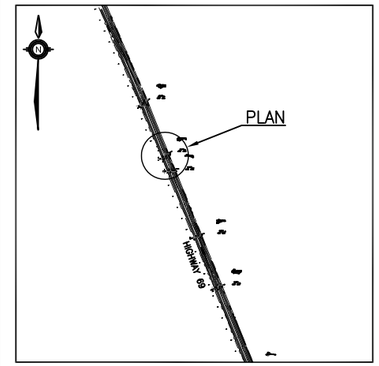
CONT No
WP No 5134-12-22/23

HIGHWAY 69 FOUR-LANING
NORTH SECTION
CULVERT 236 AND 237
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MMM GROUP

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⊕ / ⊕	Culvert Report Borehole / Cone
⊕ / ⊕	Other Borehole / Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
⧗	Water Level During Drilling
⧗	Water Level in Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BH47A-01	195.4	5 064 426.3	229 727.1
BH47A-02L	195.1	5 064 433.7	229 712.3
BH47A-03	195.1	5 064 449.4	229 717.8
BH47A-04R	195.1	5 064 465.2	229 723.3
C236-D1	195.1	5 064 451.2	229 731.8
C237-1	194.9	5 064 432.1	229 704.5
C237-2	196.7	5 064 421.6	229 686.5
C237-3	194.3	5 064 414.4	229 675.9
D47A-02R	195.1	5 064 442.0	229 732.7
D47A-03L	195.1	5 064 456.9	229 702.9

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 41H-129

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	LRB	CHK	MRA	CODE	LOAD
DRAWN	MFA	CHK	LRB	SITE 44-612/C1&C2	STRUCT

DATE AUG. 2014
DWG 1

FILENAME: H:\Drafting\13\5161\V21\ted6121-Plan&Sections(Culverts).dwg
PLOTDATE: 9/22/2014 9:54 AM

Appendix K

Culvert 238 (Station 15+118 NBL)
and
Culvert 239 (Station 15+107 SBL)
Boreholes C238-1 and BH48-02/03L/04 and C239-1 & 2 and BH49-02L/03/04R
DCPT D49-02L

Record of Borehole Sheets
Laboratory Test Results
Borehole Locations and Soil Strata Drawings

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C238-1 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION N 5 064 890.8 E 229 553.3 ORIGINATED BY SLL
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.05.23 - 2012.05.23 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
191.8	**Ground Surface**										
0.0	**PEAT:** (200mm)										
0.2	**SAND**, trace roots and rootlets Very Loose Dark Brown Moist to Wet		1	SS	4	▽	191				
			2	SS	2						
190.4											
1.4	Silty **CLAY** Very Soft to Soft Brown to Grey		3	SS	2		190				
			4	SS	3		189				0 0 48 52
			5	SS	0						
187.9							188	3.0			
3.9	**SAND**, trace gravel, trace silt Very Loose to Compact Grey Wet		6	SS	0		187				1 96 3 (SI+CL)
			7	SS	18		186				
184.5							185				
7.3	END OF BOREHOLE AT 7.3m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN TO 2.9m AND WATER LEVEL AT 0.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.9m, THEN CUTTINGS TO SURFACE.										

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

$\overset{20}{15\oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C239-1 1 OF 2 METRIC

GWP# 5294-08-00 LOCATION N 5 064 870.4 E 229 525.3 ORIGINATED BY SLL
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.05.23 - 2012.05.23 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.2	**Ground Surface**										
0.0	**PEAT** Black Wet		1	SS	1		192				
190.9			2	SS	2		191				
1.3	**SAND**, trace silt Very Loose Brown		3	SS	3						
190.4	Wet						190				
1.8	Sandy **SILT**, some clay Very Loose to Loose Brown to Grey Moist		4	SS	5						0 34 50 16
189.2							189	3.0			
3.0	Silty **CLAY** Very Soft Grey		5	SS	1		188				
			6	SS	0		187	4.0			0 0 46 54
			1	TW			186				
							185	3.0			
			7	SS	1		184				
183.8											
8.4	**SAND**, trace to some gravel, trace silt Very Dense to Compact Grey Wet		8	SS	76		183				15 81 4 (SI+CL)

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C239-1 2 OF 2 METRIC

GWP# 5294-08-00 LOCATION N 5 064 870.4 E 229 525.3 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2012.05.23 - 2012.05.23 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	SAND, trace to some gravel, trace silt Very Dense to Compact Grey Wet						182				
			9	SS	12		181		o		
179.7	No recovery		10	SS	100/ 0.150		180				
12.5	END OF BOREHOLE AT 12.5m UPON AUGER REFUSAL ON PROBABLE BEDROCK. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun.05/12 0.5 191.7 Jun.21/12 0.5 191.7 Jul.05/12 0.6 191.6										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C239-2 1 OF 2 METRIC

GWP# 5294-08-00 LOCATION N 5 064 861.9 E 229 519.7 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.06.25 - 2012.06.25 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.0	**Ground Surface**							UNCONFINED ○ FIELD VANE + QUICK TRIAXIAL ● LAB VANE ×			
0.0	**ASPHALT:** (40mm)										
	SAND, some gravel, some silt, occasional cobbles Compact Brown (FILL)		1	GS							
192.6			1	SS	15		193				
1.4	**ROCK FILL**		1	RUN			192				
191.8											
2.2	**SAND**, some silt, trace gravel Compact Brown Wet		2	SS	14						
190.9							191				
3.1	Silty **CLAY**, some sand to sandy Soft to Very Soft Grey		3	SS	4						0 15 64 21
							190	2.0 2.0			
	Occasional sand layers		4	SS	1		189				
								2.0 2.0			
			5	SS	0		188				
							187	5.0 4.0			
			6	SS	0		186				
								5.0 3.0			
			7	SS	0		185				0 24 44 32

Continued Next Page

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

$\frac{20}{15}$ $\frac{5}{10}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C239-2 2 OF 2 METRIC

GWP# 5294-08-00 LOCATION N 5 064 861.9 E 229 519.7 ORIGINATED BY ES

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2012.06.25 - 2012.06.25 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 20 40 60 80 100: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
183.3								4.0			
10.7	**SAND**, some gravel Compact Grey Wet		8	SS	13		183				
182.2											
11.8	END OF BOREHOLE AT 11.8m UPON REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.9m, CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.										

