

**FOUNDATION INVESTIGATION AND DESIGN REPORT
CULVERT REPLACEMENTS
HIGHWAY 7
BROCK ROAD TO HIGHWAY 12
PICKERING / WHITBY
G.W.P. No. 2075-08-00**

GEOCRES Number: 30M14-319

Report to

MMM Group Ltd.

Thurber Engineering Ltd.
2010 Winston Park Drive, Suite 103
Oakville, Ontario
L6H 5R7
Phone: (905) 829 8666
Fax: (905) 829 1166

November 6, 2009
File: 19-5161-26

\\Torserver1\Projects\19\5161\26 Hwy 7 Brock to
Brock\Reports\Culverts\195161226 Hwy 7 Culverts FIDR.doc

TABLE OF CONTENTS

PART 1 FACTUAL INFORMATION

1	INTRODUCTION	1
2	SITE DESCRIPTION	1
3	SITE INVESTIGATION AND FIELD TESTING	2
4	LABORATORY TESTING	5
5	DESCRIPTION OF SUBSURFACE CONDITIONS	5
5.1	General	5
5.2	Topsoil and Peat	5
5.3	Pavement	6
5.4	Fill	6
5.5	Sands and Silts	7
5.6	Silt to Clayey Silt	8
5.7	Silty Clay	9
5.8	Sand and Silt Till to Silty Sand Till	9
5.9	Groundwater Conditions	10
6	MISCELLANEOUS	13

PART 2 ENGINEERING DISCUSSION AND RECOMMENDATIONS

7	GENERAL	14
8	CULVERT FOUNDATIONS	16
8.1	General	16
8.2	Foundation Alternatives	16
8.3	Foundation Design	17
8.4	Concrete Open Frame with Spread Footings on Native Soil	17
8.4.1	Geotechnical Resistance	18
8.5	Footings on Engineered Fill	19
8.6	Closed Concrete Box	21
8.7	Cast-in-place and Prefabricated Culvert Options	21
8.8	Culvert 19 Pile Foundation	21
8.8.1	Axial Resistance	22
8.8.2	Pile Installation	22

8.8.3	Lateral Resistance of Piles.....	22
8.9	Settlements.....	23
8.10	Subgrade Preparation.....	24
9	CULVERT BACKFILL AND LATERAL EARTH PRESSURES	24
10	EMBANKMENT DESIGN AND CONSTRUCTION.....	26
11	EROSION CONTROL	26
12	EXCAVATIONS.....	26
12.1	General.....	26
12.2	Foundations.....	27
12.3	Excavations.....	27
13	GROUNDWATER CONTROL	27
14	ROADWAY PROTECTION.....	28
15	SEISMIC CONSIDERATIONS.....	28
16	CONSTRUCTION CONCERNS	29
17	CLOSURE.....	30

Appendices

Appendix A	Record of Borehole Sheets
Appendix B	Laboratory Test Results
Appendix C	Record of Borehole Sheets (previous investigation)
Appendix D	Borehole Locations and Soil Strata Drawings
Appendix E	Culvert and Foundation Comparison
Appendix F	Figure 1
Appendix G	SPs and NSSPs

**FOUNDATION INVESTIGATION AND DESIGN REPORT
CULVERT REPLACEMENTS
HIGHWAY 7
BROCK ROAD TO HIGHWAY 12
PICKERING / WHITBY
G.W.P. No. 2075-08-00**

GEOCRES Number: 30M14-319

PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual data obtained from a foundation investigation conducted by Thurber Engineering Ltd. (Thurber) at the locations of a number of culverts where the replacement of existing culverts are required along Highway 7 from Brock Road in the City of Pickering, Ontario to Highway 12 in the Town of Whitby, Ontario.

The purpose of this investigation was to obtain subsurface information at the culvert locations and, based on the data obtained, to provide borehole location plans, stratigraphic profiles, records of boreholes, laboratory test results, and a written description of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained at each culvert location during the course of the present investigation.

Thurber was retained by the MMM Group Ltd. (MMM) to carry out this foundation investigation under the Ministry of Transport Ontario (MTO) Agreement Number 2006-E-0064.

In preparation of this report and in addition to the boreholes drilled for the extension of the existing culvert at West Lynde Creek (Culvert C13), general reference has been made to the following documents:

- Thurber Engineering report titled "Preliminary Foundation Investigation and Design Report – Culvert Extension at West Lynde Creek, Highway 7 Widening, from Brock Road to Highway 12, Town of Whitby, Ontario", G.W.P. No. 2110-05-00, dated September 21, 2007 (Reference 1)

A copy of the borehole logs sheets provided in Reference 1 are provided in Appendix C.

2 SITE DESCRIPTION

The culvert sites are located within an approximately 13 km section of Highway 7 between Brock Road and Highway 12. The west section of the project lies in the City of Pickering and the east section in the Town of Whitby, Ontario.

Currently, all of the culverts are open frame type with the exception of Culvert C20 which is a box culvert. The extensions on Culverts C04, C17, C11, C12, C13, C21, C24 and C25 are box type extensions while Culverts C05 and C17 have been extended with pipe culvert sections.

The grade of the existing Highway 7 in the vicinities of the culverts ranges between approximate Elevations 145 m and 193 m. The embankment fill heights at the culverts vary from approximately 1 m to 6 m.

The culvert sites are located in rural areas adjacent to agricultural fields, forests and residential dwellings. There is moderate vegetation cover in the areas surrounding most of the culvert locations.

The site is situated in the Physiographic area known as the South Slope, which lies between the Oak Ridges Moraine and the Iroquois Plain and typically is characterized by overburden composed of sand and silt, underlying or overlying glacial till sheets. Lacustrine clay deposited by Lake Iroquois, is often encountered between or overlying the till sheets. The bedrock is composed of black bituminous shale of the Whitby formation.

3 SITE INVESTIGATION AND FIELD TESTING

This borehole investigation and field testing program was carried out from between August 11, 2008 and September 5, 2008, from between October 8, 2008 and October 24, 2008, from November 24, 2008 to December 12, 2008 and on January 6, 2009. The program consisted of drilling and sampling 42 boreholes to depths ranging from 6.3 m to 17.4 m (El. 131.0 to 182.1 m). Three boreholes were drilled at each culvert location. The boreholes were positioned so that one borehole was advanced through the paved shoulder of the road and two boreholes were drilled in the ditches adjacent to each end of the culverts.

Prior to the start of drilling, the borehole locations were marked/staked in the field and utility clearances were obtained by representatives of Thurber. The drilled boreholes were subsequently surveyed by MMM.

The boreholes advanced through the paved shoulder were drilled and sampled using a truck mounted drill rig. A track mounted drill rig was used to drill and sample the boreholes where access through the MTO lands was conventional. In areas where access was unconventional and/or inaccessible through MTO lands, the boreholes were drilled and sampled in the ditches using a light duty, low overhead track mounted drill rig.

Solid and hollow stem augers were used to advance the boreholes. Soil samples were obtained at selected intervals using a 50 mm diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT). Groundwater conditions in the open boreholes were observed throughout the drilling operations. The details of piezometer installations and borehole completion are summarized in Table 3.1.

Table 3.1
Borehole Completion and Piezometer Installation Details

Borehole Number	Piezometer Installations			Completion Details
	Screen Depth (m)	Screen El. (m)	Sand Filter Stratum	
C01-A	3.0 – 4.5	157.6 – 156.1	Sand	Sand to 2.4 m, bentonite holeplug to ground surface
C01-B	9.9 – 11.4	155.8 – 154.3	Sand	Sand to 8.5 m, bentonite holeplug to 1.5 m, sand to 0.5 m, concrete to surface
C01-C	5.3 – 6.8	154.5 – 153.0	Sand / Gravel	Sand to 4.6 m, bentonite holeplug to ground surface
C04-A	3.0 – 4.5	144.5 – 143.0	Sand	Sand to 2.1 m, bentonite holeplug to ground surface
C04-B	4.5 – 6.0	143.8 – 142.3	Silt / Sand	Sand to 4.0 m, bentonite holeplug to 0.5 m, concrete to surface
C04-C	3.0 – 4.5	144.2 – 142.7	Sand	Sand to 2.4 m, bentonite holeplug to ground surface
C05-A	2.7 – 4.2	163.6 – 162.1	Sand and Silt Till	Sand to 2.1 m, bentonite holeplug to ground surface
C05-B	6.1 - 7.6	165.1 – 163.6	Sand and Silt Till	Sand to 5.8 m, bentonite holeplug to 0.5 m, concrete to surface
C05-C	None Installed			Bentonite grout to surface
C07-A	10.7 – 12.2	138.7 – 137.2	Clayey Silt	Sand to 9.8 m, bentonite holeplug to ground surface
C07-B	4.5 – 6.0	146.3 – 144.8	Sand and Silt Till	Sand to 4.0 m, bentonite holeplug to 0.5 m, concrete to surface
C07-C	7.5 – 9.0	141.5 – 139.9	Sand and Silt Till	Sand to 7.0 m, bentonite holeplug to ground surface
C11-A	4.5 – 6.0	147.6 – 146.1	Sand and Silt Till	Sand to 4.3 m, bentonite holeplug to ground surface
C11-B	6.1 - 7.6	149.2 – 147.7	Sand and Silt Till	Sand to 5.2 m, bentonite holeplug to 0.5 m, concrete to surface
C11-C	None Installed			Bentonite holeplug to 0.2 m, cuttings to surface
C12-A	2.1 – 3.6	150.9 – 149.4	Sand and Silt Till	Sand to 1.5 m, bentonite holeplug to ground surface
C12-B	6.1 - 7.6	150.2 – 148.7	Silty Sand	Sand to 5.8 m, bentonite holeplug to ground surface
C12-C	6.1 - 7.6	145.9 – 144.3	Sand and Silt Till	Sand to 5.5 m, bentonite holeplug to 0.2 m, drill cuttings to ground surface
C13-A	3.0 – 4.5	160.1 – 158.5	Sand and Silt Till	Sand to 2.4 m, bentonite holeplug to ground surface
C13-B	None Installed			Bentonite holeplug mixed with cuttings to 0.15 m, asphalt cement to surface
C13-C	7.5 – 9.0	155.0 – 153.4	Sand and Silt with Clay	Sand to 7.1 m, bentonite holeplug to 0.1 m, drill cuttings to ground surface

Table 3.1
Borehole Completion and Piezometer Installation Details (Cont'd)

Borehole Number	Piezometer Installations			Completion Details
	Screen Depth (m)	Screen El. (m)	Sand Filter Stratum	
C17-A	3.0 – 4.5	167.5 – 166.0	Sand and Silt Till	Sand to 2.2 m, bentonite holeplug to ground surface
C17-B	None Installed			Bentonite holeplug mixed with cuttings to 0.45 m, asphalt cement to surface
C17-C	4.7 – 6.2	164.2 – 162.7	Silty Sand	Sand to 4.4 m, bentonite holeplug to ground surface
C18-A	3.0 – 4.5	143.1 – 141.6	Sand and Silt Till	Sand to 2.7 m, bentonite holeplug to 0.2 m, concrete to surface
C18-B	10.7 – 12.2	137.1 – 135.6	Sand and Silt Till	Sand to 7 m, bentonite holeplug to 3.0 m, sand to 0.4 m, concrete to surface
C18-C	4.5 – 6.0	140.3 – 138.8	Sand and Silt Till	Sand to 4.0 m, bentonite holeplug to 0.3 m, cuttings to ground surface
C19-A	3.8 – 5.3	141.4 – 139.9	Silty Sand	Sand to 3.5 m, bentonite holeplug to ground surface
C19-B	4.5 – 6.0	143.2 – 141.7	Silty Sand	Sand to 4.3 m, bentonite holeplug to 1.1 m, sand to 0.6 m, bentonite to 0.3 m concrete to surface
C19-C	4.3 – 4.6	141.0 – 140.7	Silty Sand	Sand to 3.0 m, bentonite holeplug to ground surface
C20-A	4.5 – 6.0	141.9 – 140.4	Sand and Silt Till	Sand to 4 m, bentonite holeplug to ground surface
C20-B	4.5 – 6.0	144.2 – 142.7	Sandy Silt	Sand to 4.0 m, bentonite holeplug to 0.2 m, concrete to surface
C20-C	2.5 – 4.0	143.3 – 141.8	Sand	Sand to 1.8 m, bentonite holeplug to 0.2 m, cuttings to ground surface
C21-A	4.9 – 6.4	151.2 – 149.6	Sandy Silt	Sand to 4.1 m, bentonite holeplug to ground surface
C21-B	6.1 - 7.6	152.9 – 151.4	Sand and Silt Till	Sand to 3.7 m, bentonite holeplug to 0.9 m, sand filter to 0.2 m, concrete to surface
C21-C	6.1 - 7.6	149.7 – 148.1	Silty Sand	Sand to 5.5 m, bentonite holeplug to 3.7 m, cuttings to ground surface
C24-A	None Installed			Holeplug to ground surface
C24-B	7.5 – 9.1	188.9 – 187.4	Silt with Clay	Sand to 7.0 m, bentonite holeplug to 0.9 m, sand filter to 0.2 m, concrete to surface
C24-C	6.1 - 7.6	190.7 – 189.2	Silt	Sand to 5.8 m, bentonite holeplug to ground surface
C25-A	None Installed			Bentonite holeplug mixed with cuttings to ground surface
C25-B	None Installed			Bentonite holeplug mixed with cuttings to ground surface
C25-C	4.5 – 6.0	188.5 – 187.0	Silty Sand	Sand to 4.0 m, bentonite holeplug to ground surface

Results of field drilling and sampling are presented on the Record of Borehole sheets in Appendix A.

A member of Thurber's technical staff supervised the drilling and sampling operations on a full time basis. The supervisor logged the boreholes, secured the recovered soil samples in labelled, air tight containers and transported the samples to Thurber's laboratory for further examination and testing.

4 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected soil samples were subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing when appropriate. The results of this laboratory testing program are shown on the Record of Borehole sheets in Appendix A and on the figures in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 General

Reference is made to the Record of Borehole sheets in Appendix A for details of the soil stratigraphy encountered in the boreholes. Stratigraphic profiles for the thirteen (13) culvert replacement locations and the location of the single culvert subject to further evaluation are presented on the Borehole Locations and Soil Strata Drawings in Appendix D for illustrative purposes. An overall description of the stratigraphy is given in the following paragraphs; however, the factual data presented in the record of boreholes governs any interpretation of the site conditions.

In general, the subsurface conditions encountered in the boreholes located on the highway shoulder consist of asphalt and granular fill overlying a layer of fill material of variable thickness which is in turn underlain by native sand and silt deposits and sand and silt till. Boreholes located in the side ditches encountered a layer of organic topsoil of variable thickness overlying native sand and silt deposits and sand and silt till. More detailed descriptions of the individual stratum are presented below.

5.2 Topsoil and Peat

Topsoil and organic peat was encountered in the boreholes drilled in the ditches adjacent to the existing culvert extensions throughout the site. The combined thickness of the organic soils (topsoil and peat) was found to range from approximately 25 to 2,030 mm in thickness. Deposits of topsoil and peat of note observed during drilling are the following:

- Sta. 24+197 (C11-A; 900 mm);
- Sta. 24+582 (C12-C; 655 mm);
- Sta. 25+229 (C13-C; 650 mm);
- Sta. 11+300 (C18-C; 600 mm);
- Sta. 12+520 (C20-A/C; 600 mm);

- Sta. 13+289 (C21-A/C; 1,295/550 mm);
- Sta. 18+480 (C25-A; 2,030 mm)

Topsoil and peat thickness may vary between and beyond the borehole locations.

A layer of buried organic peat was encountered in Borehole C11-C at a depth ranging from 1.0 to 1.7 m below the ground surface (El. 150.7 to 150.0 m). The SPT N-value obtained from within the peat material was observed as 1 blow for 0.3 m of penetration. The single moisture content from the organic peat was 45%.

5.3 Pavement

A layer of asphalt between 50 and 150 mm in thickness was encountered at ground surface in all the boreholes drilled through the paved shoulder of the highway (boreholes indicated with a B designation) with the exception of culvert C12-B which was advanced through a gravel shoulder and C25-B which encountered a 150 mm thick surficial layer of concrete cement. The asphalt and concrete cement was then underlain by a granular fill. The depth of the granular fill ranged from 0.6 to 3.6 m below the ground surface.

The borehole location may have had an impact on the observed depth of the granular pavement material. Drilling in close proximity to the existing culvert in some areas may reflect the granular backfill to the culvert and not the actual pavement structure.

The granular fill ranges from sand to sand and gravel with traces silt and clay. Occasional to frequent cobbles were encountered within the fill. Hydrocarbon odours were observed in several samples recovered from the granular fill in Boreholes C11-B and C17-B. The SPT N-values in the granular fill ranged from 17 to 65 blows per 0.3 m of penetration indicating a compact to very dense relative density. The moisture content in the granular fill deposits varied from 2 to 21%.

The result of laboratory test carried out on eight (8) samples of the granular fill was as follows:

Gravel %	13 to 38
Sand %	47 to 70
Silt & Clay %	13 to 39

The grain size distribution curves for the samples tested are shown in Figures B1 to B5, Appendix B.

5.4 Fill

Embankment fill was encountered below the pavement structure in all 'B' series boreholes except Boreholes C12-B and C25-B, where a granular fill was encountered from the ground surface or immediately below the concrete pavement comprised the full depth of the fill. Fill was also encountered in Boreholes C01-A, C01-C, C05-A, C11-C, C13-A, C17-A, C19-A,

C20-A, C25-A and C25-C either from ground surface or immediately below the organic topsoil.

The composition of the fill varies widely throughout the site ranging from a Sand to a Silty Sand / Sandy Silt to Clayey Silt and Silty Clay. Typically the fill is comprised of brown silty sand with traces of clay and gravel. Atterberg limits testing indicate that the fill is typically a low plasticity silt (ML). Where encountered, the fill was found extending to depths of 1.0 to 6.4 m depth (El 143.9 to 195.2 m). In some locations the fill contains topsoil, roots and cobbles. A hydrocarbon odour was detected in several samples recovered from the fill material in Boreholes C04-B, C05-B and C07-B.

SPT N-values measured in the cohesionless fill typically range from 6 to greater than 100 blows per 0.3 m penetration indicating a loose to very dense state. The water contents of the recovered fill samples ranged widely from between 2% and 42%.

Grain size analyses conducted on samples of the fill are presented on Figures B1 to B5 in Appendix B. The results of grain size analyses carried out on sixteen (16) samples are tabulated below. The results of Atterberg limits testing on three (3) samples of the fill are tabulated below and are shown on Figure B24 in Appendix B.

Gravel %	1 to 16
Sand %	27 to 73
Silt %	20 to 57 (where hydrometer was conducted)
Clay %	9 to 20 (where hydrometer was conducted)
Silt & Clay %	12 (sieve analysis only)
Liquid Limit %	18 to 36
Plastic Limit %	11 to 24

Auger grinding was occasionally noted while advancing the augers through the fill material and may be reflective of the presence of cobbles within the fill and should be anticipated.

5.5 Sands and Silts

A cohesionless deposit comprised of sand, sand and gravel, silty sand to sandy silt was encountered in all of the Boreholes drilled at culverts C01, C04, C24 and C25, and in Boreholes C05-C, C07-C, C11-A, C12-A, C12-C, C17-C, C18-A, C18-C, C19-A, C20-B and C20-C. Where encountered, the cohesionless deposit was contacted immediately below the topsoil and surficial fill. The depth to this layer ranged from 0.1 to 5.9 m below the ground surface. The elevations of the top of this deposit throughout the site ranged from El. 144.3 to 193.6 m.

The thickness of this cohesionless deposit varies from 0.5 to over 12 m in all of the boreholes.

SPT N-values in the cohesionless deposit varied widely from 2 blows for 0.3 m penetration to 100 blow for 0.275 mm of penetration. SPT values of less than 10 were not frequent and as a result, the layer can be described as compact to very dense. N-values greater than 50 may reflect the presence of cobbles or boulders.

Moisture contents in the sand, silty sand to sandy silt deposits varied widely from 6 to 61%, though were typically between 8 to 20%.

Grain size distribution results on samples of the cohesionless deposit are presented on the Record of Borehole sheets and Figures B6 to B9 of Appendix B. A single Atterberg limits test was carried out on an apparently cohesive sample and is presented on the Record of Borehole sheets and Figure B25 of Appendix B. The results of laboratory tests carried out on twenty six (26) samples of the cohesionless deposit were as follows:

Gravel %	0 to 76
Sand %	6 to 90
Silt %	3 to 66 (where hydrometer was conducted)
Clay %	6 to 30 (where hydrometer was conducted)
Silt & Clay %	3 to 28 (sieve analysis only)
Liquid Limit %	21
Plastic Limit %	11

5.6 Silt to Clayey Silt

Below the granular deposit, layers of a grey silt with some clay to clayey silt was encountered in the three boreholes drilled at culvert C04, C24 and in Boreholes C19-B, C25-A and C25-C. The surface of this deposit was found to range in depth from between 4.8 to 12.2 m below the ground surface. Boreholes C19-A, C24-A, B and C, and C25-A and C were all terminated in the silt at depths ranging from 10.7 to 15.8 m.

SPT N-values measured within these deposits ranged between 8 blows per 0.3 m penetration to greater than 100 blows for 0.125 m penetration, indicating a loose to very dense state.

The measured water contents of samples recovered from the fine grained silt typically ranged from 15 to 22%.

Grain size analyses conducted on six (6) samples of the silt are presented on the Record of Borehole Log Sheets and Figure B10, respectively, in Appendix B. The results are summarized in the following table.

Gravel %	0 to 1
Sand %	3 to 37
Silt %	56 to 86
Clay %	7 to 23

5.7 Silty Clay

Several boreholes drilled at culverts to the west end of the proposed highway alignment were terminated in a grey silty clay material. The cohesive silty clay deposit was encountered in all three of the boreholes drilled at culvert C4 as well as in Boreholes C01-A, C01-B, C05-B, C07-A, C11-B, C21-A and C21-C. Several boreholes central to the proposed highway alignment encountered a similar cohesive deposit either immediately below the topsoil (Boreholes C04-C, C07-A and C21-A) or interbedded in the sand and silt till to silty sand till (Borehole C21-C).

The cohesive deposit was encountered at depths ranging from 0.1 to 16.8 m below the ground surface, or at elevations ranging from El. 138.4 to 154.7 m.

SPT N-values measured within these deposits ranged from 5 blows per 0.3 m penetration to greater than 100 blows for 0.1 m penetration, indicating a firm to hard consistency. Typically the N-values were from between 9 to 25 blows for 0.3 m of penetration indicating a stiff to very stiff consistency. N-values greater than 50 may reflect the presence of cobbles or boulders.

The measured water contents of samples recovered from the silty clay ranged from 8% to 36%, though were typically between 20 and 25%.

Grain size analyses conducted on eleven (11) samples of the silty clay are presented on the Record of Borehole Log Sheets and Figures B11 and B12 in Appendix B. Atterberg limits testing on eleven (11) samples indicated that the plasticity of the clay ranges from low to high plasticity (CL - CH). The results of the Atterberg limits testing may be found on the Record of Borehole Log Sheets and Figures B26 to B27 in Appendix B. The results are summarized in the following table.

Gravel %	0 to 5
Sand %	5 to 34
Silt %	22 to 54
Clay %	26 to 74
Liquid Limit %	24 to 55
Plastic Limit %	13 to 22

5.8 Sand and Silt Till to Silty Sand Till

In all boreholes except Boreholes C01-A and B, C04-A and B, C24-A and B; and C25-A and C a cohesionless till was encountered below the upper sand and silt. The till is comprised of brown sand and silt till to silty sand till with some clay. The cohesionless till was encountered immediately below the topsoil in Boreholes C13-C, C19-C and C21-C or below the sand and silt in most other borehole locations. The till was frequently interbedded with sand, silty clay

and silt to sandy silt layers. Auger grinding was noted in several boreholes indicating the likely presence of cobbles or boulders common to ice contact glacial soils.

The surface of the sand and silt till to silty sand till was encountered at depths ranging from 0.1 to 7.6 m, though was typically from between 1.3 to 3.0 and again from 6.1 to 7.6 m below the ground surface. Over half of the forty two boreholes (25) were terminated in the cohesionless till. The elevations of the top of the glacial till ranged from 139.6 to 190.9 m and the base of the till varied from between 131.5 to 178.4 m.

SPT test results conducted in the silt/sand till deposit varied widely from 1 to greater than 50 blows for 0.025 m of penetration indicating a very loose to very dense condition. Typically the deposit is dense to very dense as the number of N-values less than 10 blows/0.3 m of penetration was generally isolated within this deposit and the lower N-values were typically encountered in the upper part of the till.

Moisture contents from this deposit ranged from 3 to 40% though were typically from 6 to 12%.

The results of grain size distribution analyses conducted on sixty-eight (68) samples are presented on the Record of Borehole Sheets and Figures B13 to B23. Atterberg limits testing indicated that the till is essentially cohesionless. The results of the Atterberg limits testing may be found on the Record of Borehole Log Sheets and Figures B28 to B31 in Appendix B. The results are summarized below.

Gravel %	0 to 13
Sand %	20 to 77
Silt %	26 to 62 (where hydrometer was conducted)
Clay %	5 to 26 (where hydrometer was conducted)
Silt & Clay %	20 (sieve analysis only)
Liquid Limit %	15 to 22
Plastic Limit %	6 to 13

5.9 Groundwater Conditions

Standpipe type piezometers were installed in all but seven of the boreholes following completion of drilling. In addition to a selected number of piezometers intended as part of the foundation investigation, a number of additional piezometers were installed at the request of MMM Group as part of their hydrogeological investigation at the various creek locations.

Details of the individual piezometers are provided on the Record of Borehole Sheets and in Table 3.1. Groundwater levels were monitored following completion of the drilling program. The measured groundwater levels in the standpipe piezometers are presented below.

Table 5.1
Groundwater Levels

Borehole ID	Date of Reading	Water Level Depth (m)	Water Level El. (m)
C01-A	January 6, 2009	0.33	160.27
	February 11, 2009	1.08	159.52
C01-B	October 17, 2008	1.96	163.74
	February 11, 2009	0.87	164.83
C01-C	January 6, 2009	0.62	159.28
	February 11, 2009	0.50	159.40
C04-A	October 17, 2008	1.57	146.03
	November 21, 2008	1.38	146.22
	January 6, 2009	1.11	146.49
	February 11, 2009	0.98	146.62
C04-B	February 11, 2009	2.02	146.38
C04-C	October 17, 2008	1.96	145.24
	November 21, 2008	1.29	145.91
	January 6, 2009	0.87	146.33
	February 11, 2009	0.79	146.41
C05-A	October 17, 2008	1.17	165.13
	November 21, 2008	1.24	165.06
	January 6, 2009	2.01	164.29
	February 11, 2009	2.09	164.21
C05-B	October 17, 2008	5.42	165.78
	February 11, 2009	4.33	166.87
C07-A	October 17, 2008	+0.75	150.05
	February 11, 2009	3.45	145.85
C07-B	February 11, 2009	3.80	147.10
C07-C	February 11, 2009	3.13	145.97
C11-A	January 6, 2009	0.26	151.94
	February 11, 2009	3.80	148.40
C11-B	February 11, 2009	2.03	153.27
C12-A	October 17, 2008	0.79	152.31
	November 21, 2008	0.62	152.48
	January 6, 2009	0.29	152.81
	February 11, 2009	1.67	151.43
C12-B	October 17, 2008	4.96	151.34
	February 11, 2009	1.88	154.42
C12-C	January 6, 2009	0.36	151.64
C13-A	November 21, 2008	0.34	162.76
	January 6, 2009	Frozen	-
	February 11, 2009	2.82	160.28

+ Artesian condition in BH C07-A

Table 5.1
Groundwater Levels (Cont'd)

Borehole ID	Date of Reading	Water Level Depth (m)	Water Level El. (m)
C13-C	January 6, 2009	4.04	158.56
	February 11, 2009	4.19	158.41
C17-A	October 17, 2008	1.48	169.02
	November 21, 2008	2.13	168.37
	January 6, 2009	4.17	166.33
	February 11, 2009	4.22	166.28
C17-C	January 6, 2009	1.23	167.67
	February 11, 2009	1.69	167.21
C18-A	January 6, 2009	1.31	144.89
	February 11, 2009	1.23	144.97
C18-B	October 17, 2008	2.00	145.80
	February 11, 2009	2.06	145.74
C18-C	January 6, 2009	4.32	140.58
	February 11, 2009	3.76	141.14
C19-A	October 17, 2008	0.44	144.76
	November 21, 2008	1.43	143.77
	January 6, 2009	1.98	143.22
	February 11, 2009	1.57	143.63
C19-B	October 17, 2008	2.65	145.15
	February 11, 2009	2.88	144.92
C19-C	January 6, 2009	3.87	141.43
	February 11, 2009	1.34	143.96
C20-A	January 6, 2009	1.13	145.37
	February 11, 2009	0.99	145.51
C20-B	October 17, 2008	3.90	144.90
	February 11, 2009	2.23	146.57
C20-C	January 6, 2009	2.42	143.38
	February 11, 2009	1.97	143.83
C21-A	January 6, 2009	1.59	154.41
	February 11, 2009	1.40	154.60
C21-B	October 17, 2008	0.94	158.06
	February 11, 2009	2.62	156.38
C21-C	January 6, 2009	3.08	152.72
	February 11, 2009	1.73	154.07
C24-C	January 6, 2009	1.77	194.73
	February 11, 2009	1.70	194.80
C25-C	January 6, 2009	0.52	192.48
	February 11, 2009	3.11	189.89

Where surface water is present, the groundwater level should be assumed to coincide with the local surface water level. Local high water levels and the effects of heavy rainfalls must also be taken into consideration.