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

$15 \overset{20}{\underset{10}{\oplus}} 5$ (%) STRAIN AT FAILURE

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH48-02 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 15+100 C/L, NBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.09.12 - 2008.09.12 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.2	**Ground Surface**										
0.0	Silty **SAND**, with organics Very Loose Brown Moist		1	SS	1		192		○		
191.5											
0.7	Silty **CLAY**, some sand Firm Grey		2	SS	6	▽	191		○		0 19 56 25
			3	SS	7				○		
	Very soft		4	SS	1		190		○		
			1	TW	PH		189				
	trace sand		5	SS	1		188		○		0 2 47 51
							187	+ 4.0			
			6	SS	1		186		○		
185.0											
7.2	END OF BOREHOLE AT 7.2m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT 1.5m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH GROUT AND HOLEPLUG TO SURFACE. DCPT CONDUCTED NEAR THE BOREHOLE. END OF DCPT AT 7.2m UPON REFUSAL ON PROBABLE BEDROCK.										

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

$15 \overset{20}{\oplus} 5$ $\overset{}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH48-03L 1 OF 2 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 15+112.5 O/S 9.4L, NBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.09.12 - 2008.09.12 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
191.9	**Ground Surface**										
0.0	Silty **SAND**, with peaty organics Very Loose Brown Moist		1	SS	0	▽					
190.8			2	SS	4		191				
1.1	Silty **CLAY**, trace to some sand, oxidized staining Very Soft to Soft Grey		3	SS	4		190				
			4	SS	1		189	5.0			0 2 49 49
			5	SS	0		188 187				
			6	SS	1		186 185				0 11 57 32
184.7											
7.2	**SAND**, trace clay, trace silt, trace gravel Very Loose Grey Moist		7	SS	4		184				9 88 3 (SI+CL)
182.8							183				
9.1	END OF BOREHOLE (SAMPLER BOUNCING) AT 9.1m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT 0.9m UPON COMPLETION OF DRILLING.										

Continued Next Page

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH48-03L 2 OF 2 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 15+112.5 O/S 9.4L, NBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.09.12 - 2008.09.12 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	BOREHOLE BACKFILLED WITH HOLEPLUG AND GROUT TO SURFACE. DCPT CONDUCTED NEAR THE BOREHOLE. END OF DCPT AT 9.1m UPON REFUSAL ON PROBABLE BEDROCK.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH48-04 1 OF 2 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 15+125 C/L, NBL ORIGINATED BY WB
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2008.09.12 - 2008.09.12 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
191.8	**Ground Surface**										
0.0 / 191.1	**PEAT**, fibrous (700mm) Dark Brown		1	SS	2		191				
0.7 / 189.4	Silty **SAND** with peaty organics Very Loose Brown Wet		2	SS	2						
			3	SS	1		190				
2.4 / 185.9	Silty **CLAY**, trace sand Very Soft Grey		4	SS	2			6.0			
			5	SS	0		189				
			6	SS	3		188				
5.9 / 184.1	**SAND**, trace silt, trace clay Very Loose Grey Wet		7	SS	2		187				0 98 2 (SI+CL)
			8	SS	52/.050		186				
7.7	END OF BOREHOLE (SAMPLER BOUNCING) AT 7.7m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT 0.15m UPON COMPLETION OF DRILLING. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.						185				

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
Oct 29/08	0.1	191.7
Jan 16/09	Frozen at Surface	
Feb 19/09	Frozen at Surface	
Apr 21/09	0.2	191.6

Continued Next Page

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

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

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH48-04 2 OF 2 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 15+125 C/L, NBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.09.12 - 2008.09.12 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Jun 05/09 Ground Surface Oct 27/09 0.3 191.5										

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

$\overset{20}{15\oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH49-02L 1 OF 2 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 15+087.5 O/S 12.5L, SBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LG

DATUM Geodetic DATE 2009.02.09 - 2009.02.09 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.1	**Ground Surface**										
0.0	Sandy **SILT**, some clay, trace gravel, occasional roots Compact to Loose Grey Moist to Wet		1	SS	21		192				
			2	SS	5		191				0 36 52 12
190.5											
1.6	Silty **CLAY**, trace sand Very Soft Grey		3	SS	0		190				
			4	SS	0						0 5 76 19
							189	4.0 +			
								6.0 +			
			5	SS	0		188				
								4.0 +			
187.1											
5.0	Sandy **SILT**, trace clay Very Loose Grey Wet		6	SS	2		187				0 38 55 7
185.5							186				
6.6	Silty **CLAY**, trace sand Very Soft Grey		7	SS	0		185				
			8	SS	0		184				0 31 49 20
							183				

Continued Next Page

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

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH49-02L 2 OF 2 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 15+087.5 O/S 12.5L, SBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LG

DATUM Geodetic DATE 2009.02.09 - 2009.02.09 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
181.6	Silty **CLAY**, sandy, occasional organics Very Soft Grey		9	SS	0		182				
10.5	Silty **SAND**, trace to some clay, trace gravel Very Loose Grey Moist						181				
180.8 11.3	Gravelly **SAND**, trace silt Compact Grey Wet		10	SS	26		180				
179.8 12.3	END OF BOREHOLE AT 12.3m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT SURFACE UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH GROUT, HOLEPLUG AND AUGER CUTTINGS TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH49-03 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 15+100 O/S 4.0L, SBL ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.10.28 - 2008.10.28 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.2	**Ground Surface**										
0.0	**ASPHALT** (50mm)										
0.0	**SAND**, some gravel Brown Moist (FILL)		1	AS			194		○		
193.5											
0.7	END OF BOREHOLE AT 0.7m UPON AUGER REFUSAL ON PROBABLE ROCK FILL. BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 0.2m, THEN COLD PATCH TO THE SURFACE.										