6 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. MMM subsequently surveyed the as-drilled locations, and provided the northing and easting coordinates and ground surface elevations.

DBW Drilling of Ajax, Ontario supplied and operated a truck-mounted D-90 and a track-mounted CME 55 drill rig to carry out part of the drilling, sampling and in-situ testing operations within the roadway and ditches. Groundwork Drilling of Etobicoke, Ontario supplied and operated a truck-mounted BOA-5M drill rig to carry out part of the drilling, sampling and insitu testing operations for boreholes drilled within the roadway. Strong Soil Search Inc. of Claremont, Ontario supplied and operated a track-mounted CME 55 drill rig to carry out the drilling, sampling and in-situ testing operations for a total of 3 boreholes within the ditches. Kodiak Environmental Ltd. of Oakville, Ontario supplied and operated a light-duty, track-mounted drill rig to carry out the drilling, sampling and in-situ testing operations for the boreholes deemed to possess unconventional access through MTO lands.

The drilling and sampling operations in the field were supervised on a full time basis by Mr. Stephane Loranger, Ms. Eckie Siu, Mr. Shane Aziz, Mr. Keli Shi, Mr. Jason Mei and Mr. Ligang Hao of Thurber. Laboratory testing was carried out by Thurber in its MTO-approved laboratory.

Overall direction of the field program was provided by Mr. David Elwood, P.Eng. Interpretation of the field data and preparation of this report was completed by Mr. David Elwood, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.



Alastair Gorman, P.Eng.
Associate, Senior Project Engineer

Report Reviewed by:
P. K. Chatterji, P.Eng.,
Review Principal, Designated MTO Contact



**FOUNDATION INVESTIGATION AND DESIGN REPORT
CULVERT REPLACEMENTS
HIGHWAY 7
BROCK ROAD TO HIGHWAY 12
PICKERING / WHITBY
G.W.P. No. 2075-08-00**

GEOCREs Number: 30M14-319

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 GENERAL

This report presents interpretation of the geotechnical data in the factual report and presents foundation recommendations for the design of the replacement of the following culverts along Highway 7 from Brock Road to Highway 12.

Based on the terms of reference, details of the existing and proposed culverts along the project alignment requiring foundation investigation and design are shown in Table 7.1 below. The culverts are numbered C01 to C25 for reporting purposes.

**Table 7.1
Culvert Details**

Culvert ID	General Location	Approx. Station* (Township)	Existing Type	Existing Size (mm)	Proposed Type	Proposed Size (mm)
C01	~600 m west of 14 th Sideline, City of Pickering	19+354 (Pickering)	Concrete Open Footing with CSP Extensions (both ends)	3,650 x 2,400	Precast Concrete Open Footing	4,750 x 2,500
C04	~415 m east of 14 th Sideline, City of Pickering	20+355 (Pickering)	Concrete Open Footing with Box Extensions (both ends)	6,100 x 1,830	Precast Concrete Open Footing	Double Culvert each 3,200 x 1,800
C05	~160 m east of Westney Road, City of Pickering	21+927 (Pickering)	Concrete Open Footing with CSP Extensions (both ends)	1,200 x 1,000	Concrete Pipe	1,500 (dia.)
C06	~790 m east of Westney Road, City of Pickering	22+563	-	-	Box Culvert	2,500 x 1,000
C07	~200 m west of Salem Road, City of Pickering	23+386 (Pickering)	Concrete Open Footing with Box Extensions (both ends)	3,660 x 3,050	Precast Concrete Open Footing	Double Culvert each 4,000 x 2,060
C11	~215 m west of 4 th Sideline, City of Pickering	24+199 (Pickering)	Concrete Open Footing with Box Extensions (both ends)	3,660 x 1,830	Precast Concrete Open Footing	4,000 x 2,000

Table 7.1
Culvert Details (Cont'd)

Culvert ID	General Location	Approx. Station* (Township)	Existing Type	Existing Size (mm)	Proposed Type	Proposed Size (mm)
C12	~170 m east of 4 th Sideline, City of Pickering	24+581 (Pickering)	Concrete Open Footing with Box Extensions (both ends)	1,900 x 1,770 (high)	Precast Concrete Open Footing	2,400 x 1,800
C13	~15 m west of Audley Road, City of Pickering	25+225 (Pickering)	Concrete Open Footing with Box Extensions (both ends)	2,450 x 1,550	Precast Concrete Open Footing	3,000 x 2,100
C17	~150 m west of Halls Road, Town of Whitby	10+271 (Whitby)	Concrete Open Footing with Concrete Pipe (north) and CSP Extensions (south)	1,550 x 1,200	Precast Concrete Open Footing	1,800 x 1,200
C18	~15 m east of Coronation Road, Town of Whitby	11+298 (Whitby)	Concrete Open Footing with Open Footing Extensions (both ends)	4,300 x 1,500	Precast Concrete Open Footing	4,300 x 1,500
C19	~250 m east of Coronation Road, Town of Whitby	11+520 (Whitby)	Concrete Open Footing with Open Footing Extensions (both ends)	7,300 x 3,000	Bridge	23.6 m long bridge with 10 m opening
C20A C20B	~350 m west of Cochrane Street, Town of Whitby	12+547 (Whitby)	Concrete Box with Box Extensions (both ends)	6,100 x 1,850	Precast Concrete Box Culvert	Twin Culverts 3,500 x 3,000 and 3,500 x 1,200
C21	~350 m east of Cochrane Street, Town of Whitby	13+289 (Whitby)	Concrete Open Footing with Box Extensions (both ends)	3,050 x 1,870	Concrete Open Footing	4,200 x 1,800
C22	~350 m west of Ferguson Avenue	13+828	-	-	Concrete Box Culvert	1,800 x 1,200
C24	~150 m west of Brock Road, City of Pickering	18+043 (Pickering)	Concrete Open Footing with Box Extensions (both ends)	1,800 x 1,220	Precast Concrete Open Footing	3,660 x 1,220
C25	~185 m east of Brougham Road, City of Pickering	18+480 (Pickering)	Concrete Open Footing with Box Extensions (both ends)	1,830 x 1,050	Concrete Box Culvert	1,830 x 1,060

Note: * Refers to Highway 7 centreline.

The discussions and recommendations presented in this report are based on our understanding of the project and on the factual data obtained during the course of this investigation.

Details of the subject culverts are described in the foundation engineering terms of reference. Plans and profiles for the as built conditions were provided by MMM. Proposed Culvert C19 has a span of

10 m and essentially comprises a bridge structure. The GA drawing indicates this structure is proposed to be founded on driven piles.

8 CULVERT FOUNDATIONS

8.1 General

The current project requirements involve the replacement of the existing culverts as outlined in Table 7.1. Physical dimensions of the existing and proposed culverts and invert elevations as provided by MMM are presented in the following Tables 7.1 and 8.1. Boreholes drilled at each culvert are also identified in Table 8.1 for reference.

Table 8.1
Physical Dimensions of Existing and Proposed Culverts

Culvert ID	Borehole ID	Existing Invert Elevations (m)		Existing Culvert Length (m)	Proposed Invert Elevations (m)		Proposed Culvert Length (m)
		Inlet	Outlet		Inlet	Outlet	
C01	C01-A, B, & C	158.75	158.49	42.0	158.9	158.5	52.0
C04	C04-A, B, & C	145.71	145.47	25.7	145.5	145.3	30.0
C07	C07-A, B, & C	146.97	146.96	27.7	147.5	147.4	35.5
C11	C11-A, B, & C	150.97	150.76	32.7	150.9	150.8	44.5
C12	C12-A, B, & C	151.12	150.56	34.3	151.5	151.1	41.0
C13	C13-A, B, & C	162.25	161.95	26.0	162.3	161.3	40.0
C17	C17-A, B, & C	168.48	167.84	40.5	168.5	167.6	57.0
C18	C18-A, B, & C	144.30	143.94	29.9	143.8	143.6	40.5
C19	C19-A, B, & C	143.49	143.28	17.2	143.9	143.9	24.0
C20	C20-A, B, & C	144.79	143.31	43.0	144.8	143.8	50.0
C21	C21-A, B, & C	155.26	154.73	30.0	155.1	154.8	34.0
C24	C24-A, B, & C	196.10	195.93	28.8	196.1	195.7	28.7
C25	C25-A, B, & C	190.38	190.03	24.7	190.4	190.0	24.0

8.2 Foundation Alternatives

This section presents discussions on available types of culverts and foundation alternatives, and provides recommendations on feasible and/or preferred foundation option(s).

Initial consideration was given to the following culvert and foundation types:

- Concrete, open frame with spread footings on the native soil
- Concrete, open frame with spread footings on engineered fill
- Concrete box (closed) culvert on the native soil

Both pre-cast and cast-in place culvert options were considered. Comparison of the technical advantages and disadvantages of various culvert and foundation types is presented in Appendix E. Table 7.1 indicates the culvert types selected by MMM Group for design.

8.3 Foundation Design

The inverts for the proposed culverts will be at or near the existing culvert invert elevations at most culvert locations. Based on the borehole data, it is anticipated that a compact to dense sand and silt till will be present near the base elevations of the culvert foundations. The cohesionless till is considered to be suitable for supporting the base of box culverts as well as shallow foundations for open frame culverts.

8.4 Concrete Open Frame with Spread Footings on Native Soil

For concrete open footing culverts, the footings should be founded at or below the elevations presented in Table 8.2 below.

Table 8.2
Recommended Highest Footing Levels

Culvert ID	North Founding Depth (m)	North (Inlet) Founding El. (m)	South (Outlet) Founding Depth (m)	Founding El. (m)	Founding Stratum
C01	2.3	158.3	1.6	158.3	Sand / Sand & Gravel
C04	2.3	145.3	1.1	146.1	Sand
C05	1.5	164.8	1.5	166.3	Sand Till / Silt
C07	2.2	147.1	0.9	148.2	Sand Till / Sandy Silt
C11	2.2	150.0	1.7	150.0	Silt / Sand Till
C12	1.5	151.6	2.2	149.8	Sand Till
C13	2.3	160.8	2.3	160.3	Sand Till
C17	2.3	168.2	2.9	166.0	Sand Till / Sand
C18	2.2	144.0	1.5	143.4	Sand Till
C19	2.2	143.0	2.3	143.0	Sand Till
C20	2.2	144.3	1.8	144.0	Sand Till / Sand
C21	1.5	154.5	1.8	154.0	Silty Clay / Sand Till
C24	0.8	196.0	1.5	195.0	Silty Sand / Sandy Silt
C25	2.9	187.8	4.6	188.4	Silty Sand / Sandy Silt

It is recommended that the culverts be designed to resist external loadings including lateral earth pressures, hydrostatic pressure, weight of embankment fill, traffic loadings and surcharge due to construction equipment.

The footing subgrade for each culvert must be inspected by a qualified Geotechnical Engineer retained by the Contract Administrator to confirm that the footings are being placed on native undisturbed compact to dense soils. The purpose of this inspection is to identify if there are any remaining organics or soft footing subgrade soils that should be subexcavated and backfilled with well compacted granular fill or leanmix concrete.

Recommendations on subgrade preparation procedures are provided in Section 8.10.

8.4.1 Geotechnical Resistance

The geotechnical resistances for culvert footing design depend on the subsurface conditions in the area of the footprints of the proposed culvert or culvert extension. Based on the results of the boreholes and assuming that the subgrade preparation procedures recommended in this report are followed, the recommended geotechnical resistances at or below the founding elevations for each of the open footing culvert locations are presented as follows:

Table 8.3
Recommended Founding Elevations
and Geotechnical Resistances

Culvert ID	Assumed Founding Conditions for Design	Highest Founding Elevations (m)	Geotechnical Resistance	
			Factored ULS (kPa)	SLS (kPa)
C01	Sand (Compact to Dense)	158.3 (north) 158.3 (south)	375	250
C04	Sand / Silt (Compact to Dense)	145.3 (north) 146.1 (south)	300	200
C05	Sand Till / Sandy Silt (Dense)	164.8 (north) 166.3 (south)	375	250
C07	Sand Till / Sandy Silt (Compact)	147.1 (north) 148.2 (south)	300	200
C11	Sandy Silt / Sand Till (Compact)	150.0 (north) 150.0 (south)	300	200
C12	Sand Till / Sandy Silt (Dense)	151.6 (north) 149.8 (south)	450	300
C13	Sand and Silt Till (Dense)	160.8 (north) 160.3 (south)	450	300
C17	Sand Till / Sandy Silt (Compact to Dense)	168.2 (north) 166.0 (south)	450	300
C18	Sand and Silt Till (Compact / Dense)	144.0 (north) 143.4 (south)	450	300
C19	Sand Till (Very Dense)	143.0 (north) 143.0 (south)	600	400
C20	Sand Till / Silty Sand (Dense)	144.3 (north) 144.0 (south)	375	250
C21	Silty Clay / Sand Till (Very Stiff / Compact)	154.5 (north) 154.0 (south)	300	200
C24	Silty Sand / Sandy Silt (Dense)	196.0 (north) 195.0 (south)	450	300
C25	Silty Sand / Sandy Silt (Compact)	187.8 (north) 188.4 (south)	225	150

The above geotechnical resistances are based on a minimum footing width of 1.5 to 2.0 m, and are for vertical, concentric loads only. Effects of load inclination and eccentricity should be taken into account as illustrated in the CHBDC (2006) Clause 6.7.3 and Clause 6.7.4.

The geotechnical resistances at SLS quoted above correspond to 25 mm settlement for an individual culvert footing under the applied load. Further comments on settlements are presented in Section 8.9 of this report.

Resistance to lateral forces/sliding resistance between precast or cast-in-place concrete and the underlying undisturbed, typically compact to dense native soils should be evaluated in accordance with the CHBDC, 2006 assuming an ultimate coefficient of friction of 0.55.

For frost protection purposes, the culvert footings should incorporate 1.2 m of earth cover over the foundation base. It is possible to reduce the thickness of earth cover by the substitution of synthetic insulation. Typically 25 mm of extruded polystyrene insulation is equivalent to 600 mm of soil cover.

Scour protection should be provided for the footings of the open frame culverts. Design of scour protection must consider hydrologic and hydraulic concerns and should be carried out by specialists experienced in this field.

8.5 Footings on Engineered Fill

Construction of spread footings on engineered fill is another option. The fill should be at least 2.0 m thick below the footing, constructed over the native undisturbed compact to dense cohesionless till, and consist of OPSS Granular A (OPSS 1010) compacted according to OPSS 501 (Method A: Clause 501.08.02). The fill pad should conform to the geometry illustrated in Fig. 1 in Appendix F.

Provided that the footing width does not exceed 2.5 m, footings bearing on a 2.0 m thick pad of engineered fill founded on native compact to dense cohesionless till may be designed for a concentric, vertical geotechnical resistance of 450 kPa at factored ULS and a resistance of 300 kPa at SLS. These resistance values are for concentric, vertical loads only. In the case of eccentric or inclined loading, the geotechnical resistance must be calculated as illustrated in CHBDC Clause 6.7.3 and Clause 6.7.4.

Based on the results of the boreholes the recommended base elevations for the engineered fills are presented in Table 8.4.

Table 8.4
Recommended Base Elevations for Engineered Fill

Culvert ID	Assumed Founding Conditions for Design	Highest Base Elevations (m)
C01	Sand	159.3 (north) 158.9 (south)
C04	Sand	147.5 (north) 146.6 (south)
C05	Sand Till / Sandy Silt	164.8 (north) 166.3 (south)
C07	Silty Clay / Sandy Silt	147.8 (north) 148.4 (south)
C11	Sandy Silt / Sand Till	151.3 (north) 150.0 (south)
C12	Sand Till / Sandy Silt	151.6 (north) 151.3 (south)
C13	Sand and Silt Till	161.6 (north) 161.9 (south)
C17	Sand Till / Silty Sand	168.9 (north) 167.4 (south)
C18	Clayey Silt / Sand	145.4 (north) 144.3 (south)
C19	Sand / Sand Till	144.4 (north) 144.6 (south)
C20	Sand Till / Silty Sand	145.0 (north) 145.2 (south)
C21	Silty Clay / Sand Till	154.6 (north) 155.2 (south)
C24	Silty Sand / Sandy Silt (Dense / Compact)	196.1 (north) 195.8 (south)
C25	Silty Sand / Sandy Silt (Compact / Loose)	187.9 (north) 189.2 (south)

A frost protection soil cover of 1.2 m or equivalent thickness of insulation should be used for foundation and backfill design to provide protection against frost action on the culvert base and foundations.

The lateral resistance of the footings founded on the engineered fill may be computed using an unfactored friction coefficient of 0.6. This is an “ultimate” value and requires a degree of sliding movement to occur to fully mobilize the resistance.

8.6 Closed Concrete Box

For closed concrete box culverts, the recommended highest subgrade elevations are the same as shown in Table 8.4 for engineered fill bases. Following excavation to the design base level of the culvert, the subgrade must be inspected by a Geotechnical Engineer retained by the CA. Any remaining fill, topsoil, peat, streambed deposits or loose soils within the culvert footprint should be subexcavated as directed by the Geotechnical Engineer to the compact to dense native cohesionless glacial till. Any fill placed below the culvert to re-establish the founding level should consist of a compacted Granular A or B Type II material. This work should be carried out in accordance with SP 902SO1.

A minimum 300 mm thick layer of bedding material conforming to OPSS Granular A requirements should be provided under the base of the box culverts, as per OPSD 803.010. The bedding material should be placed and compacted as soon as practical following inspection and approval of the final subgrade as protection from disturbance during construction.

Culverts founded on the native, undisturbed compact to dense till at the above anticipated levels should be designed using a concentric, vertical geotechnical resistance of 300 kPa at factored ULS and a resistance of 200 kPa at SLS.

The geotechnical resistances at SLS quoted above correspond to 25 mm settlement for a rigid, closed concrete box culvert under the applied load. Further comments on settlements are presented in Section 8.9 of this report.

Resistance to lateral forces / sliding resistance between the concrete slab and the underlying Granular A should be calculated using an ultimate coefficient of friction of 0.6. This is an “ultimate” value and requires a degree of sliding movement to occur to fully mobilize the resistance.

8.7 Cast-in-place and Prefabricated Culvert Options

The foundation recommendations provided in the preceeding sections for the various culvert types apply to both cast-in-place and prefabricated culvert options. Use of precast culvert sections is preferable, where possible, since they require less installation time.

8.8 Culvert 19 Pile Foundation

Review of the preliminary General Arrangement drawings indicates that Culvert 19 will essentially comprise a bridge structure. This structure may be supported on steel H-piles bearing in the very dense/hard native soil.

8.8.1 Axial Resistance

The axial geotechnical resistances of an HP 310 X 110 pile installed in the very dense/hard native soils are:

- 1 600 kN at factored ULS
- 1 400 kN at SLS

The structural resistance of the pile must be checked by the structural designer.

The underside of the pile cap is expected to be near elevation 143 m based on the preliminary GA drawing. A minimum pile length of 5 m below the pile cap is recommended, and therefore the highest recommended tip elevation is 138.0 m. The actual pile tip elevation will be controlled as described in the following section.

Downdrag on the piles is not an issue at this site.

8.8.2 Pile Installation

Pile installation should be in accordance with Special Provision No. 903S01.

The soils encountered primarily consist of very dense silty sand till with SPT values of 100 blows for less than 0.3 m of penetration recorded at shallow depths. To achieve an adequate pile length, it is recommended each pile location be pre-drilled to elevation 140.0 m prior to driving the pile.

Pile driving should be controlled by the Hiley Formula and an ultimate pile resistance to be specified by the designer in accordance with Clause 3.3.2 (b) Construction Stage of the Structural Manual. The appropriate pile driving note is “Piles to be driven in accordance with Standard SS 103-11 using an ultimate resistance of “R” kN per pile”. “R” must have a value of two times the design load at ULS calculated by the structural engineer.

Due to the potential presence of cobbles and boulders in the till soils, the tips of all piles should be fitted with driving shoes as per OPSD 3000.100.

8.8.3 Lateral Resistance of Piles

The lateral resistance of the pile may be calculated using a value for the coefficient of horizontal subgrade reaction (k_s) and ultimate lateral resistance (p_{ult}) as follows:

$$k_s = n_h \cdot z / D \quad (\text{kN/m}^3)$$

$$p_{ult} = 3 \cdot \gamma \cdot z \cdot K_p \quad (\text{kPa})$$

where

z	=	depth of embedment of pile in metres
D	=	pile width in metres
n_h	=	coefficient related to soil density
	=	8,000 kN/m ³

γ	=	unit weight (bouyant unit weight below water table)
	=	11 kN/m ³
K_p	=	passive earth pressure coefficient
	=	3.5

The above equations and recommended parameters may be used to analyze the interaction between a pile and the surrounding soil. The lateral pressures obtained from the analysis should not exceed the ultimate lateral resistance.

The spring constant, K, for analysis may be obtained by the expression, $K = k_s * L * D$ (kN/m), where k_s is the coefficient of horizontal subgrade reaction (kN/m³), D is the pile width (m) and L is the length (m) of the pile segment or element used in the analysis. The ultimate lateral resistance on any one segment of pile, P_{ult} , may be obtained from the expression, $P_{ult} = p_{ult} * L * D$. This represents the ultimate load at which the pile fails and will not support any additional load at greater displacements. It is recommended, however, that the total lateral resistance assumed in one pile be limited to no more than 120 kN at ULS and 50 kN at SLS.

The modulus of subgrade reaction may have to be reduced, based on the pile spacing. The reduction factors to be used for a pile group oriented perpendicular or parallel to the direction of loading are provided in Table 8.5. Intermediate values may be obtained by linear interpolation.

Table 8.5 – Subgrade Reaction Reduction Factors for Pile Spacing

Condition	Pile Spacing, Centre to Centre*	Reduction Factor
Pile group oriented <i>perpendicular</i> to direction of loading	4D	1.0
	1D	0.5
Pile group oriented <i>parallel</i> to direction of loading	8D	1.0
	6D	0.7
	4D	0.4
	3D	0.25

* where D is the width of pile

For conventional abutments, the lateral resistance may be provided by battered piles.

8.9 Settlements

Foundation settlements will occur primarily as a result of embankment fill loading in the vicinity of the new culverts.

Where the native sands and silts are in a compact or dense state, similar in nature to those common to this site, any settlement should be immediate in nature and should essentially be completed by the end of construction. If the geotechnical resistances recommended in Table 8.3 of this report are not exceeded for foundation design and associated embankments

for the various culverts, the settlement of the culverts should be 25 mm or less. Post construction settlement should be considered negligible. Where peat exists, removal and replacement is recommended in order to limit settlement.

8.10 Subgrade Preparation

A number of boreholes located near the culverts encountered peat or native soils with organic inclusions. The presence of alluvial and organic deposits should be expected in the vicinities of the watercourses. The combined thickness of topsoil and peat at the various culvert sites was found to range from 25 mm to 2030 mm. The actual depth of topsoil and peat are noted in Section 5.2.

In order to minimize post construction total and differential settlements, it is recommended that once the excavation reaches the design subgrade elevation, the subgrade should be inspected by a qualified Geotechnical Engineer and all remaining topsoil, organics, alluvial deposits, loose and/or soft surficial native soils or otherwise disturbed materials should be removed as directed by the Geotechnical Engineer. A NSSP to this effect is attached in Appendix G. The subgrade must be uniform and competent to support the culvert.

Backfill to the sub-excavation for reinstating the founding elevation should consist of Granular A or B Type II material placed and compacted in accordance with SP 902S01. Lean mix concrete may be used as an alternative to compacted granular backfill. In submerged areas at the watercourses or where surficial ponding water prohibits adequate compaction of new fill, it is recommended that materials that do not require compaction, such as OPSS 1004 clear crushed stone or rock fill (finer portion with maximum nominal dimension of 150 mm), be used as backfill to the sub-excavation.

9 CULVERT BACKFILL AND LATERAL EARTH PRESSURES

It is recommended that backfill to the culverts consists of free-draining, non-frost susceptible granular materials such as Granular A or B Type II conforming to the requirements of Special Provision No. 110F13, "Amendment to OPSS 1010, November 2003" dated March 2004. Reference should be made to the backfill arrangements stipulated in OPSD 803.01 as appropriate.

All fills should be placed in regular lifts and be compacted in accordance with SP 105S10 "Amendment to OPSS 501, February 1996", dated November 2004. The backfill should be placed and compacted in simultaneous lifts on both sides of a culvert, and the top of backfill elevation should be the same on both sides of the culvert at all times. Heavy compaction equipment must not be used adjacent to the walls and roofs of the culverts.

For rigid structures such as concrete open frame and box culverts, it is recommended that at-rest horizontal earth pressures be used for design.

Earth pressures acting on the culvert walls may be assumed to impose a triangular distribution. For a fully drained backfill, the pressures should be computed in accordance with the CHBDC 2006 but are generally given by the expression:

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

where

p_h	=	horizontal pressure on the wall at depth h (kPa)
K	=	earth pressure coefficient (see table below)
γ	=	bulk 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 retaining walls are dependent on the material used as backfill. Recommended unfactored values are shown in the following Table 9.1. Active pressures should be used for any wingwall or unrestrained wall.

Table 9.1
Earth Pressure Coefficients (K)

Wall Condition	Earth Pressure Coefficient (K)					
	OPSS Granular A or OPSS Granular B Type II $\phi = 35^\circ; \gamma = 22.8 \text{ kN/m}^3$		OPSS Granular B Type I (modified) $\phi = 32^\circ; \gamma = 21.2 \text{ kN/m}^3$		Earth Fill $\phi = 30^\circ; \gamma = 20.0 \text{ kN/m}^3$	
	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 (Unrestrained Wall)	0.27	0.40	0.31	0.48	0.33	0.54
At rest (Restrained Wall)	0.43	-	0.47	-	0.50	-
Passive (Movement Towards Soil Mass)	3.7	-	3.3	-	3.0	-

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 at a depth of 1.7 m for Granular A or Granular B Type II.

The design of concrete culvert walls must incorporate measures such as weepholes and/or subdrains to permit drainage of the backfill, or alternatively the culvert walls should be designed to withstand the potential build-up of hydrostatic pressures behind the walls.

10 EMBANKMENT DESIGN AND CONSTRUCTION

Embankment construction should be carried out in accordance with Special Provision No. 206S03 “Amendment to OPSS 206, December 1993” dated November 2006. The embankment material should consist of earth fill or Select Subgrade Material (SSM) in compliance with Special Provision No. 110F13, “Amendment to OPSS 1010, November 2003” March 2004.

Provided that the earth fill or SSM is placed as recommended, it is anticipated that a slope inclination of 2H:1V or flatter should remain stable. Existing earth slope surface must be benched as per OPSD 208.010 in order to enhance the keying in of the new fill.

In general, surface vegetation, peat, topsoil, organic deposits, disturbed material or otherwise loose/soft soils should be stripped from the new culvert areas and embankment footprint. Inspection and approval of the foundation surfaces by a Geotechnical Engineer retained by the CA is recommended.

11 EROSION CONTROL

Erosion protection should be provided at the culvert inlet and/or outlet areas. Design of the erosion protection measures must consider hydrologic and hydraulic factors 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. Treatment at the outlets should be in accordance with OPSD 810.010. A vegetation cover should be established on all other exposed earth surfaces to protect against surficial erosion in general accordance with SP 572S01.

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. The clay seal should extend at least 0.3 m above the high water level and laterally for the width of the granular material, and have a minimum thickness of 0.5 m. The material requirements should be in accordance with OPSS 1205.

12 EXCAVATIONS

12.1 General

All excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the native sands and silts at these sites are classified as Type 3 soils above the water level and existing fills are classified as Type 4 soils.

12.2 Foundations

Excavation and backfilling for culvert construction must be carried out in accordance with SP 902S01.

12.3 Excavations

Excavations for culvert and/or extension construction will be carried out through the existing embankment fill and peat and surficial reworked soils. At locations where there is space restriction or where a slope has to be retained, the excavations will need to be carried out in conjunction with a protection system.

The Special Provision No. 105S19 titled “Amendment to OPSS 539, November 2003, Construction Specification for Protection Systems” dated November 2006 will have to be included in the contract documents.

Temporary shoring may be required at locations where unsupported open cutting cannot be carried out. Any shoring system must be designed by a licensed Professional Engineer, experienced in such designs.

13 GROUNDWATER CONTROL

Measured groundwater levels at the culvert locations are presented in Table 5.1. The data indicates that the groundwater level at the culverts ranges from 0.5 to 4.0 m below the existing ground surface. Beyond the toes of the highway embankment, the groundwater level is expected to be governed by the water levels in the watercourses (creeks/streams and swamps). It should be noted that artesian pressure was measured in the northern borehole drilled at Culvert C07 in October 2008 (Borehole C07-A).

Groundwater perched within the embankment fill will seep into the culvert excavations. Surface runoff will also tend to accumulate in the excavations. The surficial sands and silts below the groundwater level are prone to rapid deterioration upon exposure. The contractor must make provisions to control any water seepage, surface runoff and ponding by measures including the use of properly filtered sumps and pumps to maintain dry excavations during the course of the culvert construction. If appropriate dewatering measures are not implemented, boiling of the upper sands and silts will result and the bearing capacity of the culvert footings will be compromised. Accordingly, excavations below the groundwater level are not recommended without prior dewatering. While the dewatering remains the responsibility of the contractor, suitable systems include use of sumps and pumps for minor lowering (up to 0.5 m) of groundwater. For deeper dewatering depths, use of well points or construction within a sheet pile enclosure may be required. Dewatering in conjunction with temporary culverts, pumping over temporary dams or creek diversions may be needed for maintaining a dry excavation for the footings and culvert construction. A NSSP on dewatering is included in Appendix G.

In the event that a dewatering system involving well points or construction within a sheet pile enclosure is required at some locations, the dewatering should be designed by a specialist experienced in the field of dewatering. Groundwater control is anticipated to be required for the following culverts:

Table 13.1
Footings Base Depth Below Groundwater Level

Culvert ID	Assumed Minimum Base Elevation (m)	Inlet Depth Below W.L (m)	Outlet Depth Below W.L (m)
C01	157.3	2.2	2.1
C04	143.9	2.7	2.5
C05	164.3	N/A	2.6
C11	149.4	N/A	4.0
C12	149.6	1.8	2.0
C17	166.4	N/A	0.8
C18	142.4	2.6	N/A
C19	142.7	0.9	1.3
C20	143.8	1.7	N/A
C21	153.6	1.0	0.5
C24	194.0	0.8	0.8
C25	187.8	2.1	2.1

14 ROADWAY PROTECTION

Where excavations for a culvert is located in close proximity to live traffic lanes, temporary shoring may be required to retain the embankment fill and native soils during culvert installation. Temporary shoring in the form of trench boxes or soldier piles with timber lagging may be considered. Temporary shoring should be designed by a licensed Professional Engineer experienced in design of shoring with special consideration of traffic loads and any sloping retaining surfaces.

If shoring is required during construction to retain excavations adjacent to Highway 7 or other roadways, an item titled "Roadway Protection" as per SP539S01 should be included in the contract documents. Performance Level 2 is recommended as per Clause 539.04.02.01.

15 SEISMIC CONSIDERATIONS

The following seismic parameters should be used for design:

- Velocity Related Seismic Zone 0
- Zonal Velocity Ratio 0.05
- Acceleration Related Seismic Zone 1
- Zonal Acceleration Ratio 0.05
- Peak Horizontal Acceleration 0.08

The soil profile type at this site has been classified as Type I. Therefore, according to Table 4.4.6.1 of the CHBDC, a Site Coefficient “S” (ground motion amplification factor) of 1.0 should be used in seismic design.

In accordance with Clause 4.6.4 of the CHBDC, retaining structures should be designed using active (K_{AE}) and passive (K_{PE}) earth pressure coefficients that incorporate the effects of earthquake loading. The seismic earth pressure coefficients to be used in design at this site are shown in Table 14.1.

Table 15.1 – Earth Pressure Coefficients (K) for Seismic Design

Condition	Earth Pressure Coefficient (K) for Earthquake Loading			
	OPSS Granular A or OPSS Granular B $\phi = 35^\circ, \delta = 0^\circ$		OPSS Granular B Type I $\phi = 32^\circ, \delta = 0^\circ$	
	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
At rest**, K_{OE} (Restrained Wall)	0.53	-	0.58	-
Passive*, K_{PE} (Movement Towards Soil Mass)	3.6	-	3.2	-

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

** After Woods

The potential for liquefaction of the foundation soils has been assessed using the Seed and Idriss (1971) method. The footings are anticipated to be constructed above the groundwater level and are not considered to be in danger of undergoing liquefaction.

16 CONSTRUCTION CONCERNS

During construction, the Contract Administrator should employ experienced geotechnical staff to observe construction activities related to foundation construction, and to inspect and approve the culvert footing base and culvert subgrade.

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

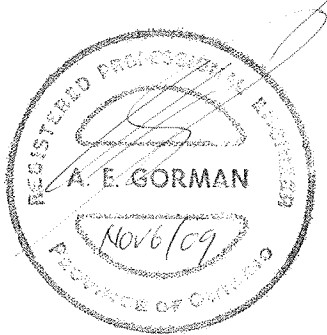
- Dewatering, in conjunction with temporary culvert, pumping over temporary dams or creek diversion if required, is essential to maintaining a reasonably dry excavation. Excavation below the groundwater level without prior dewatering is not recommended since the inflow of groundwater could cause boiling and sloughing of the soils;
- The till soils may contain cobbles and boulders that must be penetrated or removed during excavation activities. A NSSP to this effect is attached in Appendix G.

- Removal of peat, organics, loose/soft soils, fills and alluvial deposits near creek and stream channels;
- Care must be taken during excavation to avoid disturbing the culvert subgrade. The exposed subgrade should be protected from physical disturbance and the granular bedding and/or mud slab must be placed on the approved subgrade expeditiously following excavation;
- Confirmation that the culvert backfills and approach fills are adequately placed and compacted to specifications.

The successful performance of the culverts will depend largely upon good workmanship and quality control during construction. Subgrade inspection and approval should be undertaken by a qualified Geotechnical Engineer retained by the CA to confirm that the foundation recommendations are correctly implemented and material specifications are met.

17 CLOSURE

Engineering analysis and preparation of this foundation design report was carried out by Mr. David Elwood, P.Eng. The report was reviewed by Mr. Alastair Gorman, P.Eng. and Dr. P.K. Chatterji, P.Eng.



Alastair Gorman, P.Eng.
Associate, Senior Foundations Engineer



P.K. Chatterji, P.Eng.
Principal, Designated MTO Contact

Appendix A

Record of Borehole Sheets

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

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


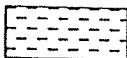
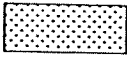


 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (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
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

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

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	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 percentage 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.

RECORD OF BOREHOLE No C01-A

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 864 798.97 E 337 522.62 ORIGINATED BY LH
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.10 - 2008.12.10 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)				
160.6	Geodetic						20 40 60 80 100				W _P W W _L				
0.0	Clayey SILT, some sand, trace gravel, trace rootlets Firm Dark Brown (FILL)		1	SS	6										
159.3			2	SS	6									4 53 29 14	
1.4	SAND fine, trace gravel, trace silt, mixed with organics, gas odour Compact Brown Wet		3	SS	12										
			4	SS	30										
	Medium sand layer Dense		5	SS	43										
			6	SS	42									1 73 26 (SI+CL)	
			7	SS	38										
			8	SS	39										
153.0	SAND and GRAVEL, trace silt Dense Brown Wet		9	SS	76										
7.6															
			10	SS	69									47 40 12 (SI+CL)	

Continued Next Page

+ 3 x 3

Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C01-A

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 864 798.97 E 337 522.62 ORIGINATED BY LH
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.10 - 2008.12.10 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	Continued From Previous Page																
150.0	SAND and GRAVEL, trace silt Dense Brown Wet																
10.7 149.7	Silty CLAY, trace sand, silty sand seams Hard		11	SS	100/												
10.9	Grey Brown END OF BOREHOLE AT 10.9m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 06-Jan-09 0.33 160.3 11-Feb-09 1.08 159.5				0.100												

ONTMT4S 6126 GPJ 20/2/09

RECORD OF BOREHOLE No C01-B

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 864 777.39 E 337 518.89 ORIGINATED BY SL
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.10.17 - 2008.10.17 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
165.7	Geodetic							20 40 60 80 100						
0.0	ASPHALT							20 40 60 80 100						
0.1	SAND, some gravel Brown Moist (FILL)			AS				20 40 60 80 100						
164.9								20 40 60 80 100						
0.8	Silty CLAY, some sand, trace gravel Hard Brown Moist (FILL)		1	SS	30		165	20 40 60 80 100						
			2	SS	13		164	20 40 60 80 100						
			3	SS	13		163	20 40 60 80 100						5 47 29 19
162.7								20 40 60 80 100						
3.0	SAND, trace silt, trace clay Compact to Very Dense Brown Moist (FILL)		4	SS	12		162	20 40 60 80 100						
			5	SS	100/ .125		161	20 40 60 80 100						
	Occasional Silty Clay layers		6	SS	8		160	20 40 60 80 100						
	Wood fragments from 5.4m to 5.7m						159	20 40 60 80 100						
159.8								20 40 60 80 100						
5.9	SAND, trace gravel, trace silt Compact Dark Brown Wet		7	SS	13		158	20 40 60 80 100						11 81 8 (SI+CL)
			8	SS	22		157	20 40 60 80 100						
			9	SS	25		156	20 40 60 80 100						

Continued Next Page

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

RECORD OF BOREHOLE No C01-B

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 864 777.39 E 337 518.89 ORIGINATED BY SL
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.10.17 - 2008.10.17 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page							20 40 60 80 100						
								O UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL X LAB VANE						
								20 40 60 80 100						
								PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT						
								w _p w w _L						
								WATER CONTENT (%)						
								20 40 60						
153.8	SAND, trace gravel, trace silt Compact Dark Brown Wet		10	SS	100/ 275		155							
11.9	Silty CLAY, trace sand Hard Grey Moist		11	SS	89		154							
152.0							153							0 5 22 74
13.7	END OF BOREHOLE AT 13.7m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 17-Oct-08 1.96 163.7 11-Feb-09 0.87 164.8													

+ 3, X 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

[illegible]

+ 3, × 3: Numbers refer to Sensitivity

RECORD OF BOREHOLE No C01-C

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 864 756.68 E 337 549.13 ORIGINATED BY SU
HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2008.11.24 - 2008.11.24 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	Continued From Previous Page																
148.7	SAND, some silt, trace gravel Very Dense Brown Grey Moist (TILL)		9	SS	88		149										
11.1	END OF BOREHOLE BOREHOLE CAVED TO 7.0m AND WATER LEVEL AT 2.7m 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) 06-Jan-09 0.62 159.2 11-Feb-09 0.50 159.3																

+ 3 . X 3 : Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

METRIC

Continued Next Page

+ 3, x 3: Numbers refer to Sensitivity

CONTMT4S 6126.GPJ 20/2/09

RECORD OF BOREHOLE No C04-A

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 865 110.63 E 338 447.67 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.08.22 - 2008.08.22 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
	Continued From Previous Page													
	Silty CLAY, trace sand Stiff Grey													
	Firm		11	SS	5		137							2 6 43 49
							136							
			12	SS	13		135							
							134							
			13	SS	13		133							0 6 54 40
							132							
131.9	Very stiff		14	SS	23									
15.7	END OF BOREHOLE AT 15.70m. BOREHOLE OPEN TO 4.57m AND WATER LEVEL AT 2.44m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 17-Oct-08 1.57 146.0 21-Nov-08 1.38 146.2 06-Jan-09 1.11 146.5 11-Feb-09 0.98 146.6													

ONTMT4S 6126 GPJ 20/2/09

+ ³ . × ³ : Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C04-B

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 865 106.20 E 338 462.15 ORIGINATED BY SA
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.09.02 - 2008.09.02 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
148.4	Geodetic												
0.0	ASPHALT: (150mm)												
0.2	SAND and GRAVEL, trace silt Compact Grey Moist (FILL)		1	SS	29		148						
147.6													
0.8	Silty SAND, trace clay, trace gravel Compact to loose Brown Slight petroleum odour Moist (FILL)		2	SS	13		147						3 59 28 11
146.4													
2.0	Silty SAND, trace clay Very dense to compact Grey with black staining Wet (FILL)		3	SS	4		146						
			4	SS	40		145						
			5	SS	26		144						
144.4													
4.0	SAND, some silt Compact Grey Moist		6	SS	24		143						
			7	SS	21		142						
143.5													
4.9	Clayey SILT, some sand, trace gravel Very stiff to Stiff Grey Moist Occasional sand layers		8	SS	13		141						1 18 66 16
			9	SS	7		140						
140.8													
7.6	Silty CLAY, trace sand Firm to stiff Grey Moist		10	SS	6		139						0 7 44 49

Continued Next Page

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

RECORD OF BOREHOLE No C04-B

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 865 106.20 E 338 462.15 ORIGINATED BY SA
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.09.02 - 2008.09.02 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
	Continued From Previous Page															
	Silty CLAY, trace sand, trace gravel Firm to stiff Grey Moist		11	SS	8											
			12	SS	5											
			13	SS	7											
			14	SS	16											
			15	SS	16											
131.0																
17.4	END OF BOREHOLE AT 17.4m. BOREHOLE OPEN TO 17.40m AND WATER LEVEL AT 2.44m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 11-Feb-09 2.02 146.4															

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

RECORD OF BOREHOLE No C04-C

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 865 081.70 E 338 468.75 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.08.21 - 2008.08.21 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
147.2	Geodetic												
0.0	TOPSOIL: (75mm)												
0.1	Clayey SILT, some sand, trace rootlets		1	SS	9		147						
146.6	Stiff												
0.6	Dark brown												
	Moist												
	SAND, some gravel, trace silt		2	SS	55		146						29 58 12 (SI+CL)
145.9	Very dense												
1.4	Brown												
	Moist												
	SAND, some silt		3	SS	33		145						
	Dense to compact												
	Brown												
	Moist												
			4	SS	19		144						0 72 28 (SI+CL)
			5	SS	21		143						
			6	SS	34		142						
			7	SS	9		141						1 73 26 (SI+CL)
141.2													
6.1	Clayey SILT, some sand, trace gravel		8	SS	15		140						
	Stiff												
	Grey												
	Moist												
139.6													
7.6	SAND and SILT, some clay		9	SS	9		139						
	Loose to Compact												
	Grey												
	Moist												
	(TILL)												
			10	SS	10		138						2 36 43 19

Continued Next Page

+ 3 x 3 Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

ORIGINATED BY ES

COMPILED BY ES

CHECKED BY DE

+ 3, X 3; Numbers refer to Sensitivity

RECORD OF BOREHOLE No C05-A

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 125.26 E 339 607.98 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.08.20 - 2008.08.20 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
166.3	Geodetic													
0.0	TOPSOIL: (125mm)													
0.1	Silty SAND, some clay Loose to compact Brown (FILL) Occasional sand layers		1	SS	8		166							
			2	SS	31		165							2 48 37 13
164.8														
1.5	SAND and SILT, some clay Compact to Dense Fissured (TILL) Grey		3	SS	44		164							4 36 35 25
			4	SS	46		163							
			5	SS	31		162							
			6	SS	36		161							
			7	SS	21		160							5 42 41 12
			8	SS	42		159							
			9	SS	44		158							
			10	SS	31		157							

Continued Next Page

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

ONTMT4S 6125 GPJ 20/2/09

RECORD OF BOREHOLE No C05-A

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 125.26 E 339 607.98 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.08.20 - 2008.08.20 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL												
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100																	
Continued From Previous Page																													
155.2	SAND and SILT, some clay Compact to Dense Grey (TILL)		11	SS	45		156																						
11.1	END OF BOREHOLE AT 11.13m. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: <table border="1"> <thead> <tr> <th>DATE</th> <th>DEPTH (m)</th> <th>ELEV. (m)</th> </tr> </thead> <tbody> <tr> <td>17-Oct-08</td> <td>1.17</td> <td>165.1</td> </tr> <tr> <td>21-Nov-08</td> <td>1.24</td> <td>165.0</td> </tr> <tr> <td>06-Jan-09</td> <td>2.01</td> <td>164.3</td> </tr> <tr> <td>11-Feb-09</td> <td>2.09</td> <td>164.2</td> </tr> </tbody> </table>	DATE	DEPTH (m)	ELEV. (m)	17-Oct-08	1.17	165.1	21-Nov-08	1.24	165.0	06-Jan-09	2.01	164.3	11-Feb-09	2.09	164.2													
DATE	DEPTH (m)	ELEV. (m)																											
17-Oct-08	1.17	165.1																											
21-Nov-08	1.24	165.0																											
06-Jan-09	2.01	164.3																											
11-Feb-09	2.09	164.2																											

ONTMT4S 6126.GPJ 20/2/09

RECORD OF BOREHOLE No C05-B

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 102.19 E 339 606.24 ORIGINATED BY SA
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.09.03 - 2008.09.03 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	PLASTIC LIMIT W P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W L	
171.2	Geodetic												
0.0	ASPHALT: (150mm)												
0.2	SAND and GRAVEL, trace silt Very dense to dense Light brown Moist (FILL)		1	SS	44		171			o			
169.9			2	SS	35		170			o			
1.3	Silty SAND, some gravel, trace clay Compact to loose Light brown to brown Slight petroleum odour Moist (FILL)		3	SS	20		170			o			10 53 28 9
			4	SS	5		169			o			
	Compact		5	SS	4		168			o			
			6	SS	10		167			o			2 40 38 20
			7	SS	11		167			o			
166.0							166						
5.2	SAND and SILT, some clay Dense to Compact Grey Moist (TILL)		8	SS	35		165			o			
			9	SS	24		164			o			
							163			o			3 39 38 19
			10	SS	21		162			o			

Continued Next Page

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

RECORD OF BOREHOLE No C05-B

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 102.19 E 339 606.24 ORIGINATED BY SA
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.09.03 - 2008.09.03 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
	Continued From Previous Page													
	SAND and SILT, some clay Dense to Compact Grey Moist (TILL)		11	SS	17		161							
							160							
			12	SS	14		159							1 39 41 19
							158							
	Very stiff		13	SS	27		157							
							156							
	Hard		14	SS	31		155							
154.4							154							
16.8	Silty CLAY, some sand, trace gravel Hard Grey Moist		15	SS	37									5 34 32 29
153.8														
17.4	END OF BOREHOLE AT 17.4m. BOREHOLE OPEN TO 17.40m AND WATER LEVEL AT 2.44m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 17-Oct-08 5.42 165.8 11-Feb-09 4.33 166.9													

ONTMT4S 6126 GPJ 20/2/09

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

RECORD OF BOREHOLE No C05-C

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 075.46 E 339 629.33 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.08.21 - 2008.08.21 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
167.8	Geodetic													
0.0	TOPSOIL: (100mm)													
0.1	Sandy SILT, trace gravel, trace rootlets Loose Dark Brown Wet		1	SS	3									
			2	SS	4		167							
	Dense to Compact		3	SS	33		166							0 25 63 12
			4	SS	24									
164.9														
2.9	SAND and SILT, some clay Compact to Dense Grey Moist (TILL)		5	SS	16		165							8 41 35 16
	Occasional silty clay nodules		6	SS	37		164							
			7	SS	29		163							
	Compact													
			8	SS	34		162							8 39 42 11
			9	SS	29		160							
			10	SS	26		159							1 41 43 16
							158							

Continued Next Page

+ 3 . X 3 : Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C05-C

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 075.46 E 339 629.33 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.08.21 - 2008.08.21 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																
156.7	SAND and SILT, some clay Compact to Dense Grey Moist (TILL)		11	SS	27		157										
11.1	END OF BOREHOLE AT 11.13m. BOREHOLE BACKFILLED WITH BENTONITE GROUT TO SURFACE.																

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

RECORD OF BOREHOLE No C07-A

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 865 973.78 E 341 012.70 ORIGINATED BY ES
HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2008.08.19 - 2008.08.20 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL							× LAB VANE	
149.3	Geodetic						20	40	60	80	100	20	40	60	GR SA SI CL			
0.1	TOPSOIL: (50mm)																	
	Silty CLAY, some sand		1	SS	9													
	Stiff																	
	Dark brown		2	SS	6													
	Brown to grey		3	SS	11										0 21 53 26			
147.1																		
2.3	Sand and SILT, some clay		4	SS	24													
	Compct to Dense																	
	Brown to grey																	
	(TILL)																	
	Occasional silt layers		5	SS	33										4 31 42 23			
			6	SS	30													
	Compact		7	SS	27										2 31 43 24			
			8	SS	22													
			9	SS	17													
			10	SS	18										1 21 62 15			

Continued Next Page

+ 3 x 3 Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

METRIC

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No C07-B

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 865 956.24 E 341 018.46 ORIGINATED BY SA
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.09.04 - 2008.09.04 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
150.9	Geodetic											
0.0	ASPHALT (0.15m)											
0.2	SAND and GRAVEL, trace silt Very Dense Grey Moist (FILL)		1	SS	60							
150.1												
0.8	SAND with some gravel, trace silt, occasional cobbles Very Dense Grey Moist (FILL) Frequent cobbles, occasional sandy silt seams		2	SS	100/ 275		150					
			3	SS	55		149					16 73 12 (SI+CL)
148.6												
2.3	Clayey SILT, trace gravel Stiff Dark Brown Moist Strong Gas Odour (FILL)		4	SS	16		148					
			5	SS	9							
147.0												
3.8	SAND and SILT, some clay Compact Grey Moist (TILL)		6	SS	13		147					3 20 61 16
			7	SS	19		146					
							145					
			8	SS	17		144					
							143					2 34 44 20
			9	SS	10		142					
							141					
			10	SS	13							

Continued Next Page

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

METRIC

+ 3, x 3: Numbers refer to Sensitivity

ONTMT4S 6126.GPJ 20/2/09

RECORD OF BOREHOLE No C07-C

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 865 938.14 E 341 026.53 ORIGINATED BY ES
HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.01.05 - 2009.01.06 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
149.1	Geodetic													
8.8	TOPSOIL (25mm)													
	Sandy SILT, some clay, occasional rootlets Loose to Compact Dark Brown		1	SS	2		149							
			2	SS	21		148							12 33 30 26
			3	SS	10		147							
			4	SS	12		146							1 16 54 30
			5	SS	22		145							
			6	SS	25		144							
144.5			7	SS	37		143							7 33 30 30
4.6	SAND and SILT, some clay, trace gravel Dense to Very Dense Grey Moist (TILL)		8	SS	60		142							
			9	SS	62		141							
			10	SS	15		140							6 45 35 14
	Compact													

Continued Next Page

+ 3 x 3 Numbers refer to
Sensitivity

20
15 10
(%) STRAIN AT FAILURE

METRIC

+ 3, X 3: Numbers refer to Sensitivity

RECORD OF BOREHOLE No C11-A

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 230.46 E 341 799.50 ORIGINATED BY SL
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.03 - 2008.12.03 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								20 40 60 80 100							
152.2	Geodetic														
0.0	TOPSOIL: (900 mm)		1	SS	6		152								
151.3			2	SS	10										
0.9	Sandy SILT, some clay, trace gravel, trace organics Compact Dark Brown to Brown Moist						151								
			3	SS	11										
			4	SS	16		150								
			5	SS	13		149								
			6	SS	10		148								
147.6			7	SS	32		147								
4.6	SAND and SILT, some clay, trace gravel Dense Grey Brown Moist (TILL)		8	SS	100		146								
	Very Dense		9	SS	100/ 0.125		145								
			10	SS	100/ 0.075		144								
							143								

Continued Next Page

+ 3 . x 3 : Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

ONTMT4S 6126 GPJ 20/2/09

RECORD OF BOREHOLE No C11-A

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 230.46 E 341 799.50 ORIGINATED BY SL
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.03 - 2008.12.03 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100									
	Continued From Previous Page																
141.4	SAND and SILT, some clay, trace gravel Dense Grey Brown Moist (TILL)		11	SS	100/		142										
10.8	END OF BOREHOLE AT 10.8m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. Moist to Damp WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 06-Jan-09 0.26 151.9 11-Feb-09 3.80 148.4				0.125												

ONTMT4S 6126.GPJ 20/2/09

RECORD OF BOREHOLE No C11-B

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 210.02 E 341 790.92 ORIGINATED BY SA
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.08.28 - 2008.08.28 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
155.3	Geodetic											
0.0	ASPHALT: (150mm)											
0.2	SAND, trace silt Dense to Very Dense Brown Moist Slight hydrocarbon odour (FILL)		1	SS	31		155					14 70 16 (SI+CL)
			2	SS	82							
153.8							154					
1.5	Silty SAND, trace gravel Compact Brown Moist (FILL)		3	SS	17							
152.9							153					
2.4	SAND and SILT, some clay Compact to Loose Brown Grey Mottled Moist (FILL)		4	SS	13							
			5	SS	6		152					1 47 37 16
	Compact		6	SS	13		151					
150.6							150					
4.7	SAND and SILT, some clay Compact Grey Moist (TILL)		7	SS	17							
			8	SS	19		149					1 41 38 20
							148					
	Grinding auger											
	Very Dense		9	SS	100/ 300		147					
					.075		146					

Continued Next Page

+ ³ × ³ Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C11-C

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 193.20 E 341 808.98 ORIGINATED BY SU
HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2008.11.25 - 2008.11.25 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)
								UNCONFINED + FIELD VANE					
								QUICK TRIAXIAL x LAB VANE					
151.7	Geodetic						20 40 60 80 100						
0.0	TOPSOIL (150mm)						20 40 60 80 100						
0.2	Silty CLAY, trace sand, trace roots and rootlets Soft Dark Brown (FILL)		1	SS	3								
150.7													
1.0	PEAT Dark Brown to Black Soft Moist		2	SS	1								
150.0													
1.7	SAND and SILT, some clay, trace gravel Compact to Dense Brown to Grey (TILL)		3	SS	18								
			4	SS	27								
			5	SS	14								
			6	SS	42								
			7	SS	56								
			8	SS	77								

Continued Next Page

+ 3 x 3 Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

ONTMT4S 6126.GPJ 20/2/09

RECORD OF BOREHOLE No C11-C

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 193.20 E 341 808.98 ORIGINATED BY SU
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.11.25 - 2008.11.25 CHECKED BY DE

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
	Continued From Previous Page						20	40	60	80	100					
140.6	SAND, trace clay, some silt Very Dense Grey Wet		10	SS	100/ 0.225	141										0 78 13 9
11.0	END OF BOREHOLE AT 11.0m. BOREHOLE OPEN TO 9.9m AND WATER LEVEL AT 0.7m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.2m, THEN CUTTINGS TO SURFACE.															

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

RECORD OF BOREHOLE No C12-A

1 OF 1

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 347.42 E 342 168.44 ORIGINATED BY ES
HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2008.08.26 - 2008.08.26 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w		
153.1	Geodetic											
0.0	TOPSOIL: (50mm)											
	Sandy SILT, some clay Loose Dark brown		1	SS	3							
			2	SS	7							
151.6												
1.5	SAND and SILT, some clay Dense to Very Dense Brown (TILL)		3	SS	38							
			4	SS	62							
			5	SS	102/ 225							
			6	SS	100/ 200							
			7	SS	100/ .125							
			8	SS	100/ .125							
145.3			9	SS	100/ .150							
7.8	END OF BOREHOLE AT 7.77m. BOREHOLE OPEN TO 1.52m AND WATER LEVEL AT 1.27m UPON COMPLETION. Well installation consists of 50.8mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 17-Oct-08 0.79 152.3 21-Nov-08 0.62 152.5 06-Jan-09 0.29 152.8 11-Feb-09 1.67 151.4											

ONTMT4S 6126.GPJ 20/2/09

+ 3 . X 3 Numbers refer to
Sensitivity 20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C12-B

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 334.97 E 342 182.44 ORIGINATED BY SL
HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2008.10.08 - 2008.10.08 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
156.3	Geodetic														
0.0	SAND and GRAVEL, trace silt Compact Brown to Grey Moist (FILL)		1	SS	23										
			2	SS	26										
			3	SS	50/ .150										
154.5	Gravel in spoon tip														
1.8	SAND and SILT, some clay, trace gravel Compact Brown Moist (TILL)		4	SS	17										
			5	SS	5										
			6	SS	5										
			7	SS	24										
			8	SS	50/ .150										
			9	SS	50/ .150										
			10	SS	82										

Continued Next Page

+ 3 × 3

Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

+ 3, × 3: Numbers refer to Sensitivity

RECORD OF BOREHOLE No C12-C

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 303.21 E 342 160.71 ORIGINATED BY SU
HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2008.11.26 - 2008.11.26 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
152.0	Geodetic												
0.0	TOPSOIL (655 mm)		1	SS	3		152						GR SA SI CL
151.3													
0.7	Sandy SILT, some clay Compact Dark Brown Moist		2	SS	14		151						0 39 49 12
			3	SS	20		150						
149.8													
2.1	SAND and SILT, some clay, trace gravel Very Dense Brown to Grey Moist (TILL)		4	SS	100/ 0.225		149						
			5	SS	100/ 0.150		148						
			6	SS	100/ 0.225		147						4 46 35 15
			7	SS	100/ 0.200		146						
			8	SS	100/ 0.225		145						
			9	SS	100/ 0.125		144						
							143						1 42 37 20

Continued Next Page

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

RECORD OF BOREHOLE No C12-C

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 303.21 E 342 160.71 ORIGINATED BY SU
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.11.26 - 2008.11.26 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40					
	Continued From Previous Page													
141.2	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		10	SS	100		142							
10.7	END OF BOREHOLE AT 10.7m. BOREHOLE OPEN AND WATER LEVEL AT 1.6m 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) 06-Jan-09 0.36 151.6				0.050									

ONTMT4S 6126.GPJ 20/2/09

RECORD OF BOREHOLE No C13-A

1 OF 1

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 553.93 E 342 773.42 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.08.26 - 2008.08.26 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
163.1	Geodetic													
0.9	TOPSOIL (50mm)		1	SS	2		163							
	Clayey SILT, some sand, trace rootlets Soft to stiff Dark brown (FILL)		2	SS	8		162							2 27 57 14
161.6														
1.5	SAND and SILT, some clay, trace gravel Compact to Very Dense Brown Fissured (TILL) Some sand layers		3	SS	10		161							3 42 39 16
			4	SS	40									
			5	SS	100/ 225		160							
	Grey		6	SS	111		159							3 43 37 17
	Occasional sand layers		7	SS	105/ 250		158							
156.8			8	SS	110/ 225		157							
6.3	END OF BOREHOLE AT 6.32m. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 21-Nov-08 0.34 162.7 06-Jan-09 Frozen at Ground Surface 11-Feb-09 2.82 160.28													

+ ³ × ³ : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C13-B

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 537.64 E 342 769.81 ORIGINATED BY SL
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.09.05 - 2008.10.16 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
165.3	Geodetic													
0.0	ASPHALT (150mm)													
0.2	SAND and GRAVEL, trace silt Very Dense Grey Moist (FILL)		1	SS	79		165							
			2	SS	28		164							
163.8														
1.5	Sandy SILT, trace gravel Compact Dark Brown Moist (FILL)		3	SS	11		163							
			4	SS	9		162							
162.0			5	SS	12		161							
3.4	SAND and SILT, some clay Dense to Very Dense Brown to Grey Moist (TILL)		6	SS	32		160							
			7	SS	100/ 0.300		159							
			8	SS	70/ 0.075		158							
			9	SS	100/ 0.175		157							
			10	SS	105/ 0.200		156							
	Occasional silty clay seams													

Continued Next Page

+ ³ × ³ Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

ONTMT4S 6126.GPJ 20/2/09

RECORD OF BOREHOLE No C13-B

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 537.64 E 342 769.81 ORIGINATED BY SL
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.09.05 - 2008.10.16 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
	Continued From Previous Page													
	SAND and SILT, some clay Dense to Very Dense Brown to Grey Moist (TILL)		11	SS	100/ 0.150		155							2 45 34 20
			12	SS	100/ 0.125		154							
			13	SS	100/ 0.125		153							3 43 35 19
			14	SS	100/ 0.150		150							
149.9														
15.4	END OF BOREHOLE AT 15.4m. BOREHOLE OPEN TO 1.2m, WATER LEVEL AT 10.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG, MIXED OF AUGER CUTTINGS TO 0.15m THEN ASPHALT TO SURFACE.													