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

$15 \oplus^{20}_{10} 5$ (%) STRAIN AT FAILURE

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH49-04R 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 15+112.5 O/S 3.0R, SBL ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2008.10.28 - 2008.10.28 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
194.1	**Ground Surface**										
0.0	**ASPHALT** (50mm)						194				
0.0	**SAND**, some gravel, occasional rock fill fragments Brown Moist (FILL)		1	AS					○		
			1	SS	115/.225				○		
192.9							193				
1.2	END OF BOREHOLE AT 1.2m UPON AUGER REFUSAL ON PROBABLE ROCK FILL. BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 0.2m, THEN COLD PATCH TO THE SURFACE.										

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

$15 \oplus^{20}_{10} 5$ (%) STRAIN AT FAILURE

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No D49-02L 1 OF 1 METRIC

GWP# 5294-08-00 LOCATION Wallbridge Twp., Station 15+112.5 O/S 12.5L , SBL ORIGINATED BY WB

HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test (DCPT) COMPILED BY LG

DATUM Geodetic DATE 2009.02.09 - 2009.02.09 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.2	**Ground Surface**										
0.0	DCPT from surface.						192				
							191				
							190				
	Probable boulder or bedrock						189				
							188				
187.3											
4.9	END OF DCPT AT 4.9m UPON REFUSAL ON PROBABLE BEDROCK.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

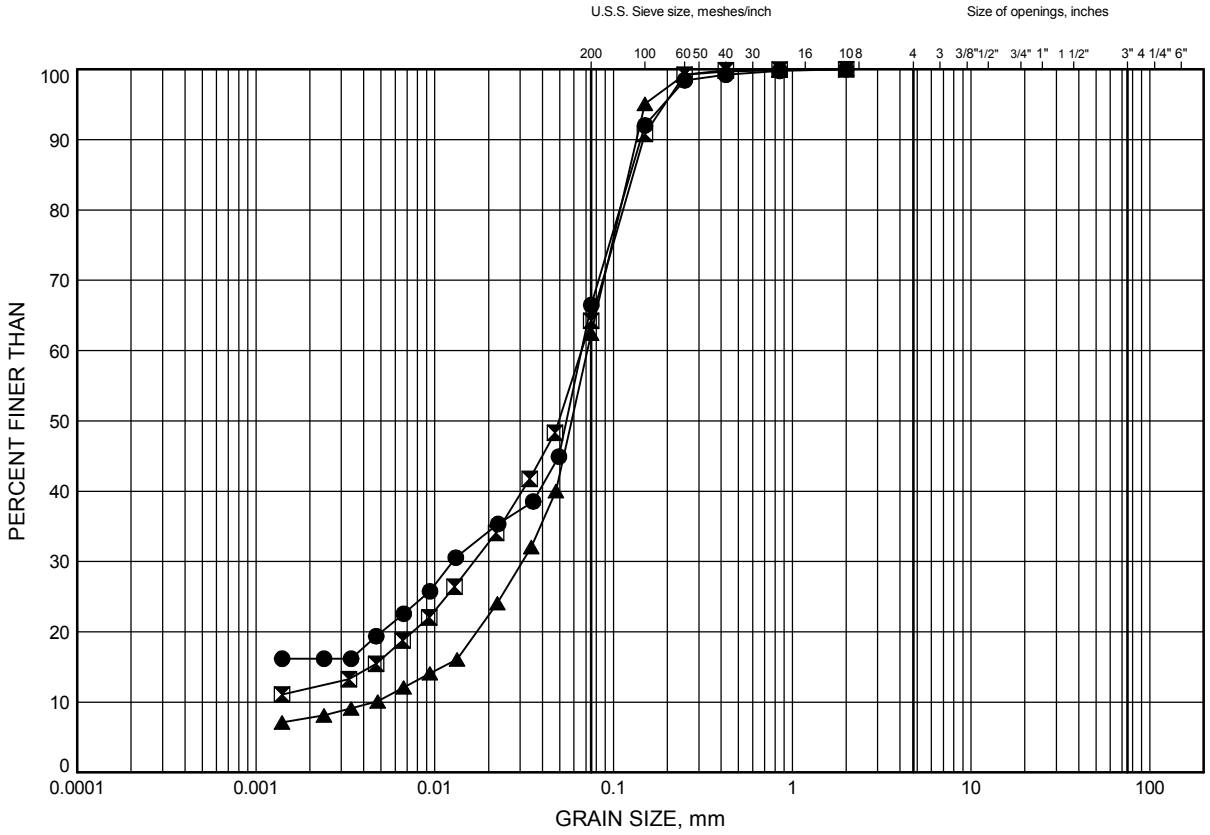
ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE K1

Sandy Silt



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C239-1	2.59	189.61
⊠	BH49-02L	1.22	190.88
▲	BH49-02L	5.79	186.31