ONTMT4S 6126 GPJ 20/2/09

RECORD OF BOREHOLE No C13-C

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 514.41 E 342 778.32 ORIGINATED BY SU
HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2008.11.27 - 2008.11.27 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)					
								○ UNCONFINED		+ FIELD VANE							● QUICK TRIAXIAL		× LAB VANE		
								20	40	60							80	100	20	40	60
162.6	Geodetic																				
0.0	TOPSOIL (650 mm)		1	SS	9																
161.9	SAND and SILT, some clay, trace gravel Loose to Very Dense Grey Brown Mottled Moist (TILL)		2	SS	9										1 45 40 14						
0.7			3	SS	12																
			4	SS	58										5 40 33 22						
			5	SS	100/ 0.200																
			6	SS	100/ 0.150																
			7	SS	100/ 0.250										4 41 34 21						
		8	SS	100/ 0.050																	
153.4			9	SS	100/ 0.075																
9.2	END OF BOREHOLE AT 9.2m. BOREHOLE OPEN AND WATER LEVEL AT 8.0m UPON COMPLETION OF DRILLING. Piezometer installation consists of																				

Continued Next Page

+ 3 . X 3 Numbers refer to
Sensitivity 20
15 5
10 (%) STRAIN AT FAILURE

ONTMT4S 6126 GPJ 20/2/09

METRIC

COIL PROFILES	DATA FILES			DYNAMIC CONE PENETRATION			
---------------	------------	--	--	--------------------------	--	--	--

+ 3, X 3: Numbers refer to Sensitivity

RECORD OF BOREHOLE No C17-A

1 OF 1

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 924.46 E 343 836.69 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.08.28 - 2008.08.28 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
170.5	Geodetic													
0.0 0.1	TOPSOIL (75mm)		1	SS	6		170							
	SAND and SILT, trace clay Loose Dark brown (FILL)		2	SS	4									1 47 42 9
168.9							169							
1.5	SAND and SILT, some clay, trace gravel Compact to Very Dense Brown Moist (TILL) Auger grinding		3	SS	13									
			4	SS	103		168							2 42 37 19
			5	SS	100/ .125									
			6	SS	100/ .150		167							4 47 32 17
			7	SS	100/ .025		166							
			8	SS	100/ .025		165							
			9	SS	100/ .050		164							
162.8							163							
7.7	END OF BOREHOLE AT 7.67m. BOREHOLE OPEN AND DRY UPON COMPLETION. Well installation consists of 50.8mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 17-Oct-08 1.48 169.0 21-Nov-08 2.13 168.4 06-Jan-09 4.17 166.3 11-Feb-09 4.22 166.3													

ONTMT4S 6126 GPJ 20/2/09

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

RECORD OF BOREHOLE No C17-B

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 900.36 E 343 828.59 ORIGINATED BY SA
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.08.26 - 2008.08.26 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
								WATER CONTENT (%)									
175.1	Geodetic						20	40	60	80	100						
0.0	ASPHALT: (150mm)						20	40	60	80	100						
0.2	SAND and GRAVEL, trace silt Very dense to dense Light brown Moist Slight hydrocarbon odour (FILL)		1	SS	65/ .125												
			2	SS	61												
			3	SS	56											13 51 35 (SI+CL)	
			4	SS	61												
			5	SS	35											15 47 39 (SI+CL)	
171.3			6	SS	9												
3.8	Silty SAND, trace clay Loose Dark brown Moist (FILL)		7	SS	9											3 54 29 13	
			8	SS	8												
168.7			9	SS	26											3 35 41 21	
6.4	SAND and SILT, some clay Compact to Very Dense Brown Moist (TILL)		10	SS	100/ .125												

Continued Next Page

+ 3, X 3 Numbers refer to
Sensitivity 20
15 10 5 0
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C17-B

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 900.36 E 343 828.59 ORIGINATED BY SA
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.08.26 - 2008.08.26 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
	Continued From Previous Page													
	SAND and SILT, some clay Compact to Very Dense Brown Moist (TILL) Grinding auger	0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80 84 88 92 96 100	11	SS	90/ .100		165							
	Grinding auger	0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80 84 88 92 96 100					164							4 45 34 17
	Grinding auger	0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80 84 88 92 96 100	12	SS	80/ .100		163							
	Grinding auger	0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80 84 88 92 96 100	13	SS	60/ .050		162							
	Grinding auger	0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80 84 88 92 96 100	14	SS	100/ .050		161							
158.2		0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80 84 88 92 96 100	15	SS	80/ .075		160							
16.8	END OF BOREHOLE AT 16.84m. BOREHOLE OPEN TO 11.58m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO 0.45m THEN BENTONITE GROUT TO SURFACE.	0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80 84 88 92 96 100					159							

+ ³ . ³ : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C17-C

1 OF 1

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 873.79 E 343 836.69 ORIGINATED BY JM
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.11 - 2008.12.12 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
168.9	Geodetic													
0.0	TOPSOIL (130mm)													
0.1	Silty SAND, trace clay, trace gravel Compact Brown Moist		1	SS	14									
			2	SS	4									
							168							1 54 34 11
	Wet		3	SS	13									
			4	SS	14									
							167							
	Grey		5	SS	40									
							166							
165.3														
3.7	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		6	SS	100/									
					0.075		165							
			7	SS	100/									7 44 32 17
					0.100		164							
							163							
			8	SS	100/									
					0.075		162							
161.2														
7.7	END OF BOREHOLE AT 7.7m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.		9	SS	100/									
					0.075									
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 06-Jan-09 1.23 167.7 11-Feb-09 1.69 167.2													

+ ³ . X ³ : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C18-A

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 238.29 E 344 792.20 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.01 - 2008.12.01 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
146.2	Geodetic							20	40	60	80	100						
0.0	TOPSOIL (50mm)																	
145.4	Silty SAND, trace clay, trace rootlets Loose Dark Brown Moist		1	SS	7		146											
0.8	Clayey SILT, some sand, trace gravel Stiff Dark Brown		2	SS	14		145											
144.9	SAND and SILT, some clay, trace gravel Compact to Very Dense Brown Moist (TILL)		3	SS	17		144											
1.3			4	SS	87		143											
			5	SS	84		142											
			6	SS	118		141											
			7	SS	131		140											
			8	SS	158/ 0.275		139											
138.6	SAND, some silt, trace gravel Very Dense Grey Moist		9	SS	157		138											
7.6			10	SS	125/ 0.225		137											
136.7	SAND and SILT, some clay, trace gravel Very Dense																	
9.4																		

Continued Next Page

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

RECORD OF BOREHOLE No C18-A

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 238.29 E 344 792.20 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.01 - 2008.12.01 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100									SHEAR STRENGTH kPa			WATER CONTENT (%)		
																	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE				w _p w w _L	
	Continued From Previous Page																					
135.4	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		11	SS	100/		136															
10.8	END OF BOREHOLE AT 10.8m. WATER LEVEL AT 2.4m 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) 06-Jan-09 1.31 144.9 11-Feb-09 1.23 145.0				0.100																	

+ 3 x 3 Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C18-B

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 225.64 E 344 803.34 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.08.11 - 2008.08.11 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
147.8	Geodetic													
0.0	ASPHALT (100mm)													
0.1	SAND and GRAVEL, trace silt Dense Brown Moist (FILL)		1	SS	30		147							15 69 16 (SI+CL)
146.7			2	SS	32									
1.1	Silty SAND, trace clay, trace gravel Compact to Loose Dark brown with grey striations Moist (FILL)		3	SS	18		146							9 62 20 9
			4	SS	4		145							
			5	SS	7		144							
143.9			6	SS	13		143							
4.0	SAND and SILT, some clay, trace gravel Compact to Very Dense Grey (TILL)		7	SS	80		142							
			8	SS	93		141							3 41 35 21
			9	SS	82		140							1 36 37 26
			10	SS	178/ .275		139							
							138							

Continued Next Page

+ 3 . X 3 Numbers refer to
Sensitivity 20
15 10 5
(%) STRAIN AT FAILURE

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100			
	Continued From Previous Page										
135.5	SAND and SILT, some clay, trace gravel Very Dense Grey (TILL)		11	SS	100/ .100		137				
12.3	END OF BOREHOLE AT 12.32m. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 17-Oct-08 2.00 145.8 11-Feb-09 2.06 145.7		12	SS	100/ .125		136				

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C18-C

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 191.33 E 344 806.77 ORIGINATED BY LH
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.09 - 2008.12.09 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
144.9	Geodetic													
0.0	TOPSOIL (600mm)		1	SS	6									
144.3														
0.6	SAND, trace silt Loose Dark Brown Moist		2	SS	9		144							
143.4														
1.5	SAND and SILT, some clay, trace gravel Dense to Very Dense Grey Moist (TILL)		3	SS	33		143							
			4	SS	100/ 0.250		142							5 37 41 17
			5	SS	100/ 0.100		141							
			6	SS	100/ 0.250		140							
			7	SS	100/ 0.250		139							
			8	SS	100/ 0.150		138							1 46 40 12
			9	SS	100/ 0.050		137							
			10	SS	100/ 0.150		136							3 42 38 17
							135							

Continued Next Page

+ 3 × 3 : Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C18-C

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 191.33 E 344 806.77 ORIGINATED BY LH
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.09 - 2008.12.09 CHECKED BY DE

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	Continued From Previous Page																
134.1	SAND and SILT, some clay, trace gravel Dense to Very Dense Grey Moist (TILL)		11	SS	100/												
10.8	END OF BOREHOLE AT 10.8m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 06-Jan-09 4.32 140.5 11-Feb-09 3.76 141.1				0.100												

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

RECORD OF BOREHOLE No C19-A

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 309.29 E 345 026.88 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.08.28 - 2008.08.28 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
145.2	Geodetic															
0.9	TOPSOIL: (50mm)		1	SS	5											2 27 54 18
144.4	Clayey SILT, some sand Firm Dark brown (FILL)		2	SS	11											
0.8	SAND and GRAVEL, trace silt Compact Brown Wet		3	SS	102											
143.4	Silty SAND, some clay, trace gravel Very Dense Brown to Grey Moist (TILL)		4	SS	150/ 225											6 45 35 13
1.8			5	SS	100/ 200											
			6	SS	100/ 200											
			7	SS	75											7 51 36 7
			8	SS	48											
			9	SS	55											
			10	SS	49											

Continued Next Page

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

RECORD OF BOREHOLE No C19-A

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 309.29 E 345 026.88 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.08.28 - 2008.08.28 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
134.1	Continued From Previous Page Silty SAND, some clay, trace gravel Very Dense Brown to Grey Moist (TILL)		11	SS	119		135										
11.1	END OF BOREHOLE AT 11.13m. BOREHOLE OPEN TO 6.71m AND WATER LEVEL AT 3.05m UPON COMPLETION. Well installation consists of 50.8mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 17-Oct-08 0.44 144.7 21-Nov-08 1.43 143.7 06-Jan-09 1.98 143.2 11-Feb-09 1.57 143.6																

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

RECORD OF BOREHOLE No C19-B

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 292.19 E 345 008.98 ORIGINATED BY SA
HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2008.08.25 - 2008.08.25 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
147.8	Geodetic													
0.0	ASPHALT: (150mm)													
0.2	SAND and GRAVEL, trace silt Dense to Compact Brown Moist (FILL)		1	SS	41		147							
			2	SS	32									
	Increasing silt		3	SS	23		146							23 64 13 (SI+CL)
145.2			4	SS	23									
2.6	Silty SAND, some clay, trace gravel Very Dense to Compact Brown Moist (FILL)		5	SS	56/ 200		145							16 50 23 11
	Trace topsoil Trace wood fragments Dark brown		6	SS	13		144							4 65 22 9
143.2			7	SS	51		143							
4.6	Silty SAND, trace clay, trace gravel Very Dense Grey Moist (TILL)		8	SS	100/ 300		142							6 57 32 5
			9	SS	100/ 300		141							
			10	SS	82		140							
							139							
							138							

Continued Next Page

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

RECORD OF BOREHOLE No C19-B

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 292.19 E 345 008.98 ORIGINATED BY SA
HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2008.08.25 - 2008.08.25 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	Continued From Previous Page																
135.6	Silty SAND, trace clay, trace gravel Very Dense Grey Moist		11	SS	17		137										
	Compact (TILL)																
12.2	Clayey SILT, some sand, trace gravel Hard Grey Moist		12	SS	100/ 175		136										
133.7			13	SS	100/ 225		135										
14.1	END OF BOREHOLE AT 14.10m. BOREHOLE OPEN TO 6.71m AND WATER LEVEL AT 4.57m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 17-Oct-08 2.65 145.1 11-Feb-09 2.88 144.9						134										

+ 3 × 3 Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C19-C

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 272.28 E 345 015.99 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.10 - 2008.12.11 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
145.3	Geodetic													
0.0	TOPSOIL (100mm)													
0.1	Silty SAND, some clay, trace gravel Loose to Very Dense Brown to Grey Moist (TILL)		1	SS	6		145							
			2	SS	44		144							
			3	SS	41		143							
			4	SS	65		142							2 46 37 15
			5	SS	100/ 0.125		141							
			6	SS	140/ 0.225		140							
			7	SS	72		139							13 50 29 8
			8	SS	140/ 0.250		138							
			9	SS	179/ 0.275		137							4 52 34 10
136.0			10	SS	100/ 0.150									
9.3	END OF BOREHOLE AT 9.3m. BOREHOLE OPEN AND WATER LEVEL AT 0.7m UPON COMPLETION OF DRILLING. Piezometer installation consists of													

Continued Next Page

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

ONTMT4S 6126.GPJ 20/2/09

RECORD OF BOREHOLE No C19-C

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 272.28 E 345 015.99 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.10 - 2008.12.11 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	Continued From Previous Page																
	19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 06-Jan-09 3.87 141.4 11-Feb-09 1.34 144.0																

ONTMT4S 6126 GPJ 20/2/09

RECORD OF BOREHOLE No C20-A

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 621.61 E 345 970.34 ORIGINATED BY SL
HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2008.12.04 - 2008.12.04 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
146.5	Geodetic															
0.0	TOPSOIL (600mm)		1	SS	8											
145.9																
0.6	Clayey SILT, some sand, trace gravel, trace rootlets Firm Dark Brown (FILL)		2	SS	11											
145.0																
1.5	SAND and SILT, trace clay, trace gravel Compact to Dense Brown to Grey Moist (TILL)		3	SS	11											
			4	SS	44											2 49 43 6
	Very Dense		5	SS	100/ 0.250											
	Increasing Sand		6	SS	66											7 54 33 6
			7	SS	100/ 0.100											
			8	SS	100/ 0.125											
			9	SS	100/ 0.150											2 41 34 23
			10	SS	100/ 0.100											

Continued Next Page

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

RECORD OF BOREHOLE No C20-A

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 621.61 E 345 970.34 ORIGINATED BY SL
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.04 - 2008.12.04 CHECKED BY DE

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
Continued From Previous Page																
135.7	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		11	SS	100/		136									
10.8	END OF BOREHOLE AT 10.8m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 06-Jan-09 1.13 145.4 11-Feb-09 0.99 145.5				0.150											

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

RECORD OF BOREHOLE No C20-B

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 611.40 E 345 984.33 ORIGINATED BY SA
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.08.27 - 2008.08.27 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60	w _p w w _L				
SHEAR STRENGTH kPa								20 40 60 80 100	WATER CONTENT (%)					
○ UNCONFINED + FIELD VANE														
● QUICK TRIAXIAL × LAB VANE														
148.8	Geodetic													
0.0	ASPHALT (100mm)													
0.1	SAND and GRAVEL, trace silt Dense to compact Brown Moist (FILL)		1	SS	41									
147.7			2	SS	19									20 65 15 (SI+CL)
1.1	Clayey SILT, some sand, trace gravel Stiff Brown (FILL)													
			3	SS	10									
			4	SS	11									
			5	SS	42									
144.7														
4.0	Sandy SILT, trace clay Compact to very dense Brown Moist		6	SS	28									
			7	SS	41									0 29 66 6
142.5														
6.2	SAND and SILT, some clay Very Dense Grey Moist (TILL)		8	SS	100/ .300									

Continued Next Page

+ 3 X 3 Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No C20-C

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 588.79 E 345 993.40 ORIGINATED BY SU
HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2008.11.28 - 2008.11.28 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
145.8	Geodetic													
0.0	TOPSOIL (600mm)		1	SS	7									
145.2														
0.6	Silty SAND, trace clay, trace gravel Compact Brown Moist		2	SS	12		145							
			3	SS	25		144							10 64 20 6
	Very Dense		4	SS	100		143							
			5	SS	100/ 0.275		142							
141.2														
4.6	SAND, trace silt, trace gravel Very Dense Grey Moist		6	SS	50		141							1 90 9 (SI+CL)
							140							
			7	SS	100/ 0.275		139							
							138							
			8	SS	100									
	Auger resistance from 8.5m to 9.1m.						137							
136.6														
9.1	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		9	SS	100/ 0.125									5 44 33 18
							136							

Continued Next Page

+ 3 x 3 Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C20-C

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 588.79 E 345 993.40 ORIGINATED BY SU
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.11.28 - 2008.11.28 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40					
135.1	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL)													
10.7	Continued From Previous Page END OF BOREHOLE UPON AUGER REFUSAL AT 10.7m. BOREHOLE OPEN TO 3.9m AND WATER LEVEL AT 2.1m 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) 06-Jan-09 2.42 143.4 11-Feb-09 1.97 143.8													

+ 3 . X 3 : Numbers refer to 20
Sensitivity 15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C21-A

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 876.70 E 346 701.82 ORIGINATED BY SL
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.05 - 2008.12.05 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								WATER CONTENT (%)				
156.0	Geodetic						20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
0.0	TOPSOIL (1295mm)		1	SS	2							
154.7	Silty CLAY, trace gravel, trace sand Very Stiff to Stiff Grey Moist		2	SS	6							
1.3			3	SS	28							2 15 42 41
			4	SS	28							
			5	SS	14						0 10 37 53	
			6	SS	10							
			7	SS	12							
151.0	Sandy SILT, trace clay Compact Grey Brown Wet (TILL)											
5.1			8	SS	10						0 30 61 9	
			9	SS	100/ 0.225							
			10	SS	100/ 0.075							
	Moist Very Dense											

Continued Next Page

+ 3 . X 3 : Numbers refer to
Sensitivity 20
15 10 5 (%) STRAIN AT FAILURE

ONTMT4S 6126 GPJ 20/2/09

RECORD OF BOREHOLE No C21-A

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 876.70 E 346 701.82 ORIGINATED BY SL
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.05 - 2008.12.05 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	Continued From Previous Page																
145.3	Sandy SILT, trace clay Compact Grey Brown Wet (TILL)		11	SS	100		146										
10.7	END OF BOREHOLE AT 10.7m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 06-Jan-09 1.59 154.4 11-Feb-09 1.40 154.6				0.075												

ONTMT4S 6126.GPJ 20/2/09

+ 3 . X 3

Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C21-B

1 OF 2

METRIC

G.W.P. 2075-08-00

LOCATION N 4 867 864.07 E 346 694.19

ORIGINATED BY ES

HWY 7 - Brock Rd. to Hwy 12

BOREHOLE TYPE Solid Stem Augers

COMPILED BY ES

DATUM Geodetic

DATE 2008.08.12 - 2008.08.12

CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100		20 40 60			
159.0	Geodetic												
0.0	ASPHALT: (100mm)												
0.1	SAND and GRAVEL, some silt Compact Brown Moist (FILL)		1	SS	17								
			2	SS	17								17 53 30 (SI+CL)
157.5	SAND and SILT, some clay Loose to Compact Brown Moist (FILL)		3	SS	7								
1.5			4	SS	13								
			5	SS	12								1 40 40 19
154.9	SAND and SILT, some clay, trace gravel Very Dense to Compact Brown Moist (TILL)		6	SS	45								
4.1			7	SS	15								
			8	SS	15								5 36 44 15
151.4	Silty SAND, trace clay Compact to Very Loose Brown Moist (TILL)		9	SS	11								
7.6			10	SS	1								0 58 35 7

Continued Next Page

+³, X³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C21-B

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 864.07 E 346 694.19 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
 DATUM Geodetic DATE 2008.08.12 - 2008.08.12 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
	Continued From Previous Page														
148.3	Silty SAND, trace clay Compact to Very Loose Brown Moist (TILL)		11	SS	117		149								
10.7	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		12	SS	100/ .125		148								
			13	SS	100/ .115		147								
			14	SS	100/ .125		146								
143.6	END OF BOREHOLE AT 15.37m. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 17-Oct-08 0.94 158.1 11-Feb-09 2.62 156.4						145								
15.4							144								

+³. ×³: Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C21-C

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 836.51 E 346 683.89 ORIGINATED BY SL
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.02 - 2008.12.02 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
							20	40	60	80	100	20	40	60			
	Continued From Previous Page																
145.0	Silty SAND, trace gravel, trace clay Loose to Compact Grey Wet (TILL)		11	SS	1007												
10.7	END OF BOREHOLE AT 10.7m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 06-Jan-09 3.08 152.7 11-Feb-09 1.73 154.1				0.075												

ONTMT4S 6126.GPJ 20/2/09

RECORD OF BOREHOLE No C24-A

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 864 365.31 E 336 284.32 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.02 - 2008.12.02 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
196.8	Geodetic													
0.0	TOPSOIL (50mm)		1	SS	3									
196.2	SILT, some sand, trace roots Loose Dark Brown Moist													
0.6	Silty SAND, some clay, trace gravel Dense Brown Moist		2	SS	42		196							13 49 23 15
			3	SS	66		195							
			4	SS	47		194							2 43 34 20
	Very Dense		5	SS	118									
			6	SS	100/ 0.150		193							
			7	SS	130/ 0.200		192							
190.7							191							
6.1	SILT, some clay, trace sand Very Dense Brown Damp		8	SS	120/ 0.175									0 3 86 11
			9	SS	126/ 0.200		189							
							188							
	Sand layers		10	SS	135/ 0.225									
							187							

Continued Next Page

+ 3 x 3 Numbers refer to
Sensitivity 20
15 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C24-A

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 864 365.31 E 336 284.32 ORIGINATED BY ES
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.02 - 2008.12.02 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	Continued From Previous Page																
185.9	SILT, some clay, trace sand Very Dense Brown Damp		11	SS	127/												
10.9	END OF BOREHOLE AT 10.9m. WATER LEVEL AT 3.3m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.				0.225												



ONTMT4S 6126.GPJ 20/2/09

RECORD OF BOREHOLE No C24-B

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 864 352.15 E 336 283.15 ORIGINATED BY LH
HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2008.10.24 - 2008.10.24 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL	×						LAB VANE		
Continued From Previous Page							20	40	60	80	100	20	40	60						
182.7	SILT, some clay, some sand Very Dense Grey Moist		11	SS	100/ 0.150		188										0 6 86 8			
			12	SS	100/ 0.275		186													
			13	SS	37		185													
				</																

+ 3 . × 3 : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C24-C

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 864 322.65 E 336 282.08 ORIGINATED BY LH
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.02 - 2008.12.08 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
196.5	Geodetic														
0.0	TOPSOIL (200mm)														
0.2	Sandy SILT, some clay, trace gravel, trace roots Loose Dark Brown Moist Compact to Very Dense		1	SS	3		196								
			2	SS	15										
			3	SS	53		195								
			4	SS	102/ 0.200		194								
193.5			5	SS	100/ 0.150		193								
3.0	SAND and SILT, some clay, trace gravel, occasional silt layers Very Dense Grey Moist (TILL) Auger grinding from 3.6 to 3.8m Auger grinding from 4.0 to 4.3m		6	SS	100/ 0.050		192								
			7	SS	100/ 0.100		191								
190.4			8	SS	149		190								
6.1	SILT, some sand, trace clay Very Dense Grey Moist		9	SS	145		189								
			10	SS	138/ 0.200		188								
							187								

Continued Next Page

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

RECORD OF BOREHOLE No C24-C

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 864 322.65 E 336 282.08 ORIGINATED BY LH
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.02 - 2008.12.08 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	Continued From Previous Page																
185.7	SILT, some sand, trace clay Very Dense Grey Moist		11	SS	123/		186										
10.9	END OF BOREHOLE AT 10.9m. WATER LEVEL AT 2.1m 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) 06-Jan-09 1.77 194.7 11-Feb-09 1.70 194.8				0.200												

ONTMT4S 6126.GPJ 20/2/09

RECORD OF BOREHOLE No C25-A

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 864 492.24 E 336 685.57 ORIGINATED BY LH
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.12 - 2008.12.12 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	Continued From Previous Page																
179.9	Clayey SILT, some sand, trace gravel Light Brown Hard Moist		11	SS	100/												
10.8	END OF BOREHOLE AT 10.8m. WATER LEVEL AT 6.1m UPON COMPLETION OF DRILLING.				0.125												

ONTMT4S 6126.GPJ 20/2/09

+ 3, X 3 Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

METRIC

Continued Next Page

+ 3, x 3. Numbers refer to Sensitivity

ONTMT4S 6126.GPJ 2012/09

RECORD OF BOREHOLE No C25-B

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 864 484.67 E 336 689.63 ORIGINATED BY LH
HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2008.10.10 - 2008.10.10 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	Continued From Previous Page																
	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		11	SS	50/ .150		182										
			12	SS	50/ .150		181										
			13	SS	50/ .150		179										
178.2																	
14.6	SAND, trace silt, trace gravel Very Dense Grey Wet		14	SS	87		178										
							177										5 85 9 (SI+CL)
175.8			15	SS	50/ .150		176										
17.0	END OF BOREHOLE AT 16.9m. WATER LEVEL AT 5.4m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH CUTTINGS AND BENTONITE TO SURFACE.																

ONTMT4S 6126.GPJ 20/2/09

RECORD OF BOREHOLE No C25-C

1 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 864 464.89 E 336 700.74 ORIGINATED BY LH
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.01 - 2008.12.02 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
193.0	Geodetic													
0.0	TOPSOIL (50mm)		1	SS	18		193							
	SAND, some silt, trace clay, trace gravel Loose Dark Brown Moist (FILL)		2	SS	9		192							
			3	SS	8		191							
			4	SS	5		190							5 71 19 5
189.6			5	SS	8		189							
3.5	Sandy SILT, trace clay, trace gravel Dark Brown Damp (FILL)		6	SS	8		188							
189.2			7	SS	10		187							
3.8	Sandy SILT, some clay, trace gravel Loose to Compact Brown Moist		8	SS	6		186							
			9	SS	16		185							
185.4			10	SS	83		184							0 18 73 9
7.6	SILT, some sand, some clay Brown Compact Moist													
	Very Dense													

Continued Next Page

+ 3 x 3 : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C25-C

2 OF 2

METRIC

G.W.P. 2075-08-00 LOCATION N 4 864 464.89 E 336 700.74 ORIGINATED BY LH
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.12.01 - 2008.12.02 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT			LIQUID LIMIT			
								SHEAR STRENGTH kPa					WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE					w _p w w _L			
							● QUICK TRIAXIAL x LAB VANE									
	Continued From Previous Page							20 40 60 80 100								
182.4	SILT, some sand, some clay Brown Compact Moist						183									
10.7	SAND, some silt Very Dense Brown Moist		11	SS	163/ 0.250		182									
							181									
			12	SS	165/ 0.275											
							180									
179.1			13	SS	165/ 0.250											
14.0	END OF BOREHOLE AT 14.0m. WATER LEVEL AT 6.4M 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) 06-Jan-09 0.52 192.5 11-Feb-09 3.11 189.9															

+³ × 3³ Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

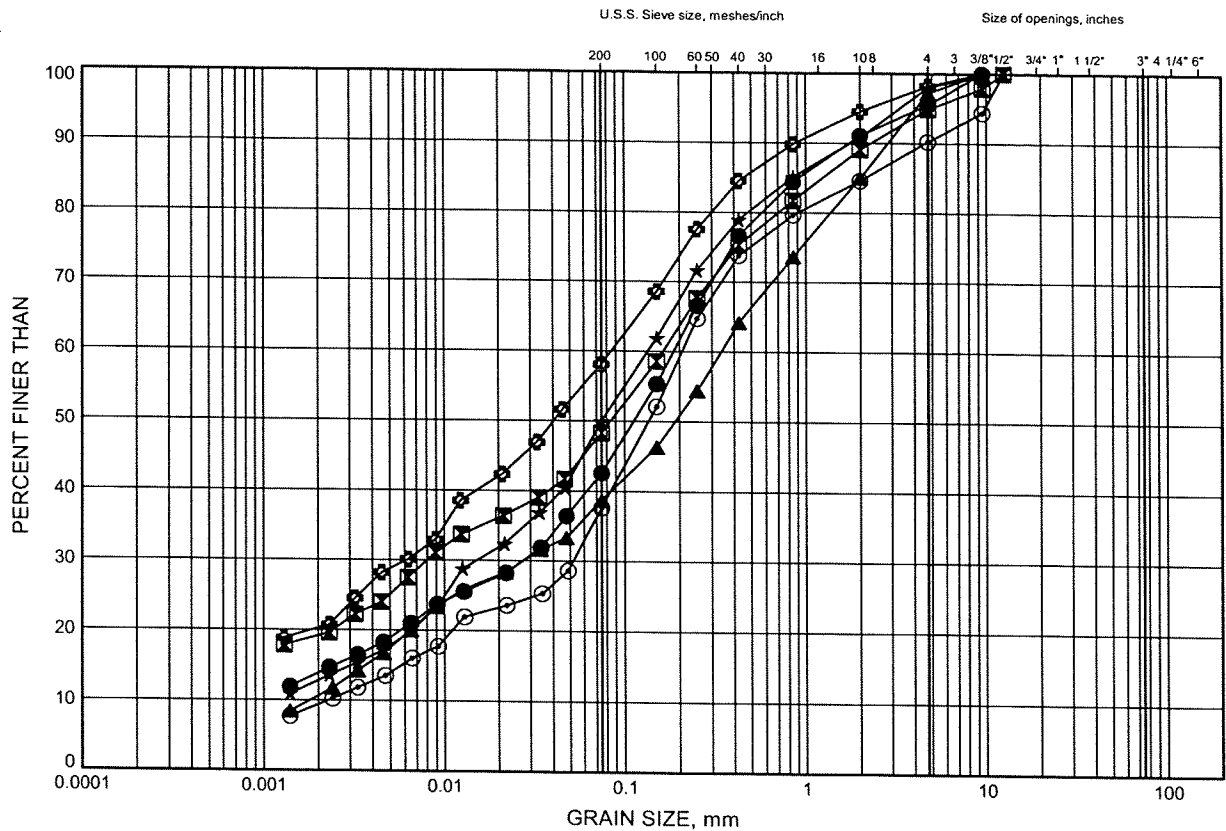
Appendix B

Laboratory Test Results

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B1

FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C01-A	1.07	159.57
⊠	C01-B	2.59	163.12
▲	C04-B	1.07	147.32
★	C05-A	0.99	165.35
⊙	C05-B	1.83	169.36
⊛	C05-B	4.11	167.07

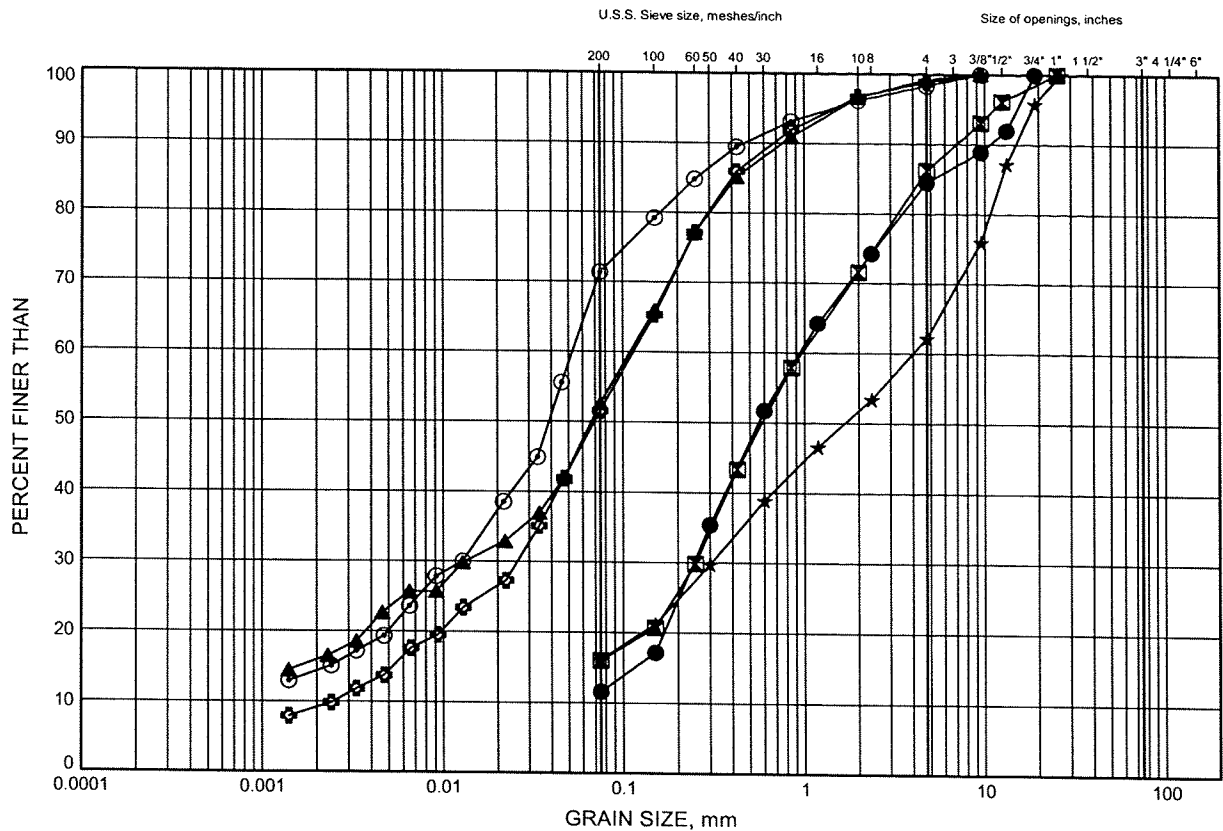


W.P.# 2075-08-00
Prepared By MFA
Checked By DEE

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B2

FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C07-B	1.83	149.02
⊠	C11-B	0.46	154.87
▲	C11-B	3.35	151.97
★	C12-B	1.07	155.26
⊙	C13-A	1.07	162.04
⊕	C17-A	0.99	169.46

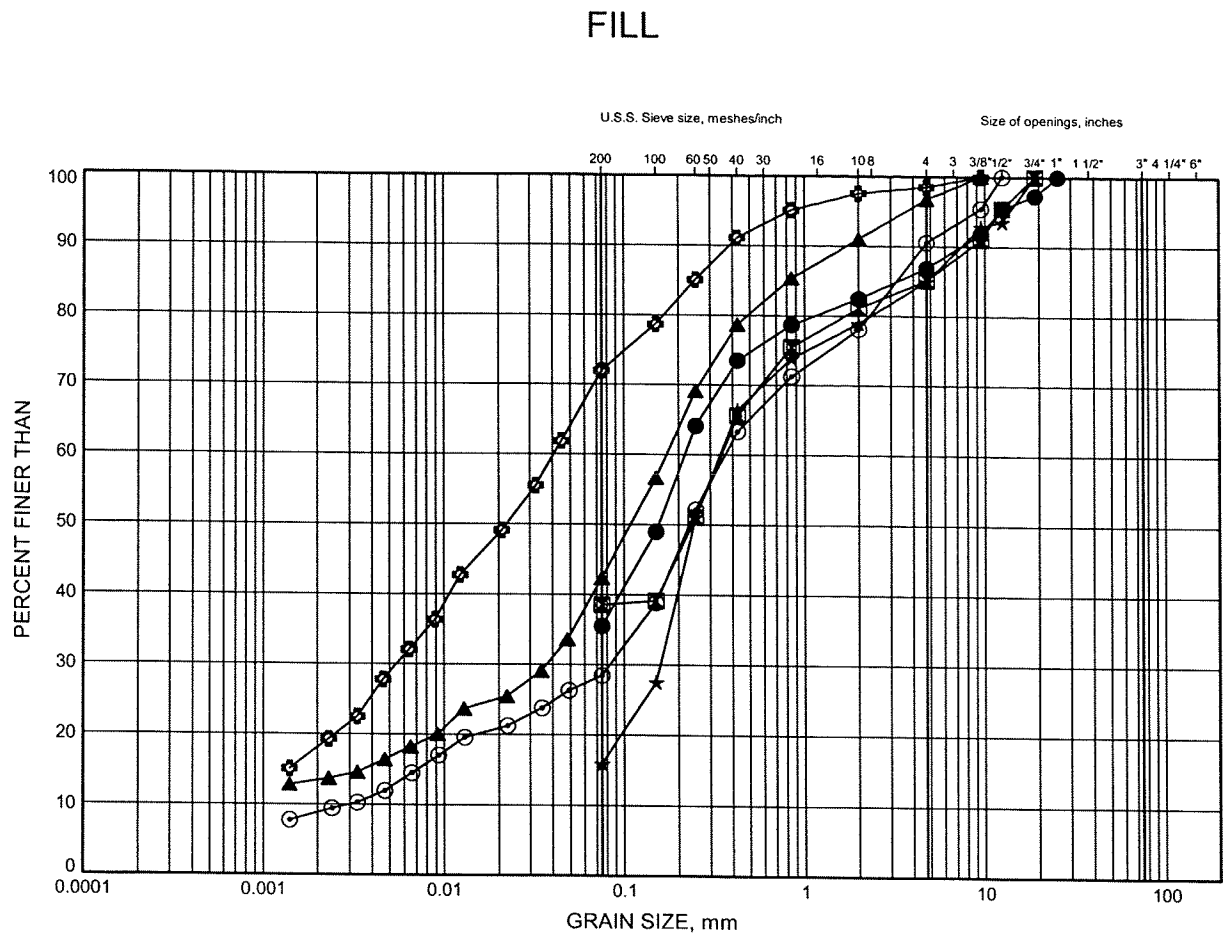
GRAIN SIZE DISTRIBUTION - THURBER 6126.GPJ 2/13/09

W.P.# 2075-08-00
Prepared By MFA
Checked By DEE



Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B3



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

LEGEND

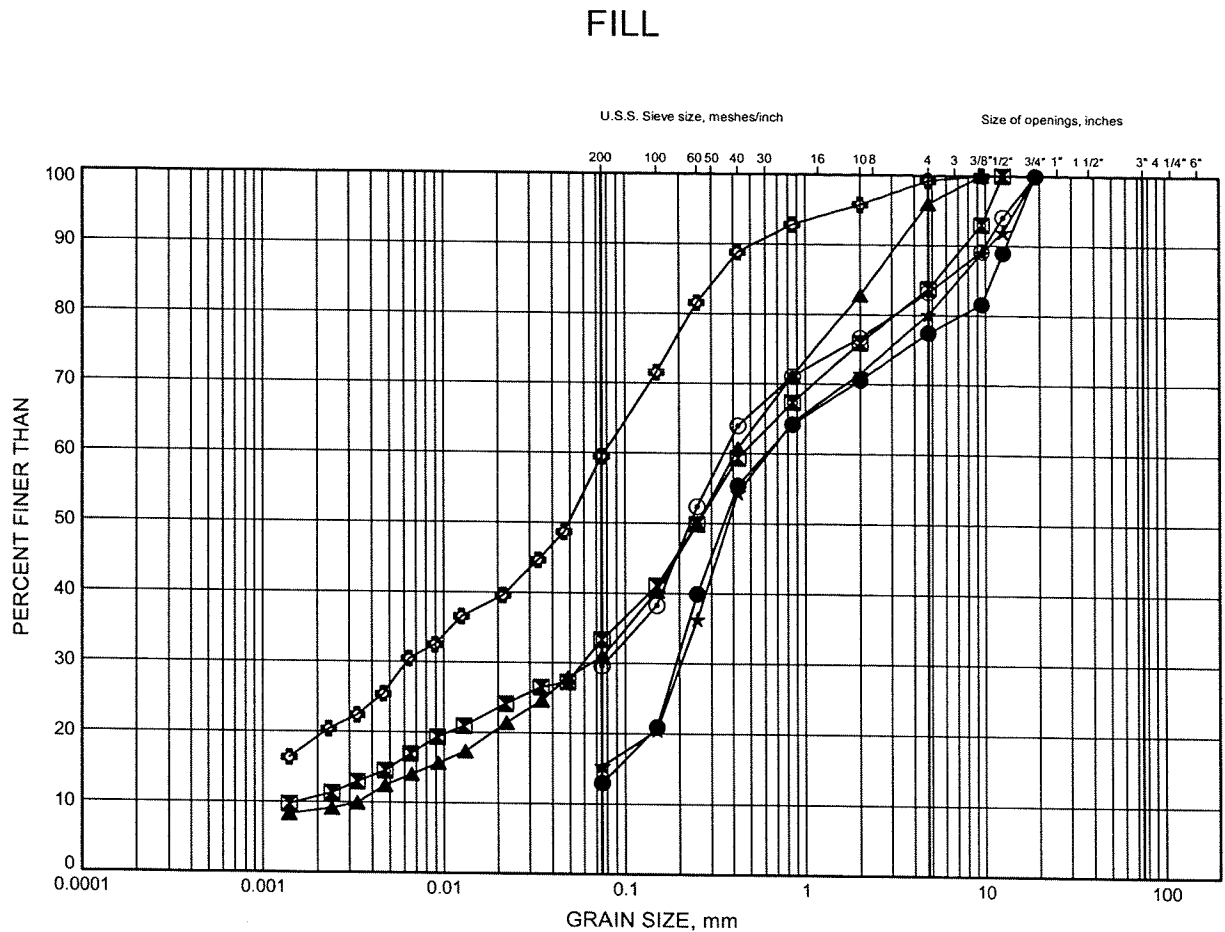
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C17-B	1.83	173.26
⊠	C17-B	3.35	171.73
▲	C17-B	4.88	170.21
★	C18-B	0.46	147.36
⊙	C18-B	1.83	145.99
⊛	C19-A	0.30	144.89



W.P.# 2075-08-00
Prepared By MFA
Checked By DEE

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B4



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C19-B	1.60	146.18
⊠	C19-B	3.35	144.43
▲	C19-B	4.11	143.67
★	C20-B	0.99	147.77
⊙	C21-B	1.07	157.92
⊛	C21-B	3.35	155.63

GRAIN SIZE DISTRIBUTION - THURBER 6126.GPJ 2/13/09

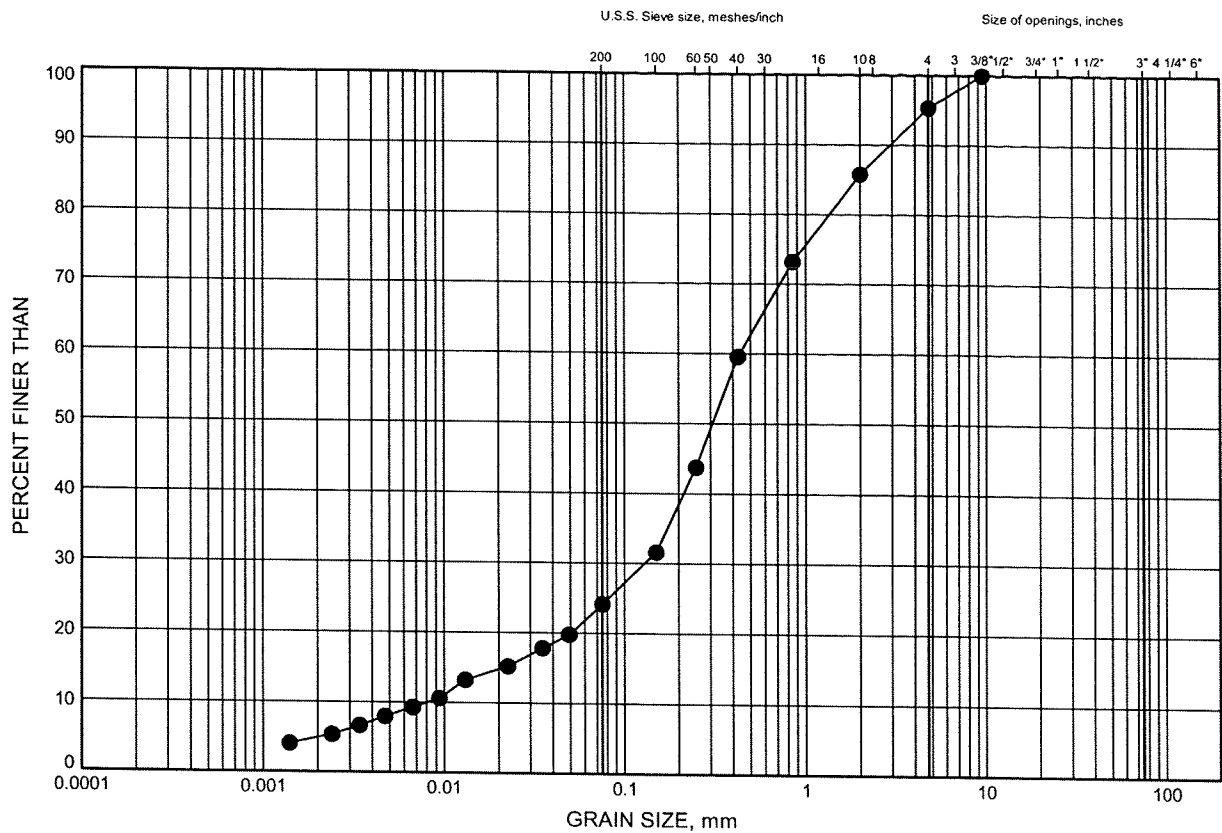
W.P.# 2075-08-00
Prepared By MFA
Checked By DEE



Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B5

FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C25-C	2.59	

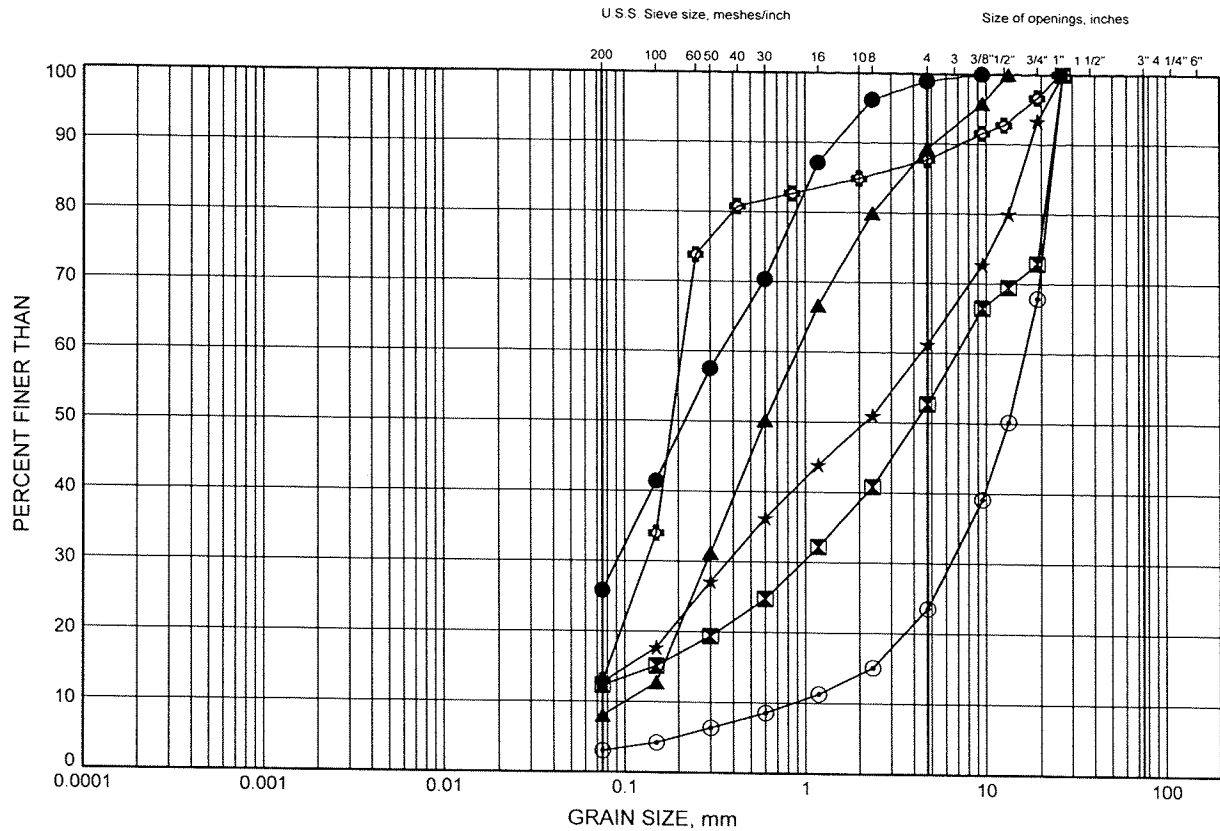


W.P.# 2075-08-00
Prepared By MFA
Checked By DEE

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B6

SAND, SAND & GRAVEL, SILTY SAND TO SANDY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C01-A	4.11	156.53
⊠	C01-A	9.45	151.19
▲	C01-B	7.92	157.78
★	C01-C	1.75	158.10
⊙	C01-C	4.80	155.05
⊕	C04-A	3.28	144.28

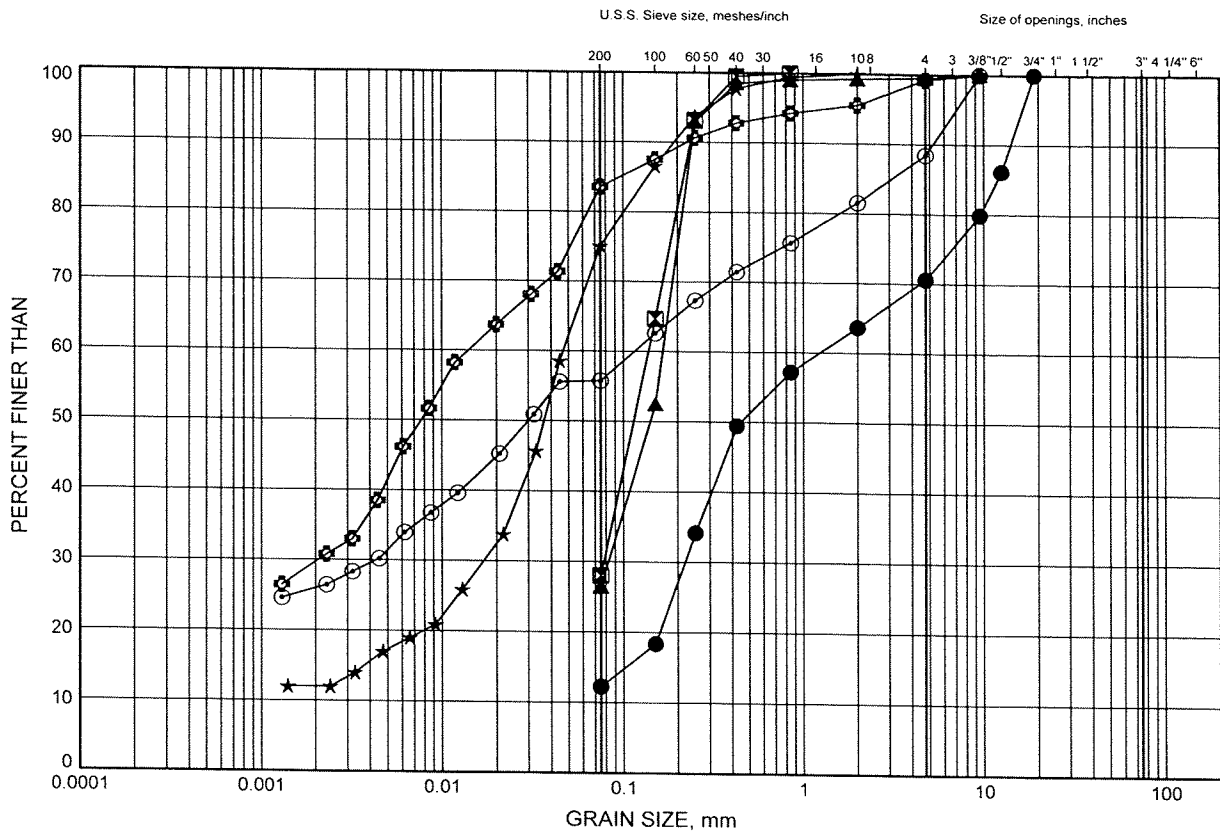


W.P.# 2075-08-00
Prepared By MFA
Checked By DEE

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B7

SAND, SAND & GRAVEL, SILTY SAND TO SANDY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C04-C	0.99	146.26
⊠	C04-C	2.59	144.66
▲	C04-C	4.80	142.45
★	C05-C	1.75	166.08
⊙	C07-C	1.07	148.01
⊛	C07-C	2.51	146.56

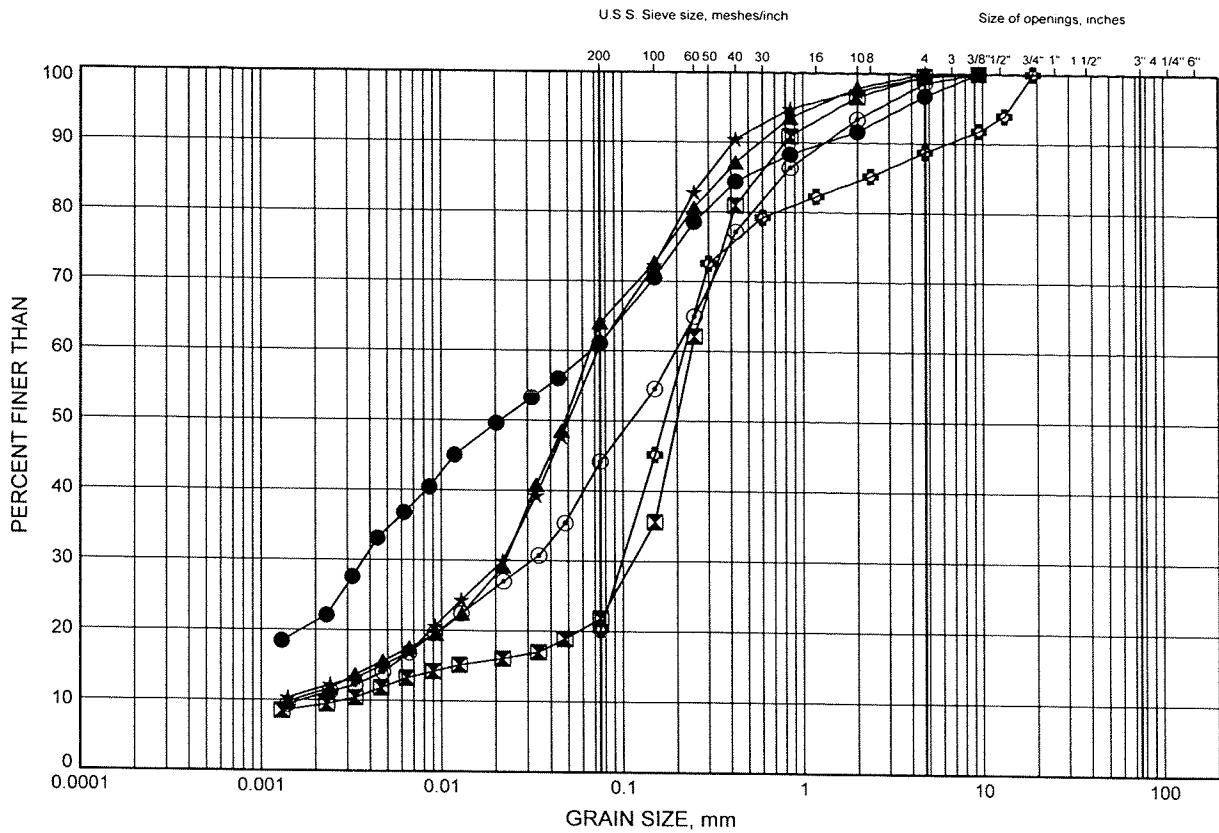


W.P.# 2075-08-00.....
Prepared By MFA.....
Checked By DEE.....