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

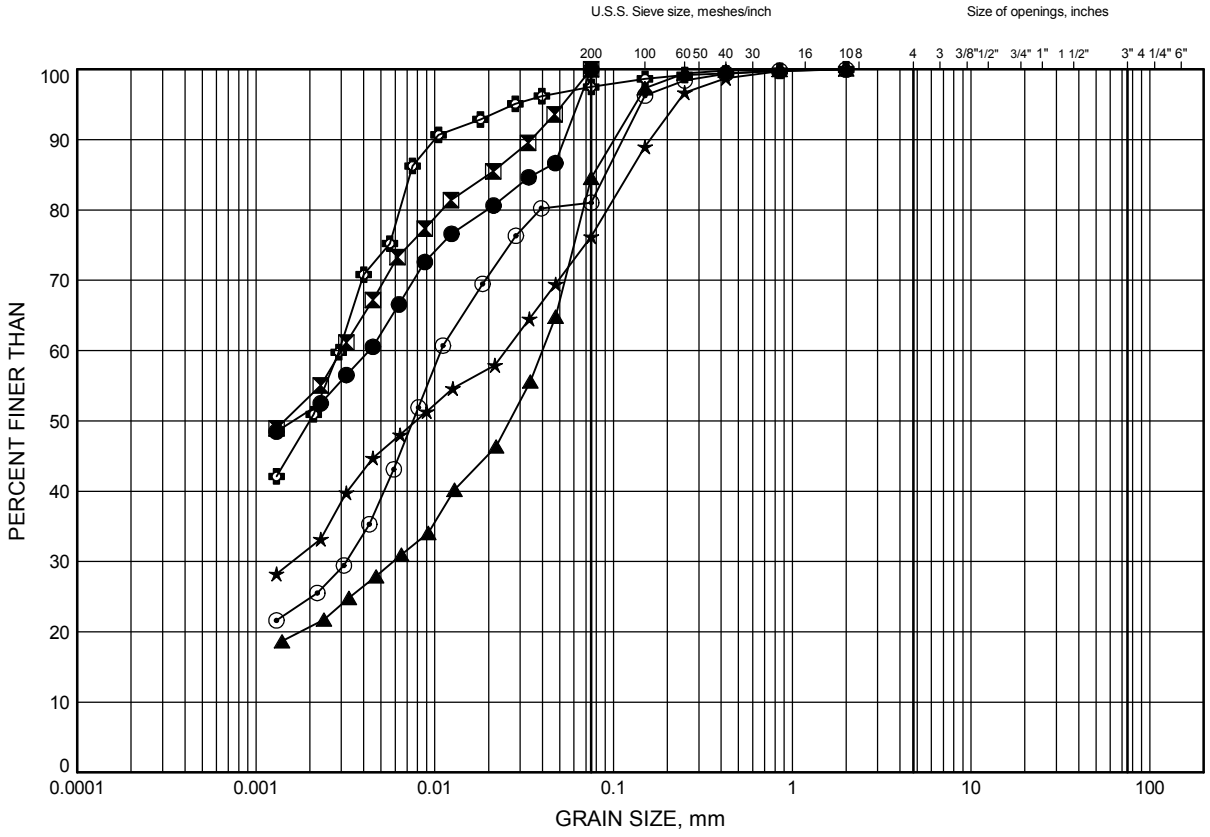
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE K2

Silty Clay



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C238-1	2.59	189.21
⊠	C239-1	4.88	187.32
▲	C239-2	3.35	190.65
★	C239-2	9.45	184.55
⊙	BH48-02	1.07	191.13
✿	BH48-02	4.88	187.32

Date August 2014

GWP# 5294-08-00

THURBER

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Chkd. MRA

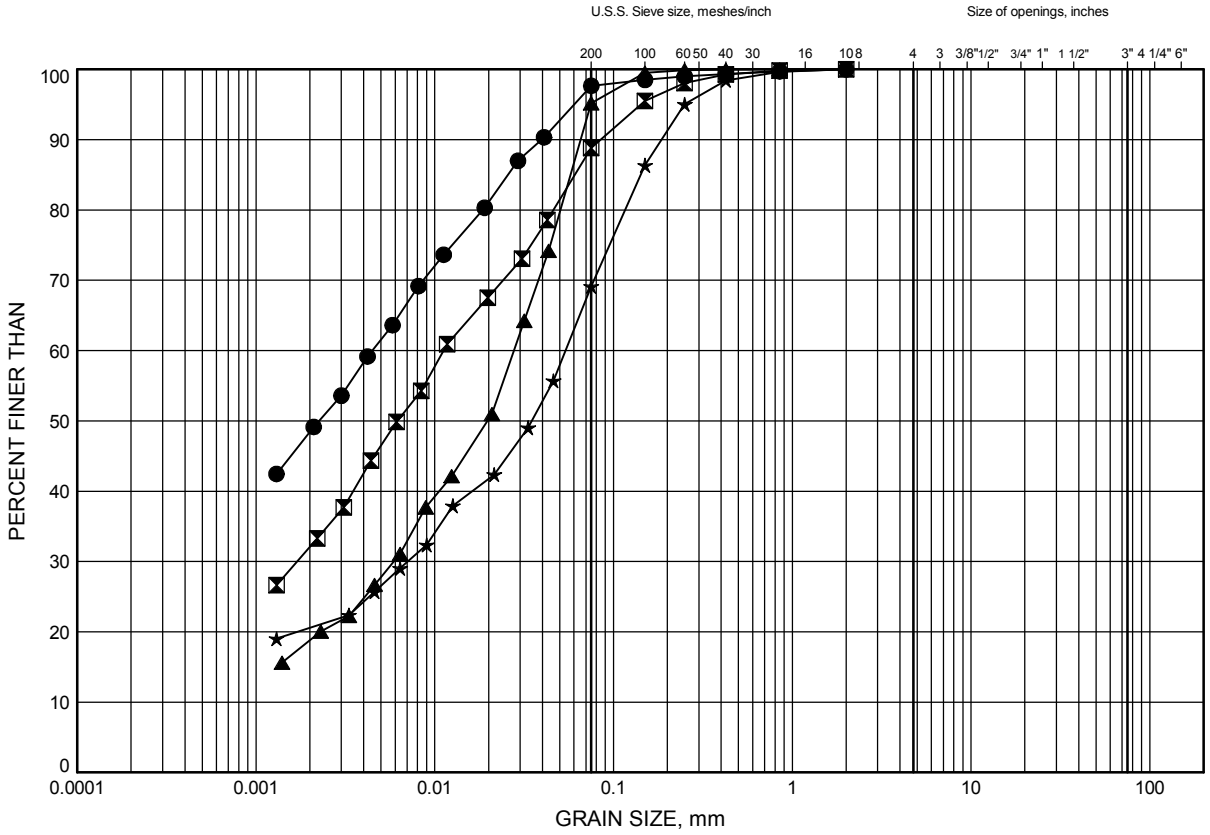
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE K3

Silty Clay



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH48-03L	2.59	189.31
⊠	BH48-03L	6.40	185.50
▲	BH49-02L	2.74	189.36
★	BH49-02L	8.84	183.26

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

Chkd. MRA

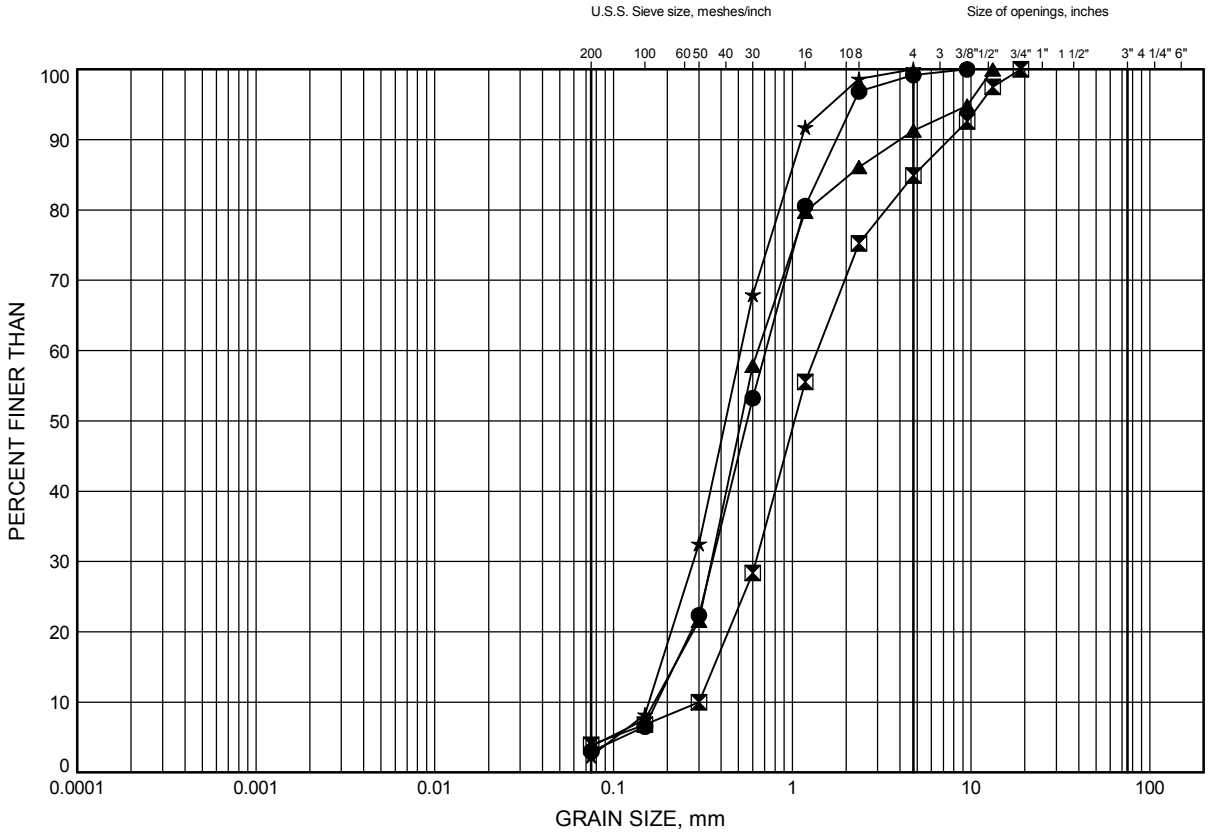
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE K4

Sand



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C238-1	4.88	186.92
⊠	C239-1	9.45	182.75
▲	BH48-03L	7.92	183.98
★	BH48-04	6.71	185.09