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B8

SAND, SAND & GRAVEL, SILTY SAND TO SANDY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C11-A	2.51	149.66
⊠	C11-C	10.82	140.83
▲	C12-A	0.99	152.09
★	C12-C	0.99	150.97
⊙	C17-C	0.99	167.94
⊛	C18-A	7.85	138.32

GRAIN SIZE DISTRIBUTION - THURBER 6126.GPJ 2/20/09

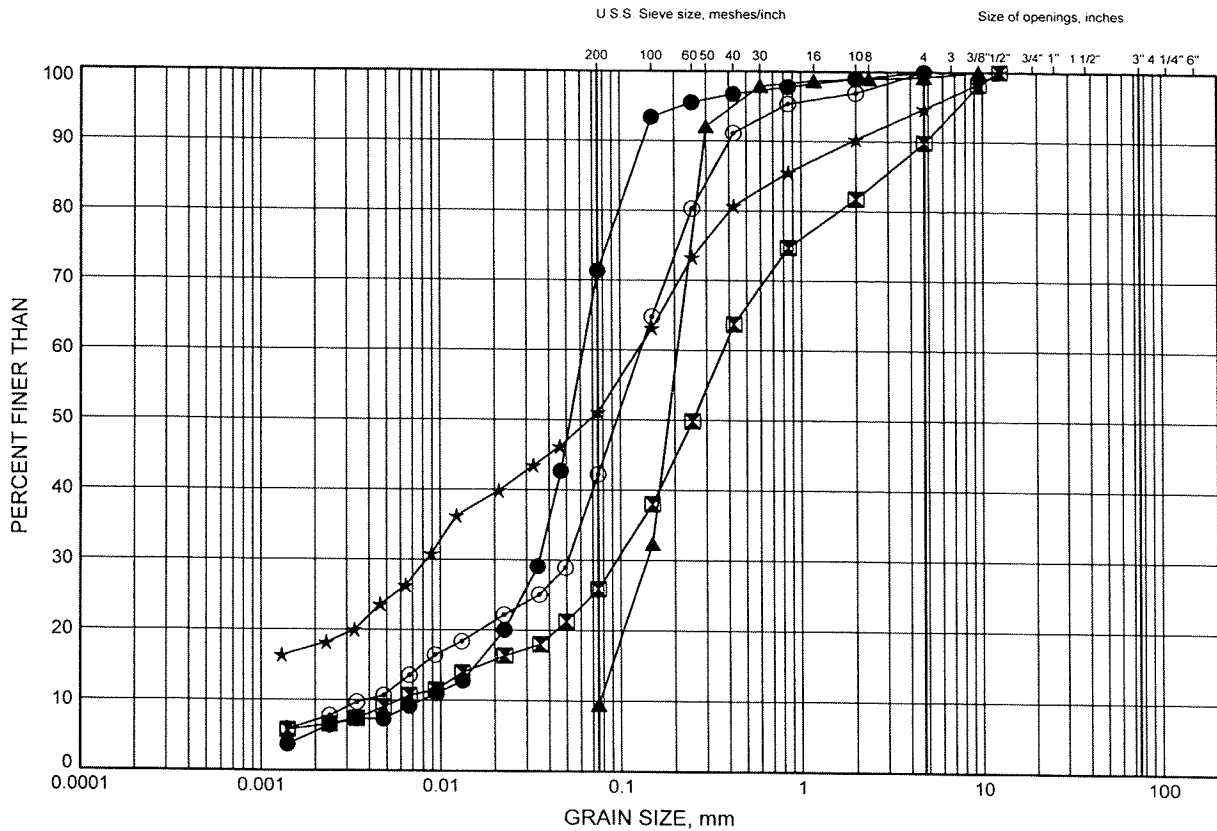
W.P.# 2075-08-00
Prepared By MFA
Checked By DEE



Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B9

SAND, SAND & GRAVEL, SILTY SAND TO SANDY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C20-B	4.88	143.89
⊠	C20-C	1.75	144.03
▲	C20-C	4.80	140.98
★	C20-C	9.30	136.48
⊙	C21-B	9.45	149.54

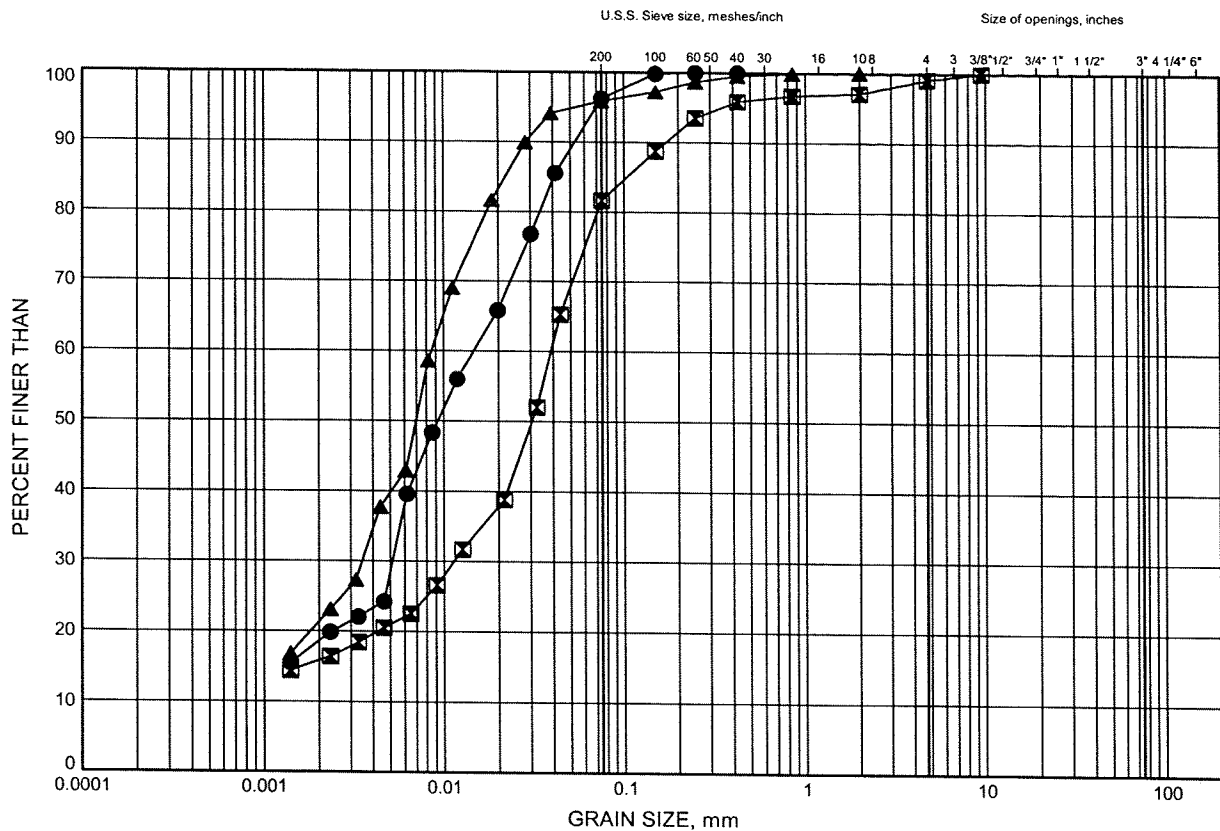


W.P.# 2075-08-00.....
Prepared By MFA.....
Checked By DEE.....

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B10

SILT TO CLAYEY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C04-A	6.32	141.24
■	C04-B	6.40	141.98
▲	C04-C	13.94	133.30

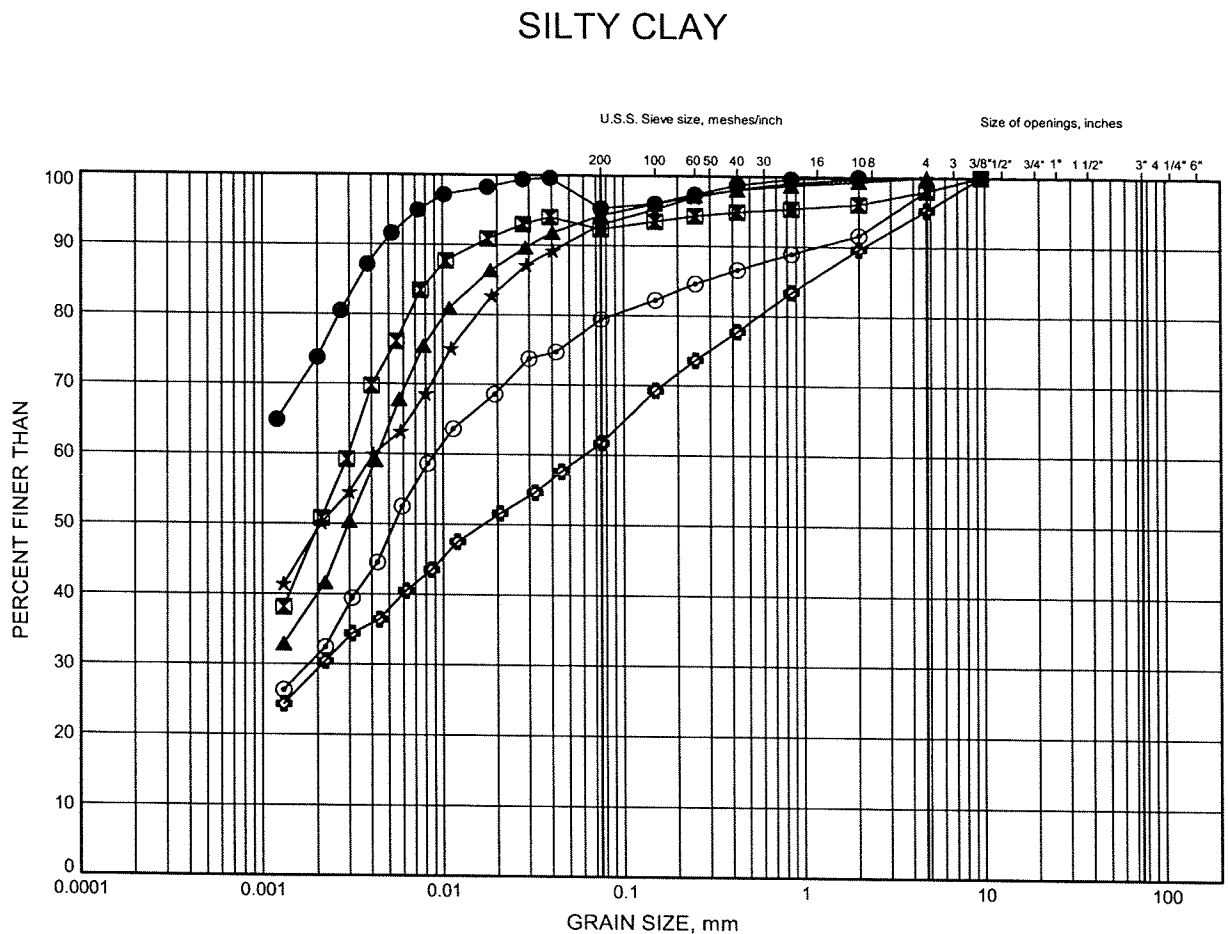
GRAIN SIZE DISTRIBUTION - THURBER 6126.GPJ 2/13/09

W.P.# 2075-08-00
Prepared By MFA
Checked By DEE



Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B11



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C01-B	12.50	153.21
⊠	C04-A	10.90	136.66
▲	C04-A	13.94	133.62
★	C04-B	9.45	138.94
⊙	C04-B	13.41	134.97
⊗	C05-B	17.07	154.12

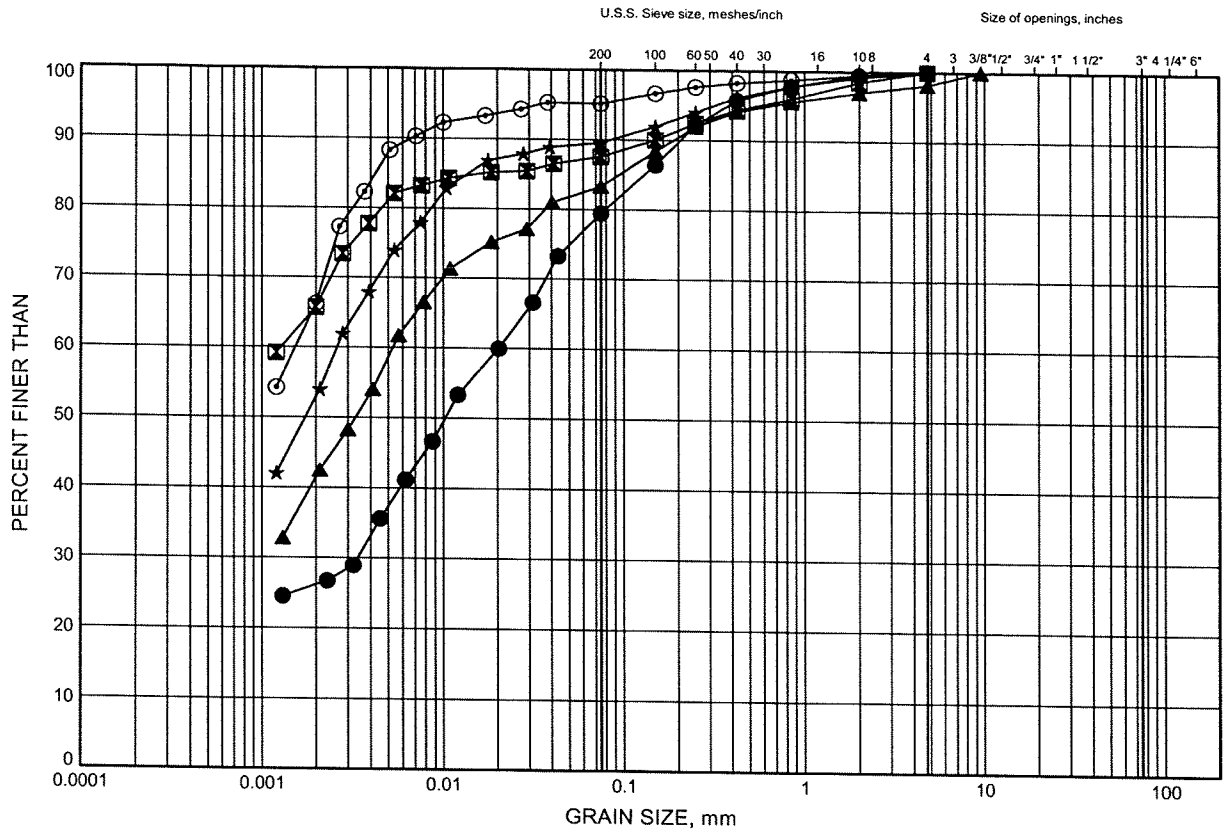


W.P.# 2075-08-00
Prepared By MFA
Checked By DEE

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B12

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C07-A	1.75	147.60
⊠	C11-B	14.02	141.30
▲	C21-A	1.83	154.21
★	C21-A	3.35	152.68
⊙	C21-C	4.80	150.97

GRAIN SIZE DISTRIBUTION - THURBER 6126.GPJ 2/13/09

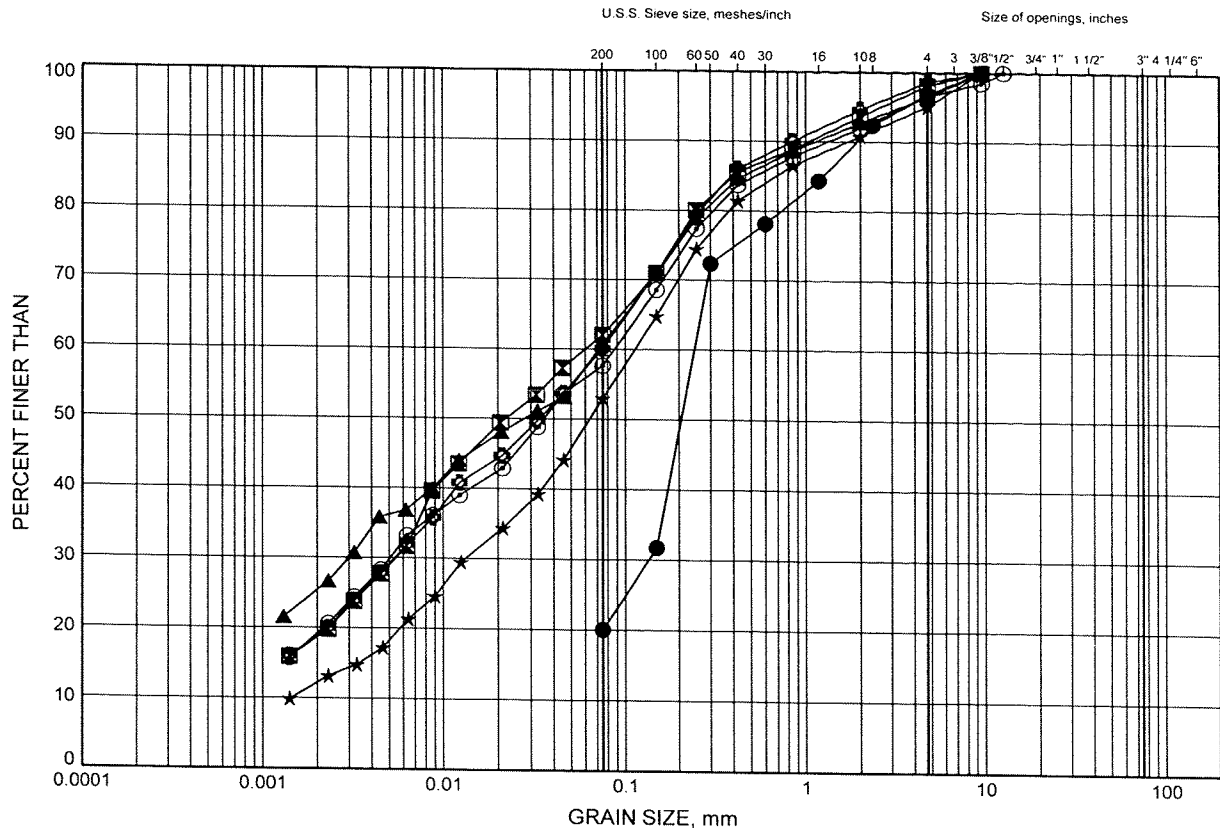
W.P.# 2075-08-00
Prepared By MFA
Checked By DEE



Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B13

SAND & SILT TILL TO SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C01-C	6.32	153.53
⊠	C04-C	9.37	137.87
▲	C05-A	2.51	163.83
★	C05-A	6.32	160.02
⊙	C05-B	7.92	163.26
⊕	C05-B	12.50	158.69

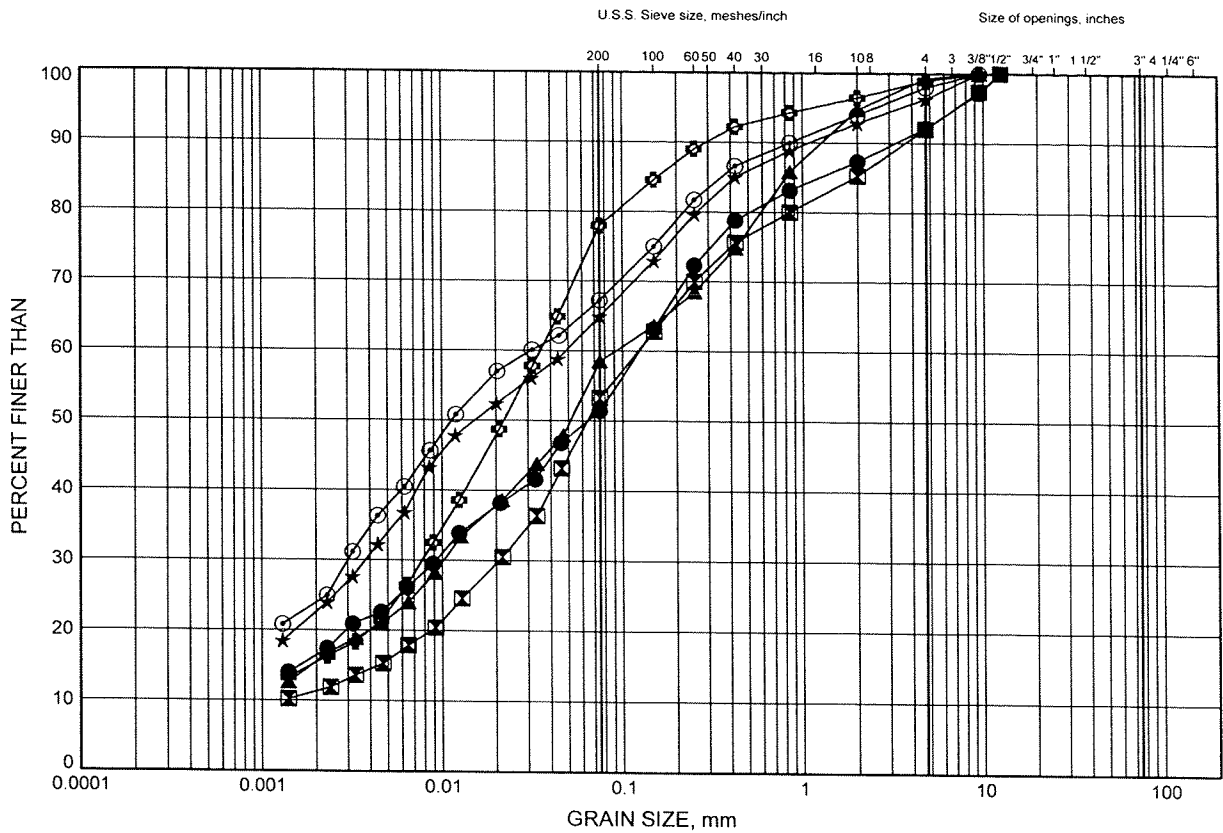


W.P.# 2075-08-00
Prepared By MFA
Checked By DEE

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B14

SAND & SILT TILL TO SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C05-C	3.28	164.56
⊠	C05-C	6.32	161.51
▲	C05-C	9.37	158.46
★	C07-A	3.28	146.07
⊙	C07-A	4.80	144.55
⊗	C07-A	9.37	139.98

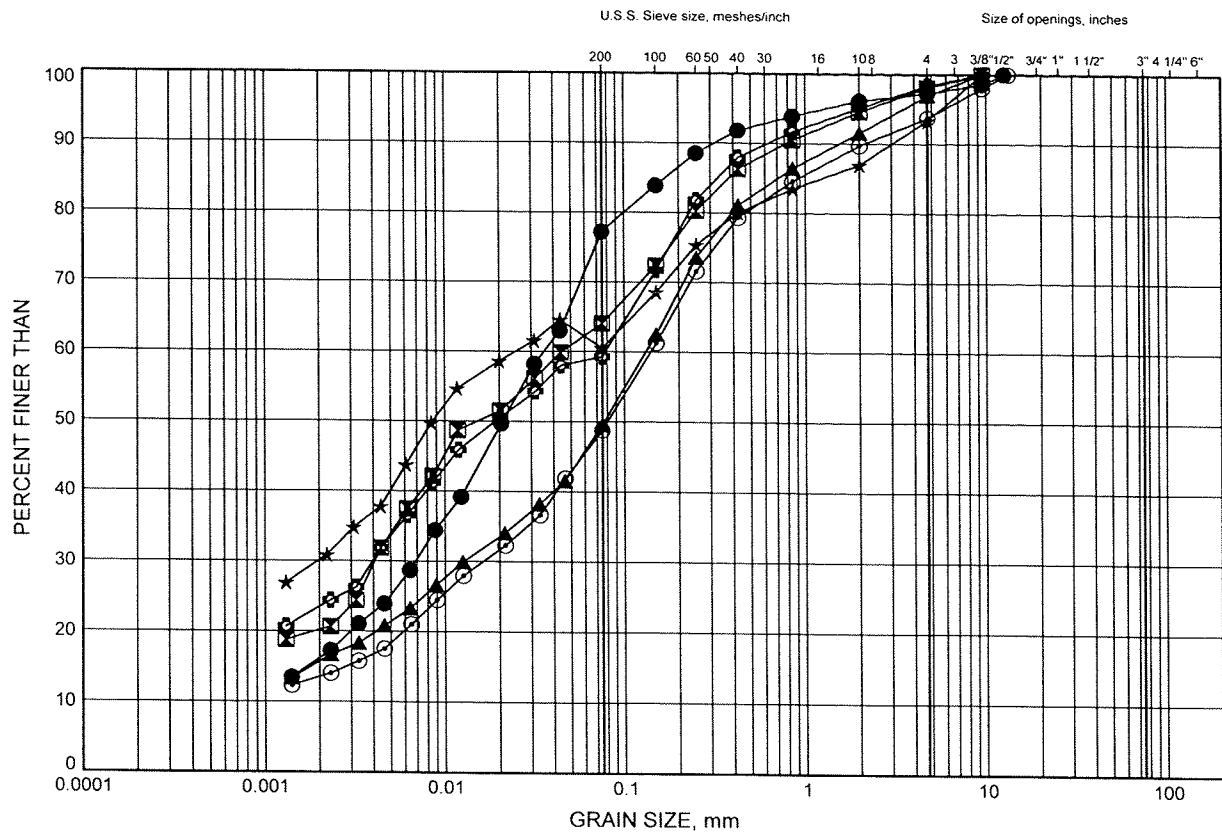


W.P.# 2075-08-00
Prepared By MFA
Checked By DEE

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B15

SAND & SILT TILL TO SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C07-B	4.11	146.74
⊠	C07-B	7.92	142.93
▲	C07-B	12.50	138.36
★	C07-C	6.32	142.75
⊙	C07-C	9.37	139.70
⊛	C07-C	12.42	136.65

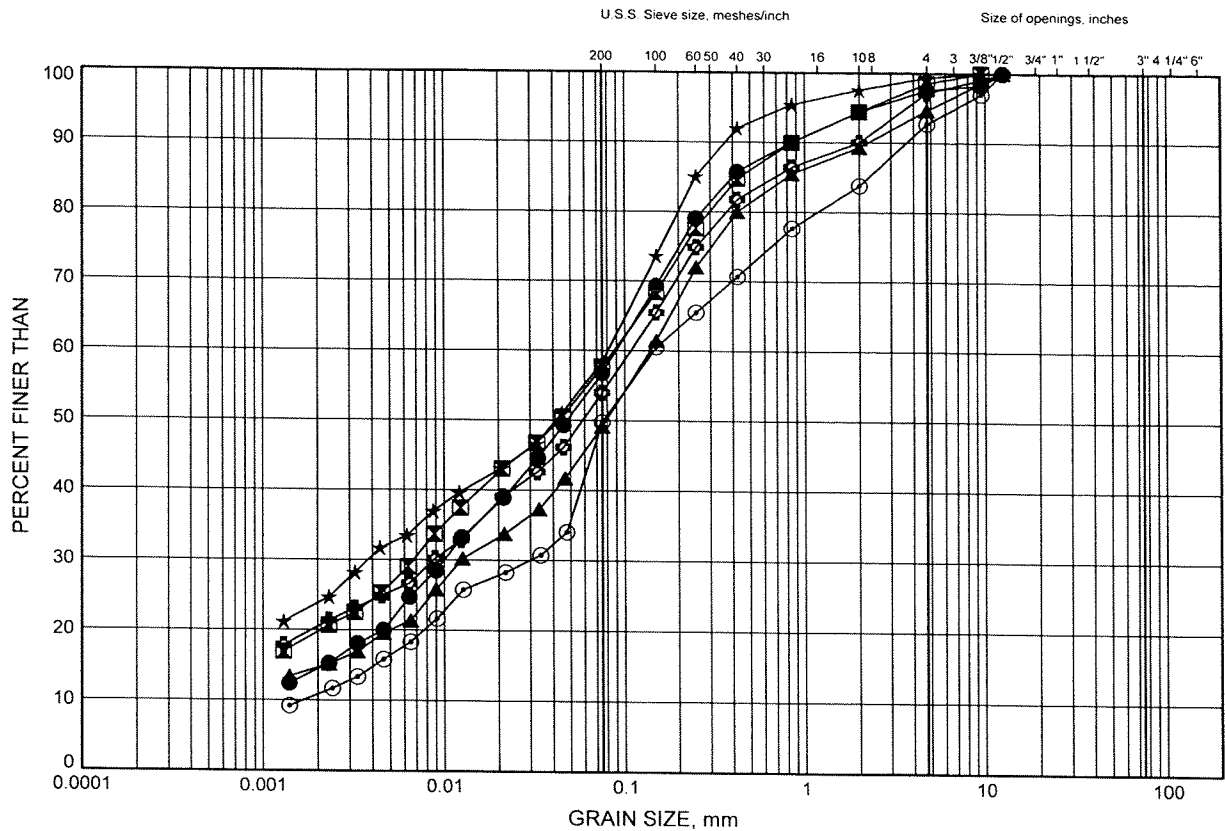


W.P # 2075-08-00.....
Prepared By MFA.....
Checked By DEE.....