Date August 2014

GWP# 5294-08-00

THURBER

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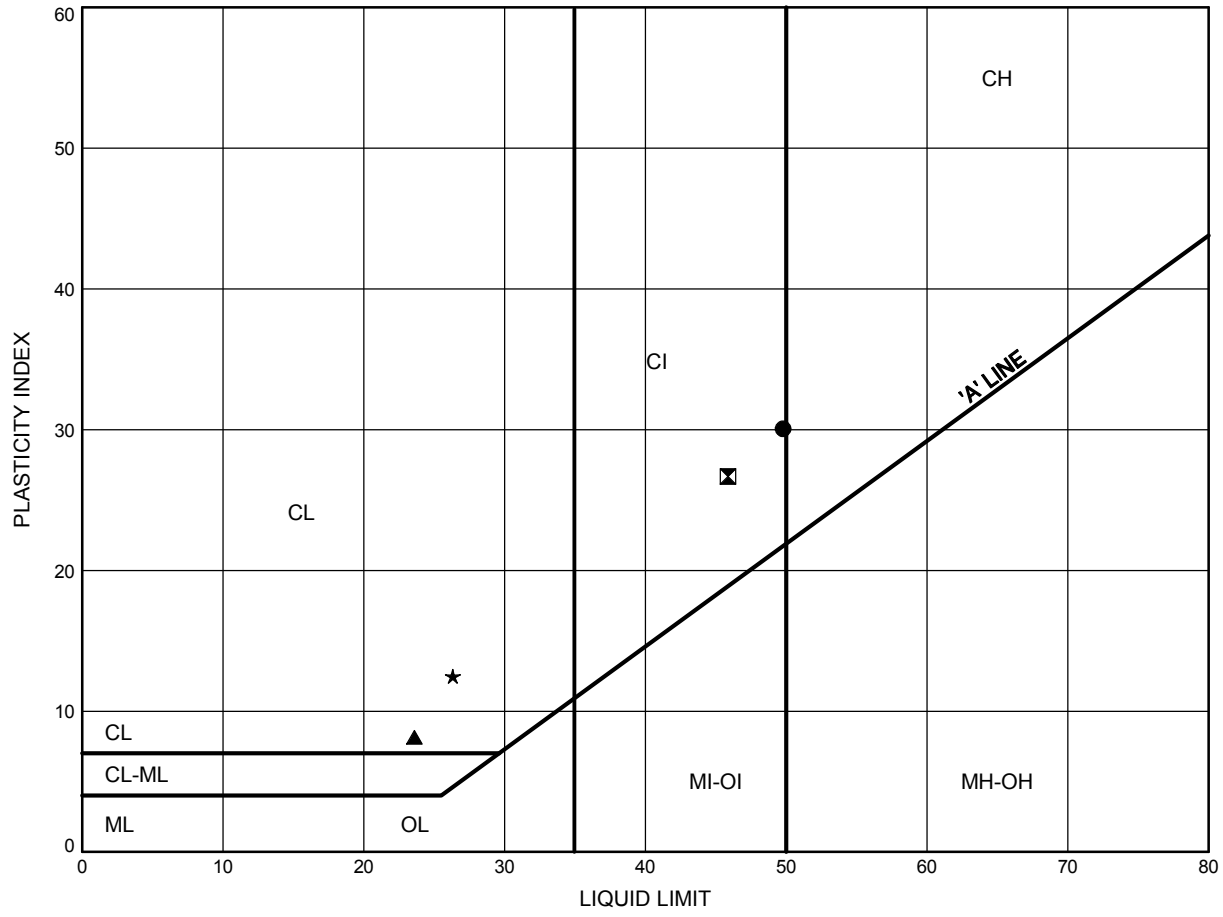
GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529

ATTERBERG LIMITS TEST RESULTS

FIGURE K5

Silty Clay



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C238-1	2.59	189.21
⊠	C239-1	4.88	187.32
▲	C239-2	3.35	190.65
★	C239-2	9.45	184.55

Date August 2014

GWP# 5294-08-00

THURBER

Prep'd MFA

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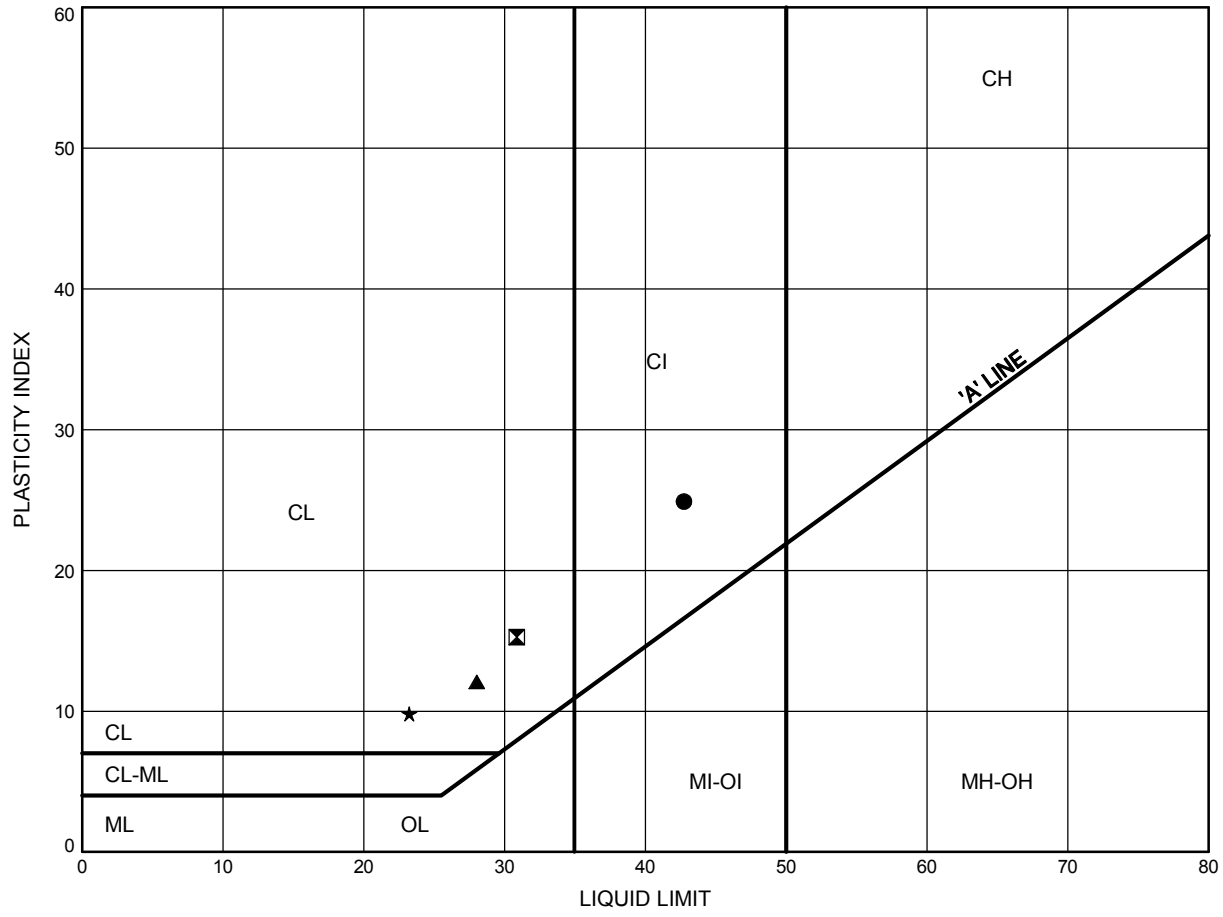
THURBALT 6121(CULVERTS).GPJ 8/22/14