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B16

SAND & SILT TILL TO SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C11-A	6.32	145.85
⊠	C11-B	6.40	148.92
▲	C11-C	3.28	148.38
★	C11-C	7.85	143.81
⊙	C12-A	2.36	150.72
⊛	C12-A	3.91	149.17



W.P.# 2075-08-00

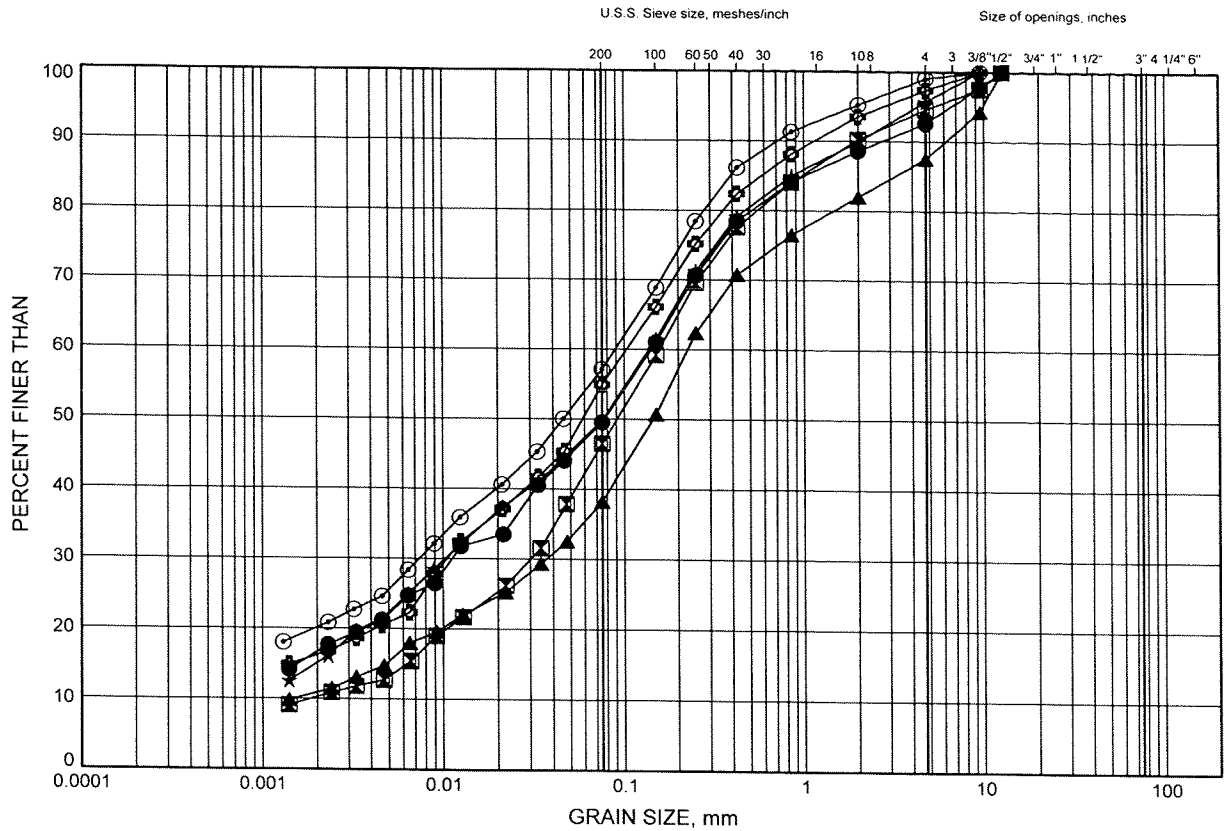
Prepared By MFA

Checked By DEE

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B17

SAND & SILT TILL TO SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C12-B	2.59	153.73
⊠	C12-B	4.88	151.45
▲	C12-B	9.37	146.95
★	C12-C	4.80	147.16
⊙	C12-C	9.30	142.67
⊛	C13-A	1.83	161.28

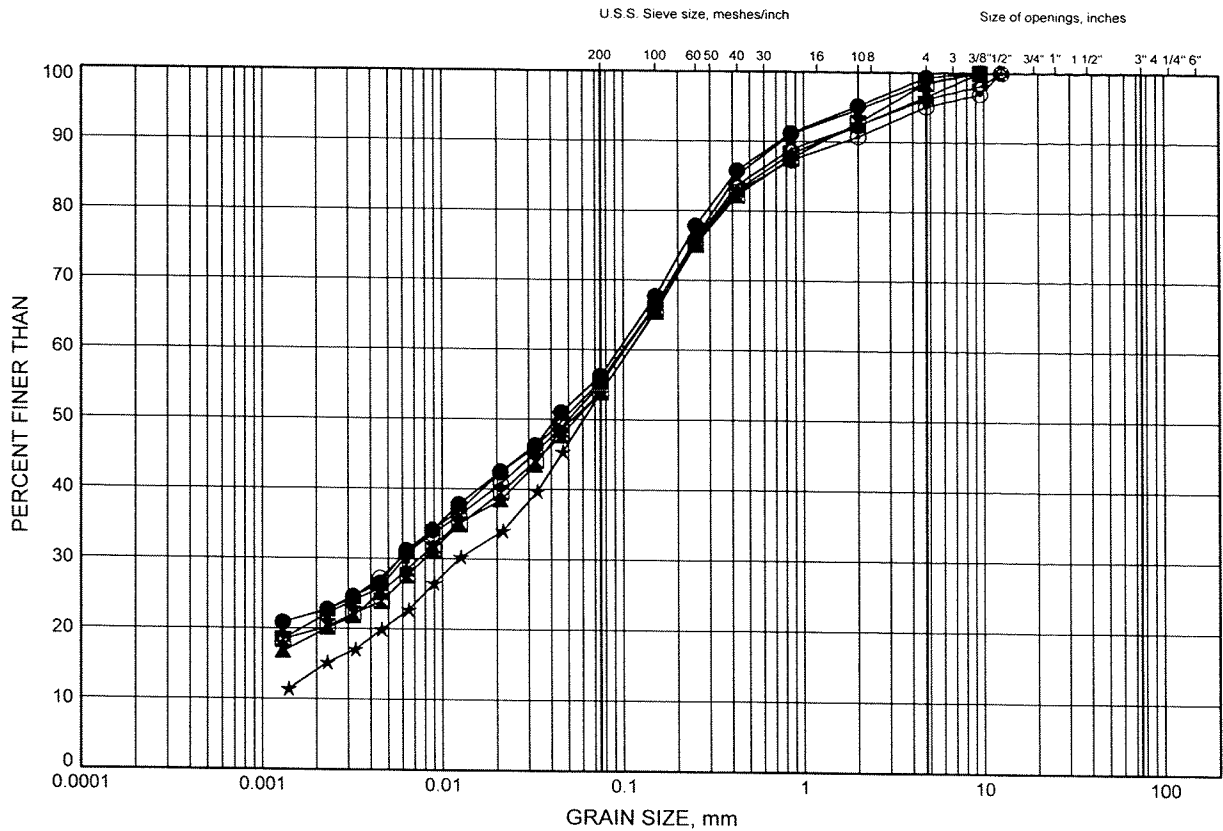


W.P.# 2075-08-00
Prepared By MFA
Checked By DEE

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B18

SAND & SILT TILL TO SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C13-B	4.88	160.44
⊠	C13-B	10.74	154.57
▲	C13-B	13.78	151.53
★	C13-C	0.99	161.59
⊙	C13-C	2.51	160.07
⊕	C13-C	6.30	156.28

GRAIN SIZE DISTRIBUTION - THURBER 6126.GPJ 2/20/09

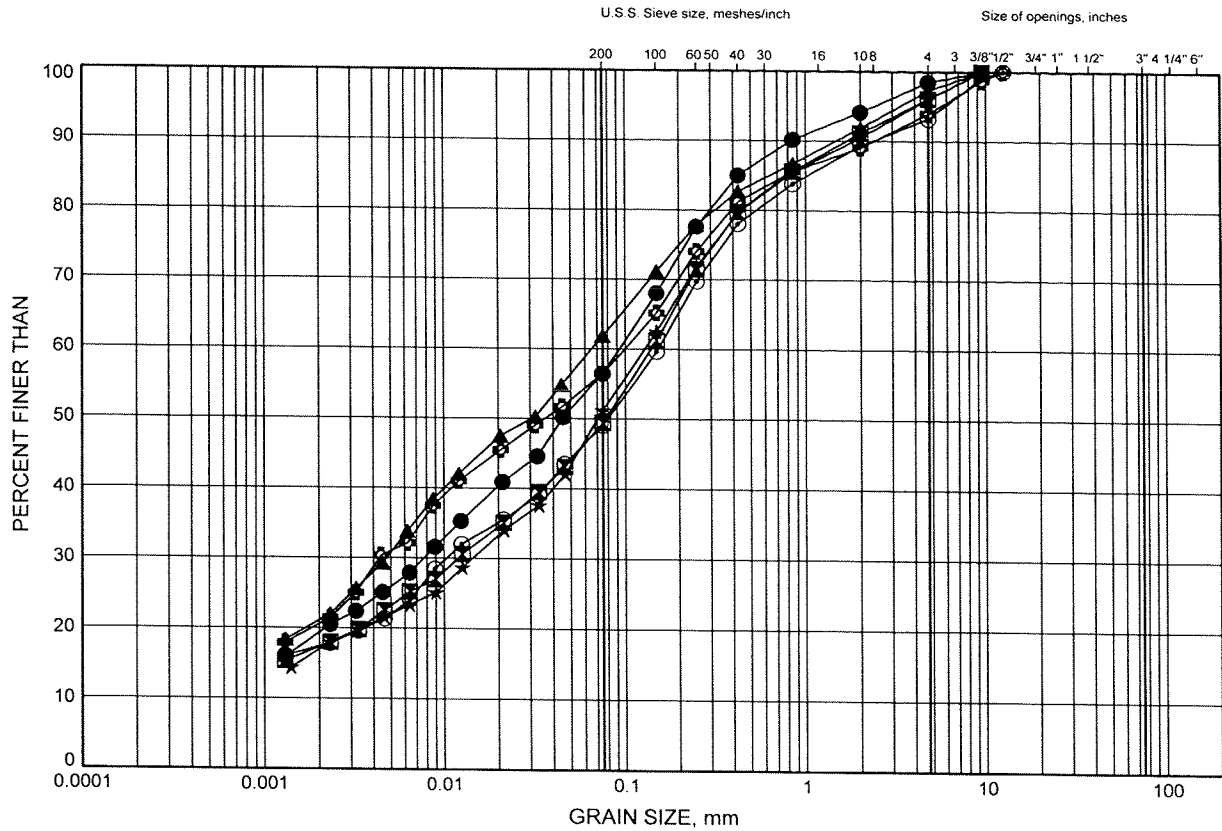
W.P.# 2075-08-00
Prepared By MFA
Checked By DEE



Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B19

SAND & SILT TILL TO SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C17-A	2.59	167.86
⊠	C17-A	3.89	166.56
▲	C17-B	7.92	167.16
★	C17-B	10.97	164.11
⊙	C17-C	4.65	164.28
⊕	C18-A	2.51	143.66

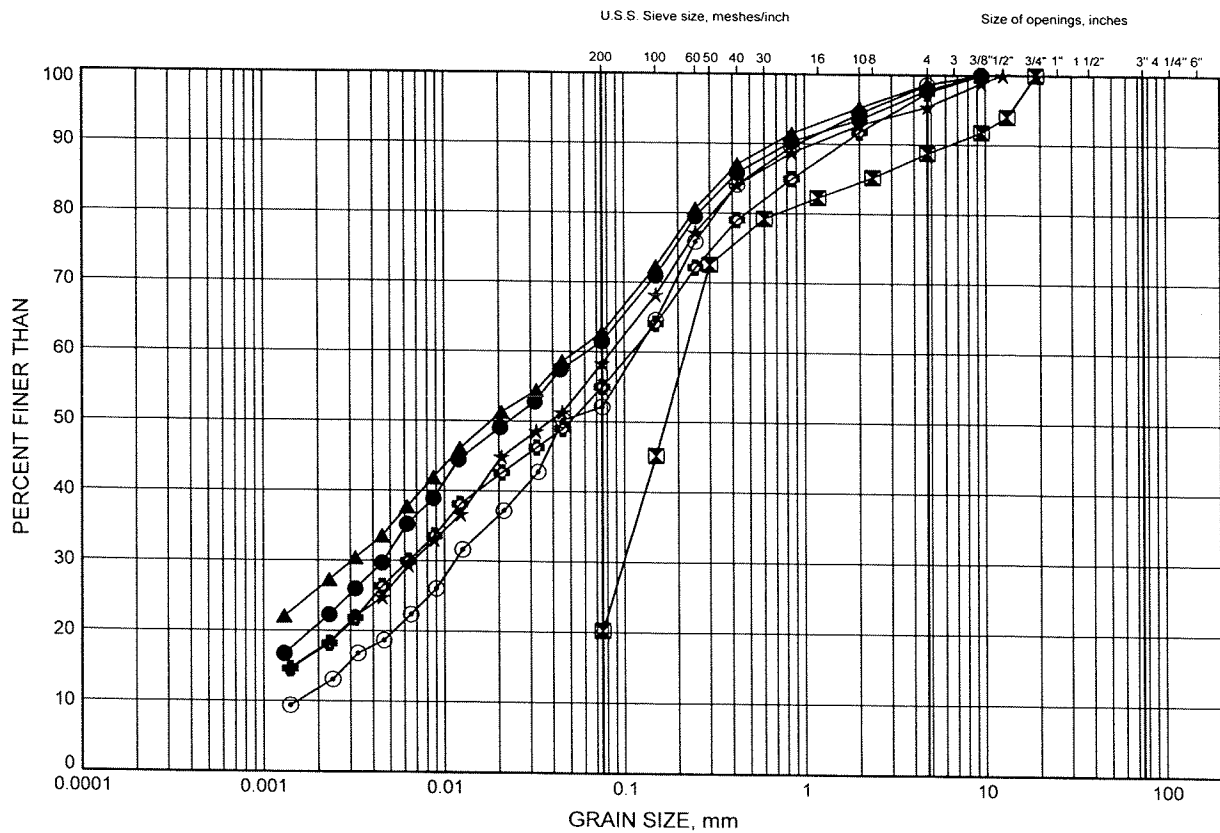


W.P.# 2075-08-00
Prepared By MFA
Checked By DEE

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B20

SAND & SILT TILL TO SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C18-A	4.80	141.37
⊠	C18-A	7.85	138.32
▲	C18-B	7.92	139.89
★	C18-C	2.59	142.31
⊙	C18-C	6.40	138.50
⊛	C18-C	9.45	135.45

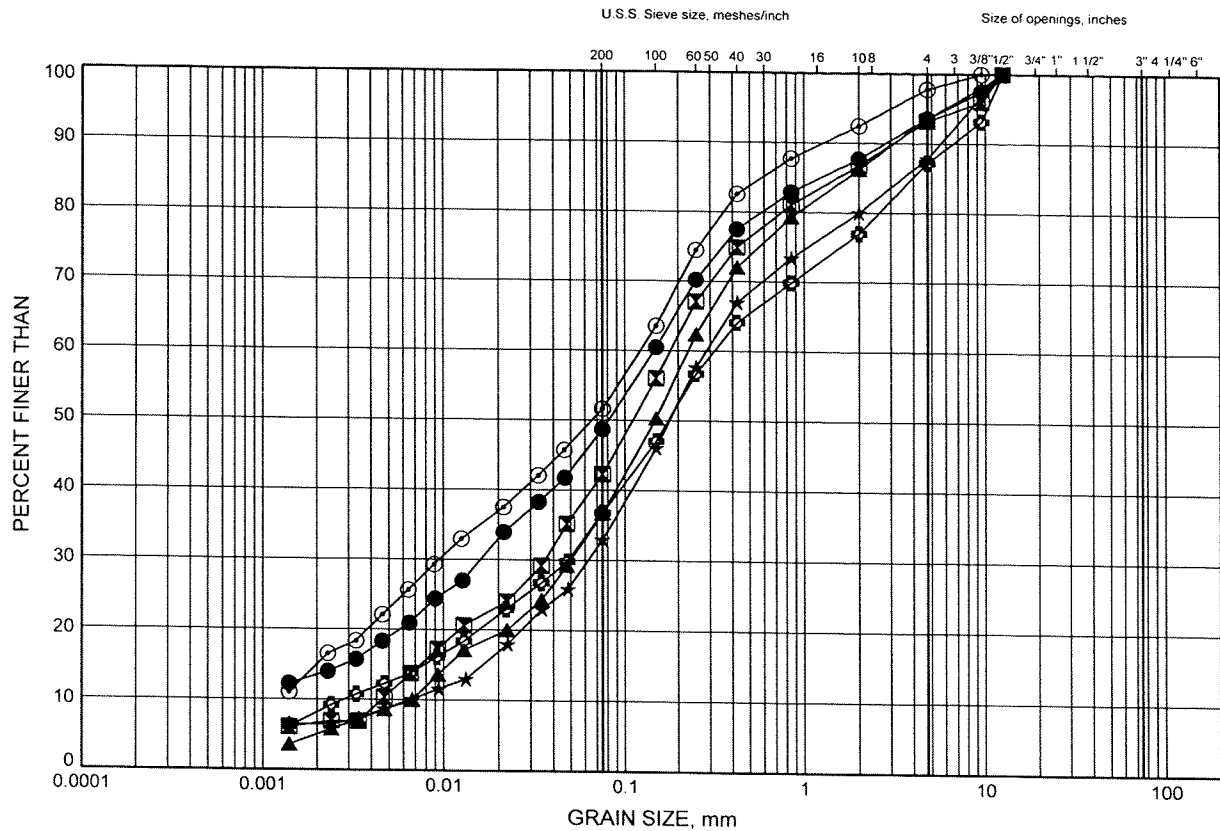


W.P.# 2075-08-00
Prepared By MFA
Checked By DEE

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B21

SAND & SILT TILL TO SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C19-A	2.40	142.79
⊠	C19-A	4.80	140.39
▲	C19-B	6.40	141.38
★	C19-B	10.97	136.81
⊙	C19-C	2.51	142.78
⊞	C19-C	4.80	140.49

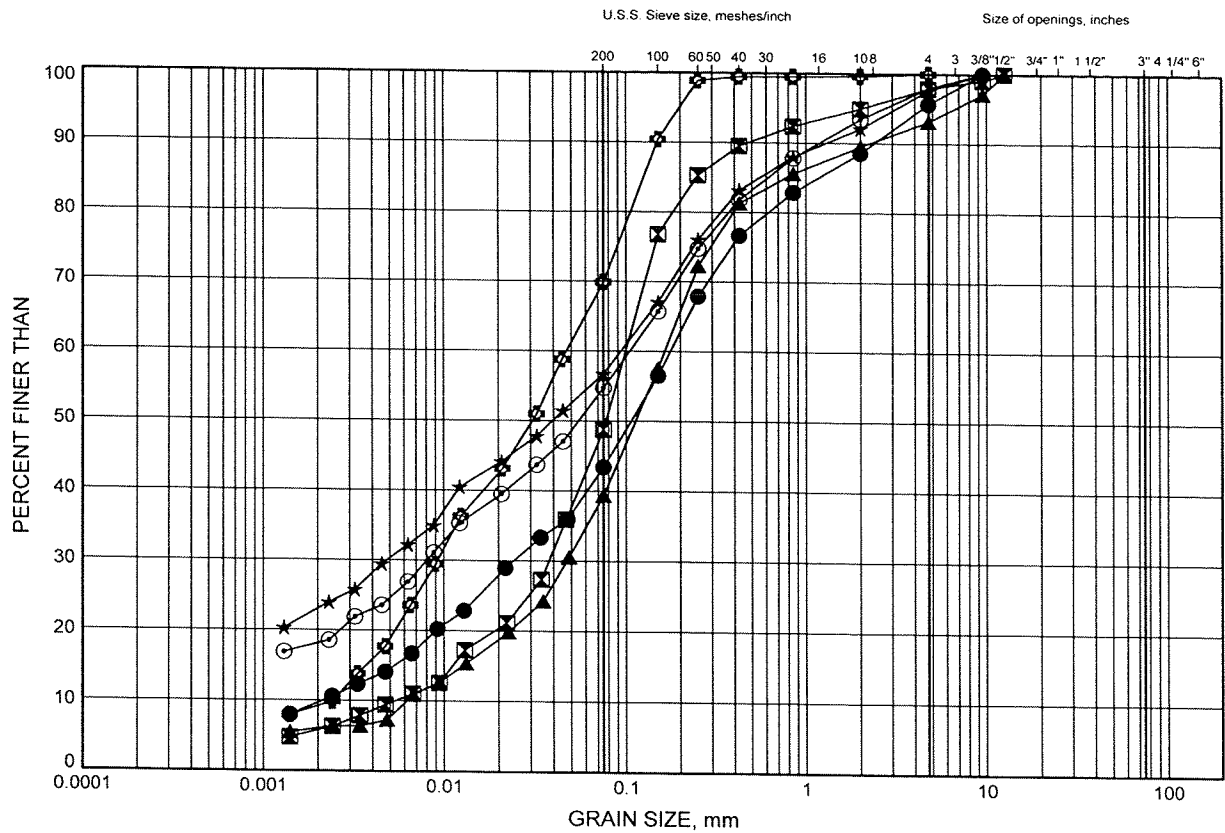


W.P.# 2075-08-00
Prepared By MFA
Checked By DEE

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B22

SAND & SILT TILL TO SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C19-C	7.76	137.53
⊠	C20-A	2.59	143.92
▲	C20-A	4.11	142.39
★	C20-A	7.70	138.81
⊙	C20-B	9.45	139.32
⊛	C21-A	6.40	149.64

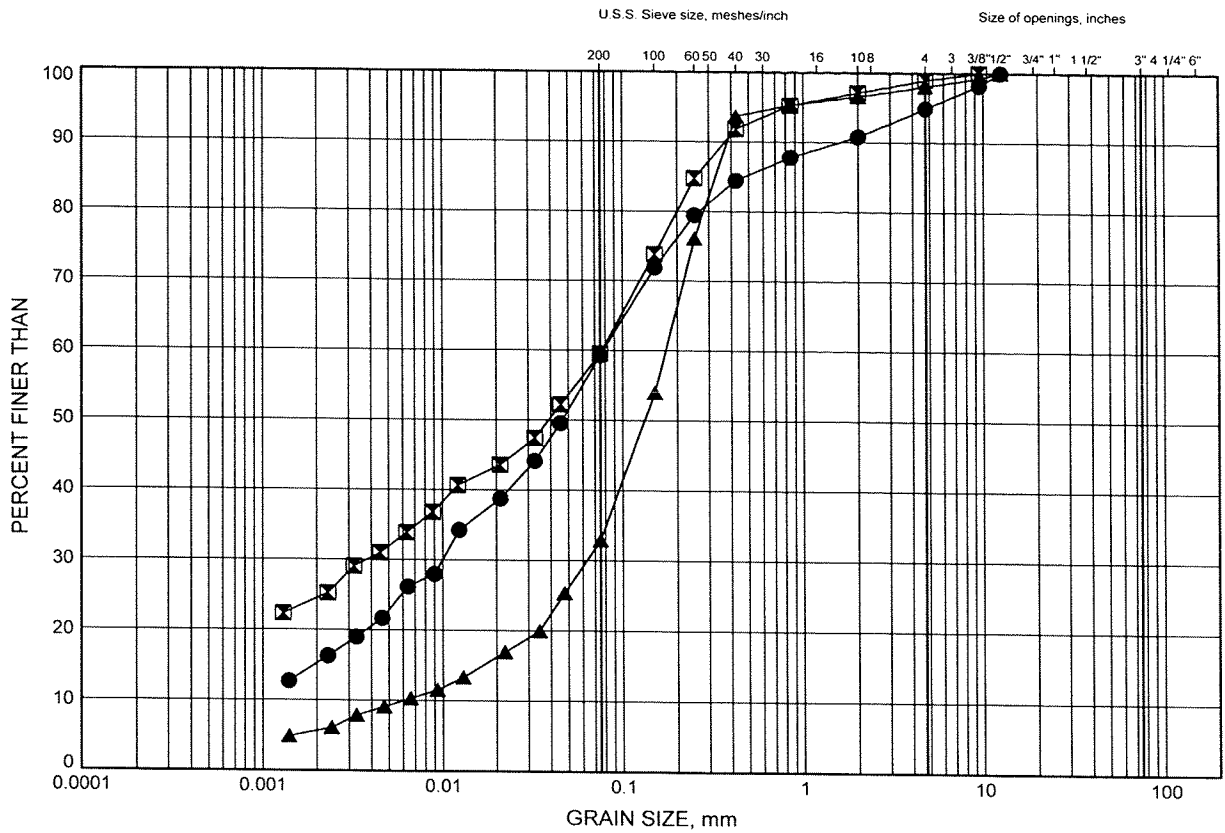


W.P.# 2075-08-00
Prepared By MFA
Checked By DEE

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B23

SAND & SILT TILL TO SILTY SAND TILL



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

LEGEND

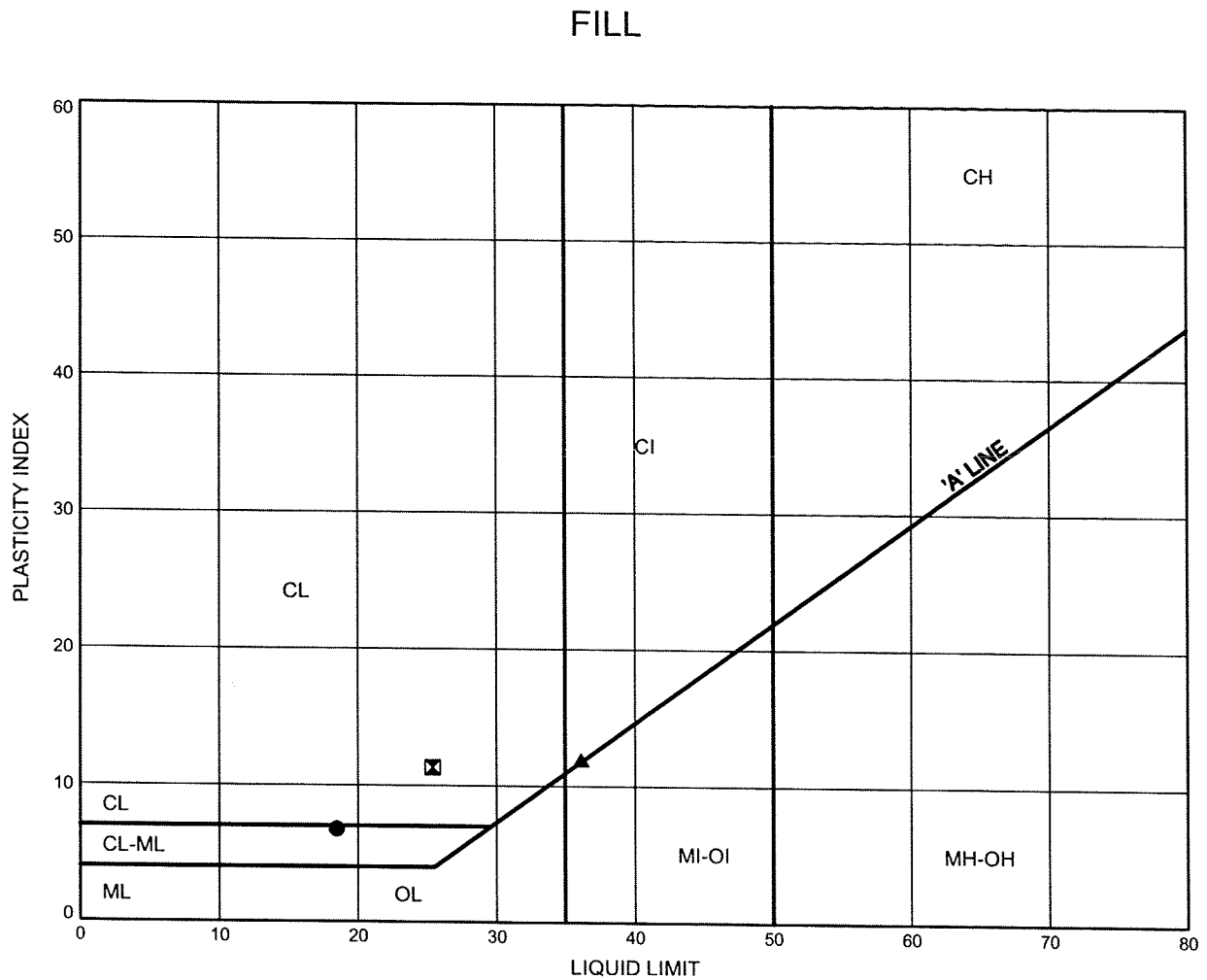
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C21-B	6.48	152.51
⊠	C21-C	0.99	154.78
▲	C21-C	6.32	149.44



W.P.# 2075-08-00
Prepared By MFA
Checked By DEE

Hwy 7 Brock to Hwy 12 ATTERBERG LIMITS TEST RESULTS

FIGURE B24



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	C05-A	0.99	165.35
⊠	C11-B	3.35	151.97
▲	C13-A	1.07	162.04

THURBALT 6126.GPJ 2/13/09

Date February 2009
Project 2075-08-00



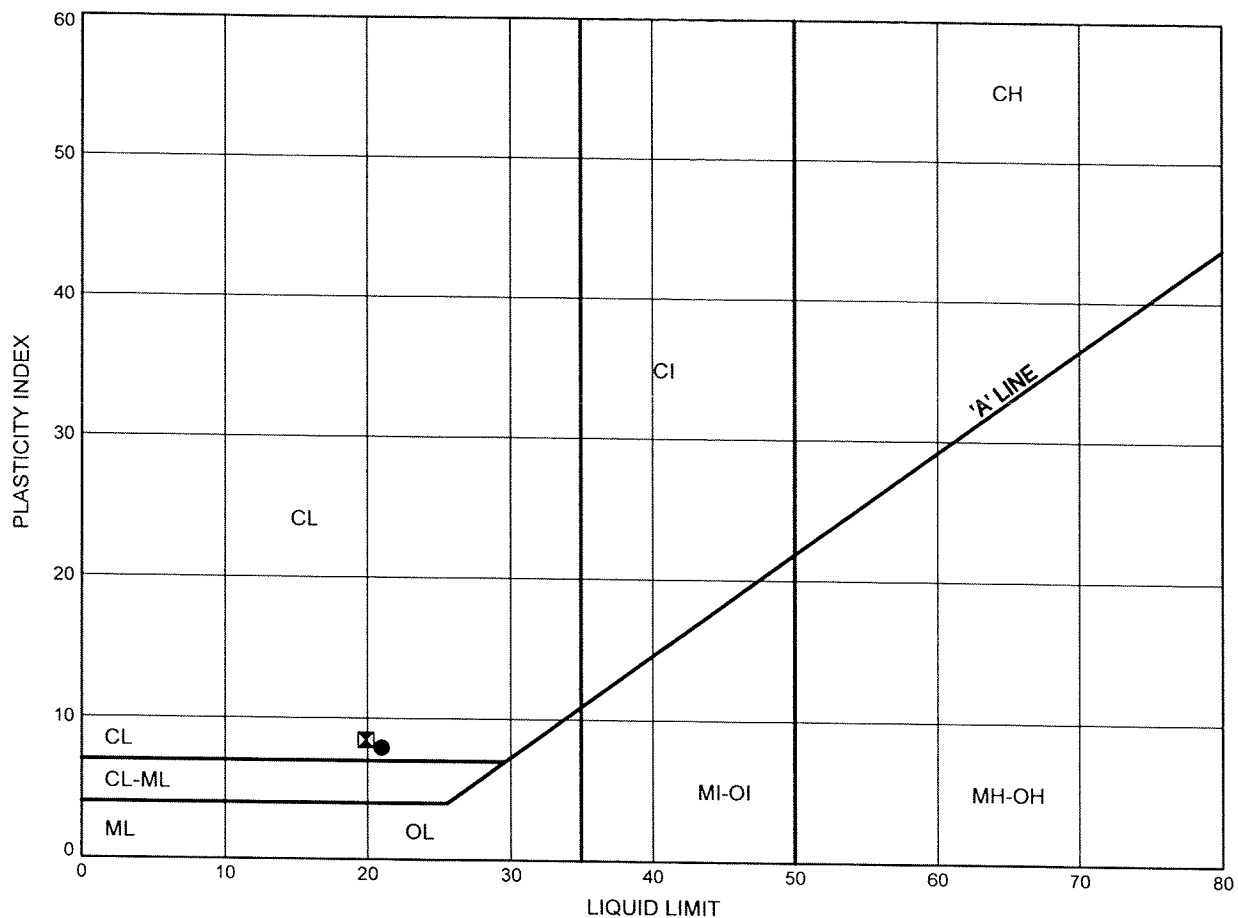
Prep'd MFA
Chkd. DEE

Hwy 7 Brock to Hwy 12

ATTERBERG LIMITS TEST RESULTS

FIGURE B25

SAND, SAND & GRAVEL, SILTY SAND TO SANDY SILT



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	C07-C	2.51	146.56
⊠	C11-A	2.51	149.66