Hwy 69 Four-Laning North of Hwy 529

ATTERBERG LIMITS TEST RESULTS

FIGURE K6

Silty Clay



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH48-03L	2.59	189.31
⊠	BH48-03L	6.40	185.50
▲	BH49-02L	2.74	189.36
★	BH49-02L	8.84	183.26

Date August 2014

GWP# 5294-08-00

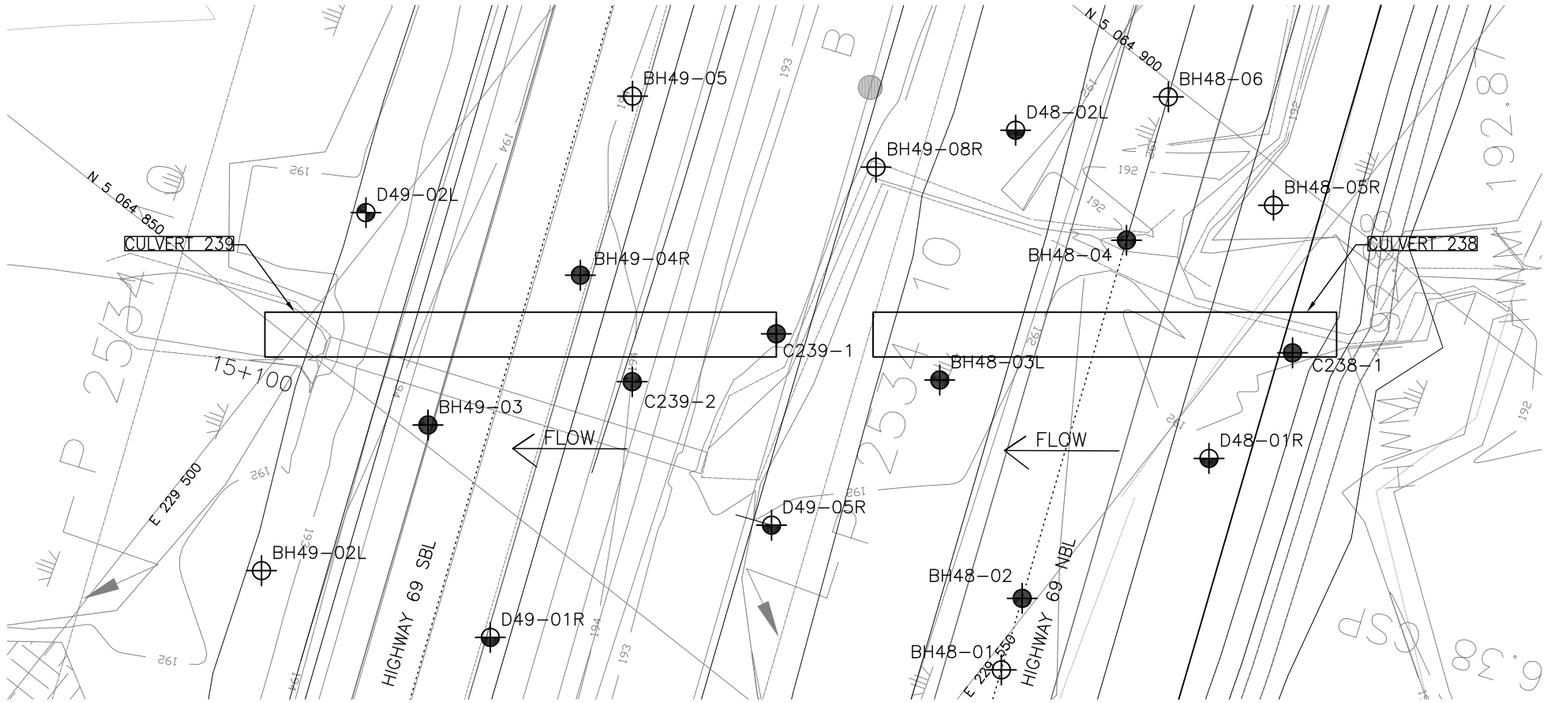
THURBER

Prep'd MFA

Chkd. MRA

THURBALT 6121.GPJ 8/20/14

MINISTRY OF TRANSPORTATION, ONTARIO

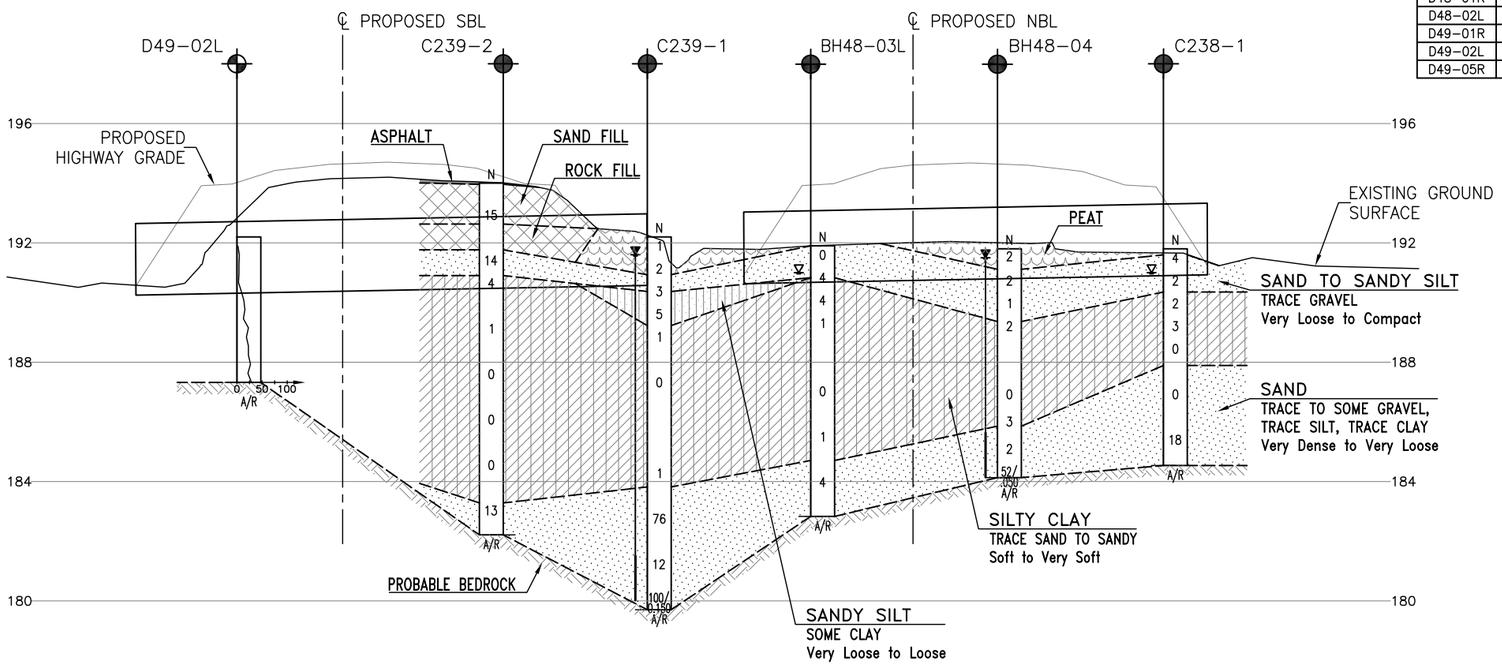


PLAN

8 0 8 16m

SCALE 1:400

NO	ELEVATION	NORTHING	EASTING
C239-2	194.0	5 064 861.9	229 519.7
D48-01R	192.1	5 064 881.8	229 553.3
D48-02L	192.0	5 064 891.1	229 529.5
D49-01R	194.3	5 064 842.6	229 522.8
D49-02L	192.2	5 064 859.7	229 498.7
D49-05R	192.0	5 064 860.1	229 533.0



CULVERT 238 AND 239

8 0 8 16m H 1:400

4 0 4 8m V 1:200

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Aug 21/14
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Aug 21/14
PROVINCE OF ONTARIO

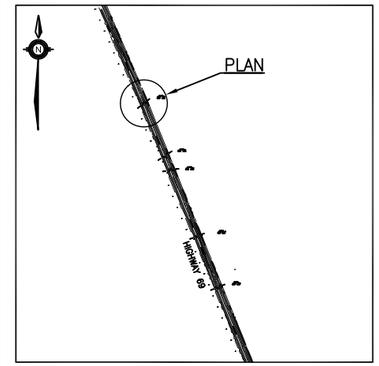
CONT No
WP No 5134-12-24/25

HIGHWAY 69 FOUR-LANING
NORTH SECTION
CULVERT 238 AND 239
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MMM GROUP

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⊕/⊕	Culvert Report Borehole / Cone
⊕/⊕	Other Borehole / Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level During Drilling
▽	Water Level in Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BH48-01	192.5	5 064 862.1	229 551.1
BH48-02	192.2	5 064 866.7	229 549.2
BH48-03L	191.9	5 064 874.8	229 535.8
BH48-04	191.8	5 064 889.9	229 539.9
BH48-05R	192.1	5 064 897.8	229 546.1
BH48-06	192.1	5 064 899.1	229 536.1
BH49-02L	192.1	5 064 836.6	229 508.0
BH49-03	194.2	5 064 851.1	229 510.7
BH49-04R	194.1	5 064 865.4	229 512.6
BH49-05	194.0	5 064 876.9	229 507.9
BH49-08R	191.5	5 064 883.3	229 523.6
C238-1	191.8	5 064 890.8	229 553.3
C239-1	192.2	5 064 870.4	229 525.3

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 41H-129

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN LRB	CHK MRA	CODE	LOAD DATE AUG. 2014
DRAWN MFA	CHK LRB	SITE 44-613/C1&C2	STRUCT DWG 1

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