Date February 2009
Project 2075-08-00

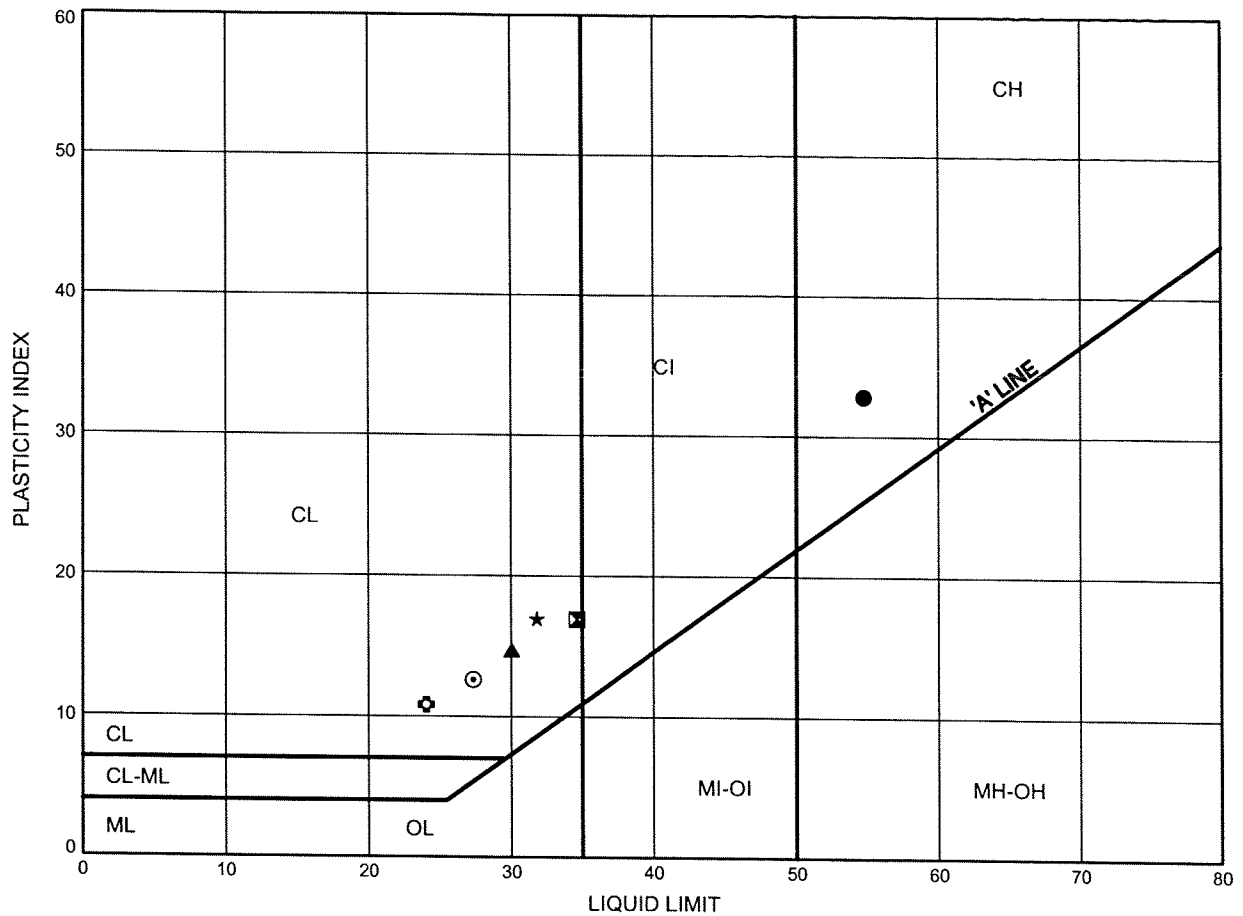


Prep'd MFA
Chkd. DEE

Hwy 7 Brock to Hwy 12
ATTERBERG LIMITS TEST RESULTS

FIGURE B26

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	C01-B	12.50	153.21
⊠	C04-A	10.90	136.66
▲	C04-A	13.94	133.62
★	C04-B	9.45	138.94
⊙	C04-B	14.02	134.36
⊕	C05-B	17.07	154.12

Date February 2009

Project 2075-08-00



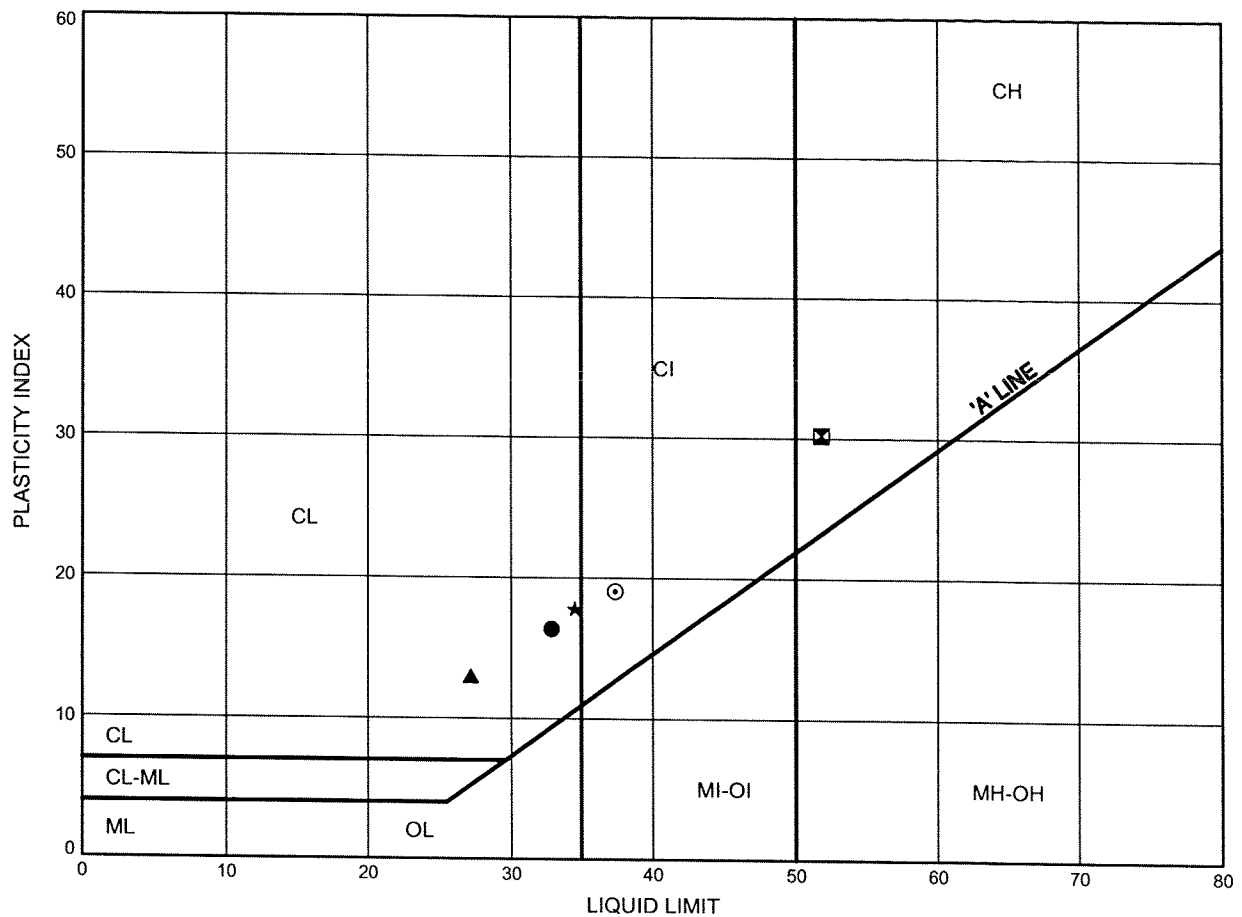
Prep'd MFA

Chkd. DEE

Hwy 7 Brock to Hwy 12
ATTERBERG LIMITS TEST RESULTS

FIGURE B27

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	C07-A	1.75	147.60
⊠	C11-B	14.02	141.30
▲	C21-A	1.83	154.21
★	C21-A	3.35	152.68
⊙	C21-C	4.80	150.97

Date February 2009

Project 2075-08-00



Prep'd MFA

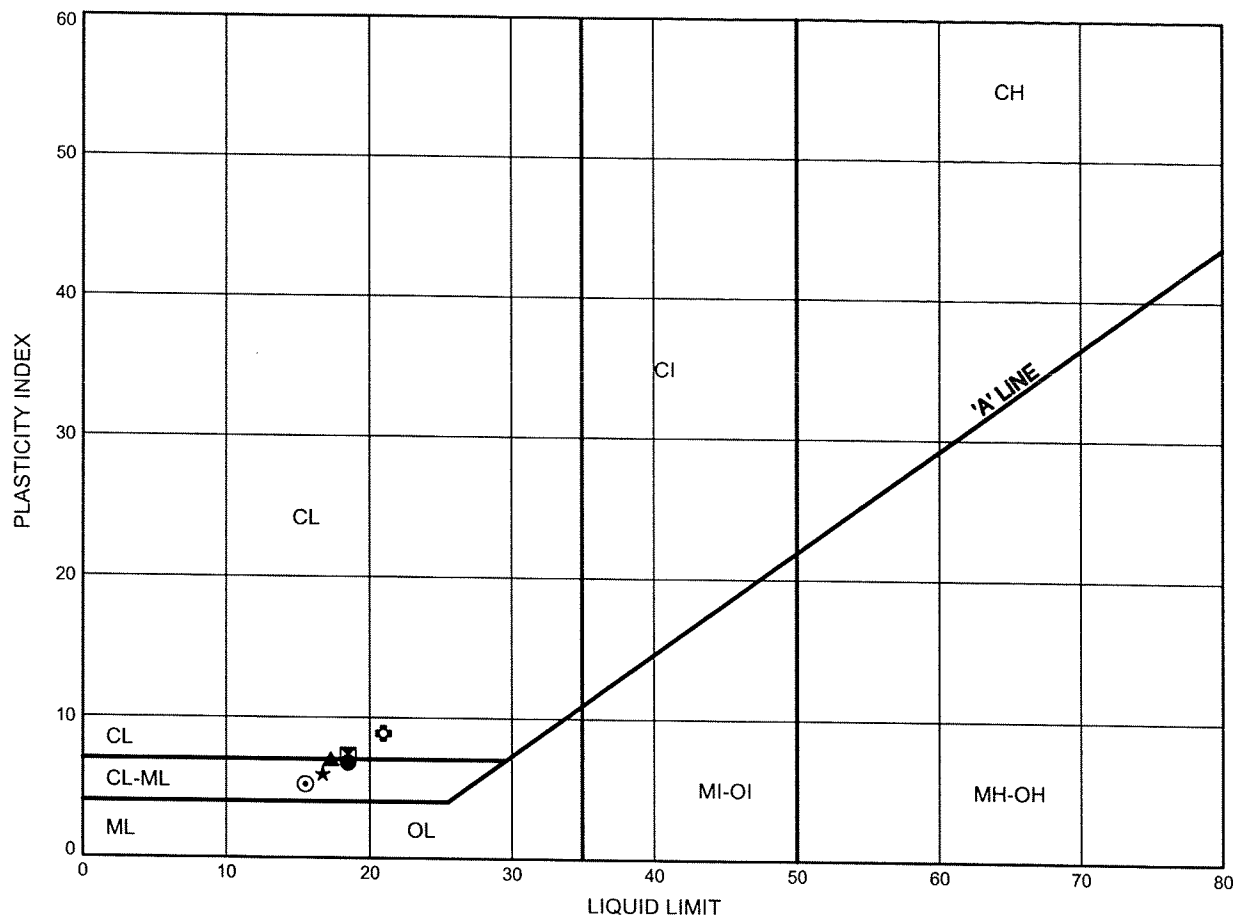
Chkd. DEE

Hwy 7 Brock to Hwy 12

ATTERBERG LIMITS TEST RESULTS

FIGURE B28

SAND & SILT TILL TO SILTY SAND TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	C05-A	0.99	165.35
⊠	C05-B	7.92	163.26
▲	C05-B	12.50	158.69
★	C05-C	3.28	164.56
⊙	C05-C	9.37	158.46
⊛	C07-A	3.28	146.07

Date February 2009
Project 2075-08-00

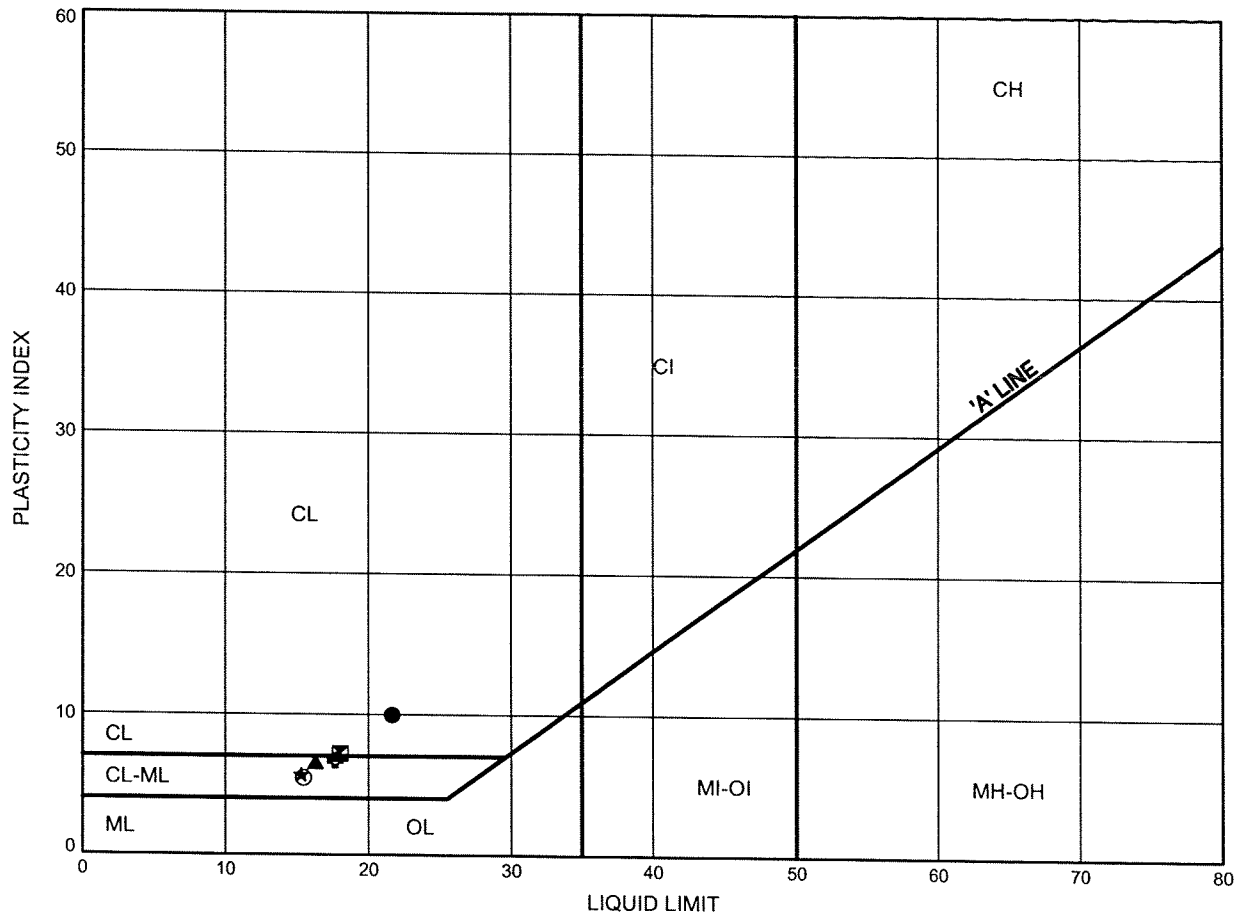


Prep'd MFA
Chkd. DEE

Hwy 7 Brock to Hwy 12
ATTERBERG LIMITS TEST RESULTS

FIGURE B29

SAND & SILT TILL TO SILTY SAND TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	C07-A	4.80	144.55
⊠	C07-B	7.92	142.93
▲	C11-B	6.40	148.92
★	C11-C	3.28	148.38
⊙	C12-C	4.80	147.16
⊕	C13-A	1.83	161.28

Date February 2009

Project 2075-08-00



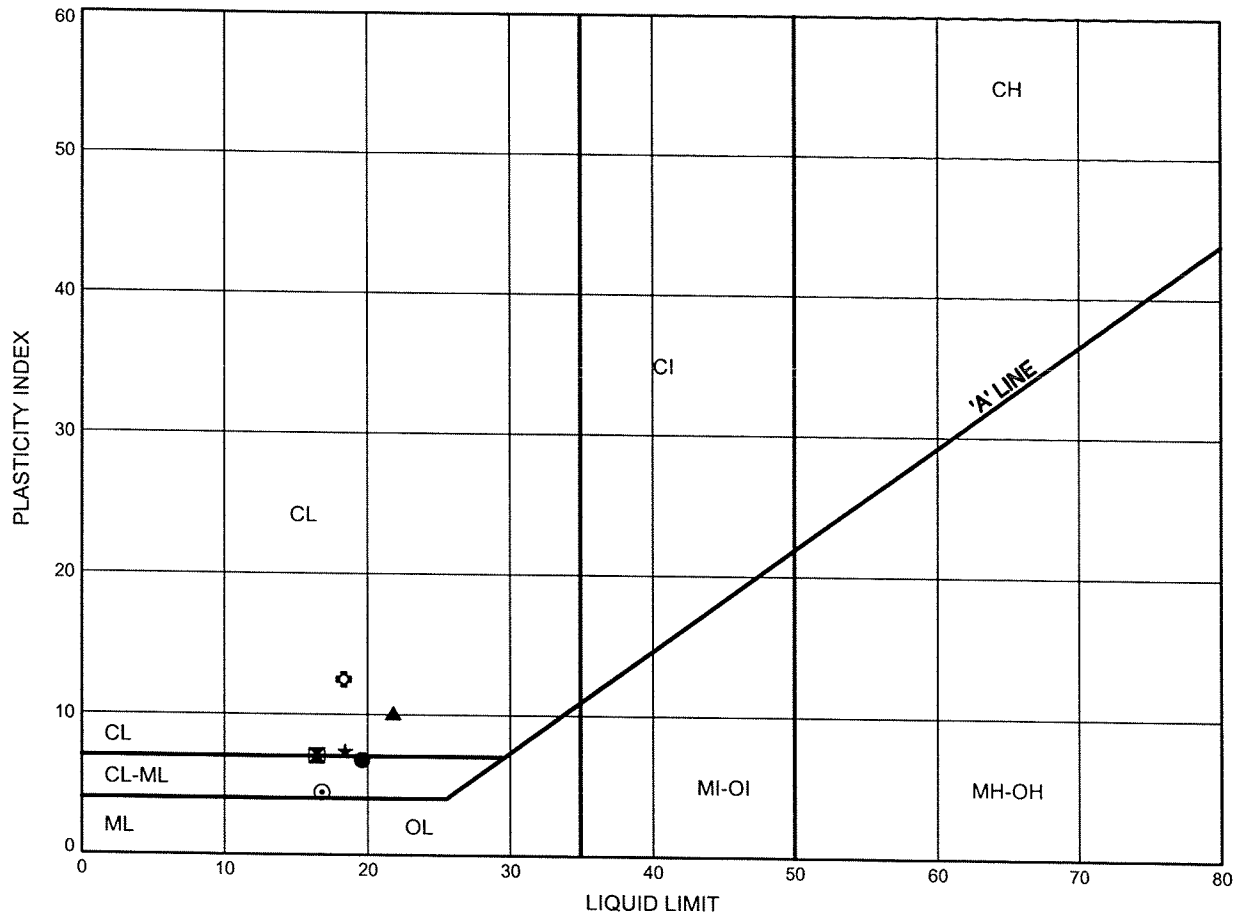
Prep'd MFA

Chkd. DEE

Hwy 7 Brock to Hwy 12
ATTERBERG LIMITS TEST RESULTS

FIGURE B30

SAND & SILT TILL TO SILTY SAND TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	C13-C	0.99	161.59
⊠	C13-C	6.30	156.28
▲	C17-B	7.92	167.16
★	C18-A	2.51	143.66
⊙	C18-A	4.80	141.37
⊕	C18-B	7.92	139.89

Date February 2009

Project 2075-08-00



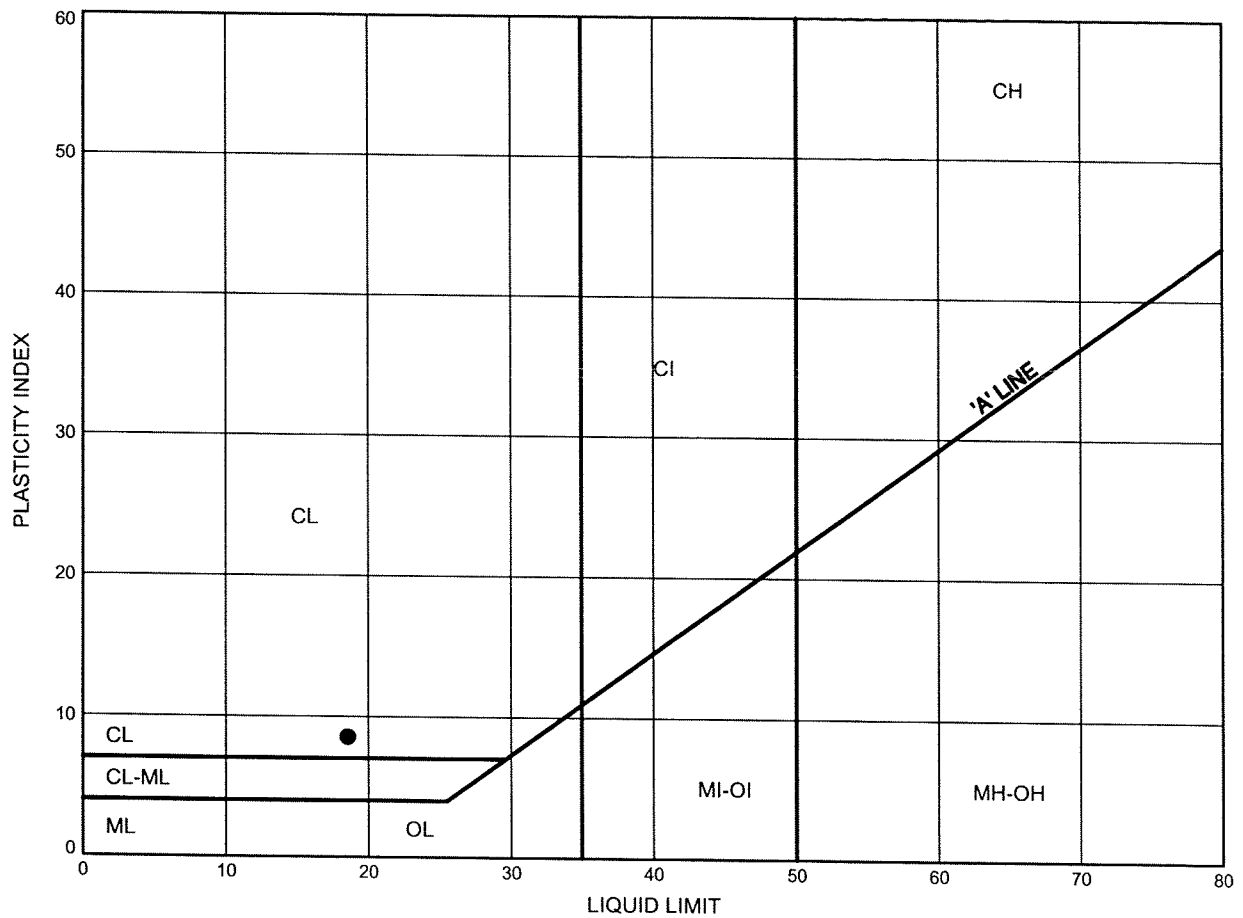
Prep'd MFA

Chkd. DEE

Hwy 7 Brock to Hwy 12
ATTERBERG LIMITS TEST RESULTS

FIGURE B31

SAND & SILT TILL TO SILTY SAND TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	C21-C	0.99	154.78

Date February 2009

Project 2075-08-00



Prep'd MFA

Chkd. DEE

Appendix C

Record of Borehole Sheets (previous investigation)

RECORD OF BOREHOLE No 07-3

1 OF 2

METRIC

G.W.P. W05-20001

LOCATION N 4 867 292.02 E 345 008.37 Stevenson Creek

ORIGINATED BY GA

HWY 7

BOREHOLE TYPE Solid Stem Augers

COMPILED BY JL

DATUM Geodetic

DATE 2007.03.27 - 2007.03.27

CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								20 40 60 80 100						
147.8														
0.0	ASPHALT: (100 mm)													
0.1	SAND, some gravel, trace silt, trace clay Dense Brown Damp (FILL)		1	SS	31									
146.3			2	SS	32									
1.4	SAND, some gravel, trace silt Compact Grey / Brown to Dark Brown Moist		3	SS	24									
145.6														
2.2	Silty SAND to Sandy SILT, trace gravel, some clay Compact Brown Damp to Moist		4	SS	13									
			5	SS	14									
	Wet		6	SS	11									
143.3														
4.5	Clayey SILT with SAND, trace gravel Hard Grey (TILL)		7	SS	32									
142.1														
5.6	Silty SAND to Sandy SILT, trace to some gravel, trace to some clay Very Dense Grey Moist to Wet (TILL)		8	SS	105									

Continued Next Page

+³, X³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 07-3

2 OF 2

METRIC

G.W.P. W05-20001 LOCATION N 4 867 292.02 E 345 008.37 Stevenson Creek ORIGINATED BY GA
HWY 7 BOREHOLE TYPE Solid Stem Augers COMPILED BY JL
DATUM Geodetic DATE 2007.03.27 - 2007.03.27 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
	Continued From Previous Page							SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
								WATER CONTENT (%)						
								PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _p — w — w _L						
134.5	Silty SAND to Sandy SILT, trace to some gravel, some clay Very Dense Grey Moist (TILL)		11	SS	84		137							
133.5														
13.3	Clayey SILT with SAND, trace gravel Hard Grey (TILL)		13	SS	107		134							
133.0														
14.8														
132.5														
15.3	END OF BOREHOLE AT 15.32 m. BOREHOLE OPEN AND WATER LEVEL AT 3.96 m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND PATCHED WITH ASPHALT AT SURFACE.		14	SS	100/ .075									

ONTMT4S 5199.GPJ 20/2/09

RECORD OF BOREHOLE No 07-4

1 OF 2

METRIC

G.W.P. W05-20001

LOCATION N 4 867 308.89 E 345 021.91 Stevenson Creek

ORIGINATED BY GA

HWY 7

BOREHOLE TYPE Solid Stem Augers

COMPILED BY JL

DATUM Geodetic

DATE 2007.04.11 - 2007.04.12

CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
145.3 0.0	Sandy SILT, trace clay, trace gravel, occasional rootlets Compact Brown Wet		1	SS	13		145							
144.7 0.6	Clayey SILT with SAND, trace gravel Very Stiff to Hard Grey (TILL)		2	SS	23		144							
143.2			3	SS	86									
2.1	Silty SAND to Sandy SILT, trace gravel, trace to some clay Very Dense Grey Damp to Wet (TILL)		4	SS	123		143							
			5	SS	138		142							
			6	SS	101		141							
	Resistance to augering from 4.5m to 6.0m		7	SS	89		140							
			8	SS	80		139							
	trace clay						138							
			9	SS	70		137							
	some clay						136							
			10	SS	98									

Continued Next Page

+³, X³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 07-4

2 OF 2

METRIC

G.W.P. W05-20001 LOCATION N 4 867 308.89 E 345 021.91 Stevenson Creek ORIGINATED BY GA
 HWY 7 BOREHOLE TYPE Solid Stem Augers COMPILED BY JL
 DATUM Geodetic DATE 2007.04.11 - 2007.04.12 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								WATER CONTENT (%)					
	Continued From Previous Page						20 40 60 80 100						
133.1	Silty SAND to Sandy SILT, trace gravel, trace to some clay Dense Grey Wet (TILL)		11	SS	46								
12.2	Very Dense		12	SS	50								
			13	SS	71								
129.6			14	SS	92								
15.7	END OF BOREHOLE AT 15.70 m. BOREHOLE OPEN TO 15.24 m AND WATER LEVEL AT 0.61 m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) Apr.15/07 0.8 144.5 Apr.30/07 1.2 144.1 Jun.28/07 1.3 144.0												

+³, x³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

Appendix D

Borehole Locations and Soil Strata Drawings

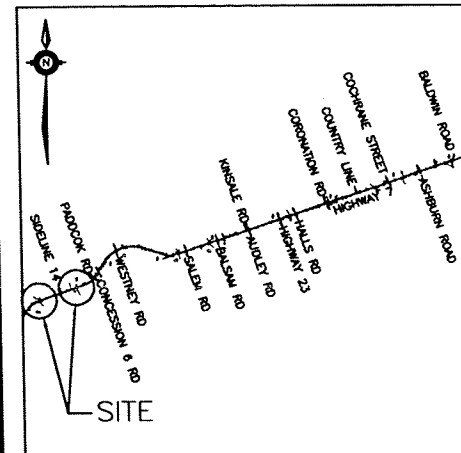
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HIGHWAY 7
CONT No
GWP No 2075-08-00



HWY 7
BROCK STREET TO HWY 12
CULVERTS C-01 & C-04
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEYPLAN

LEGEND

- Borehole
- Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

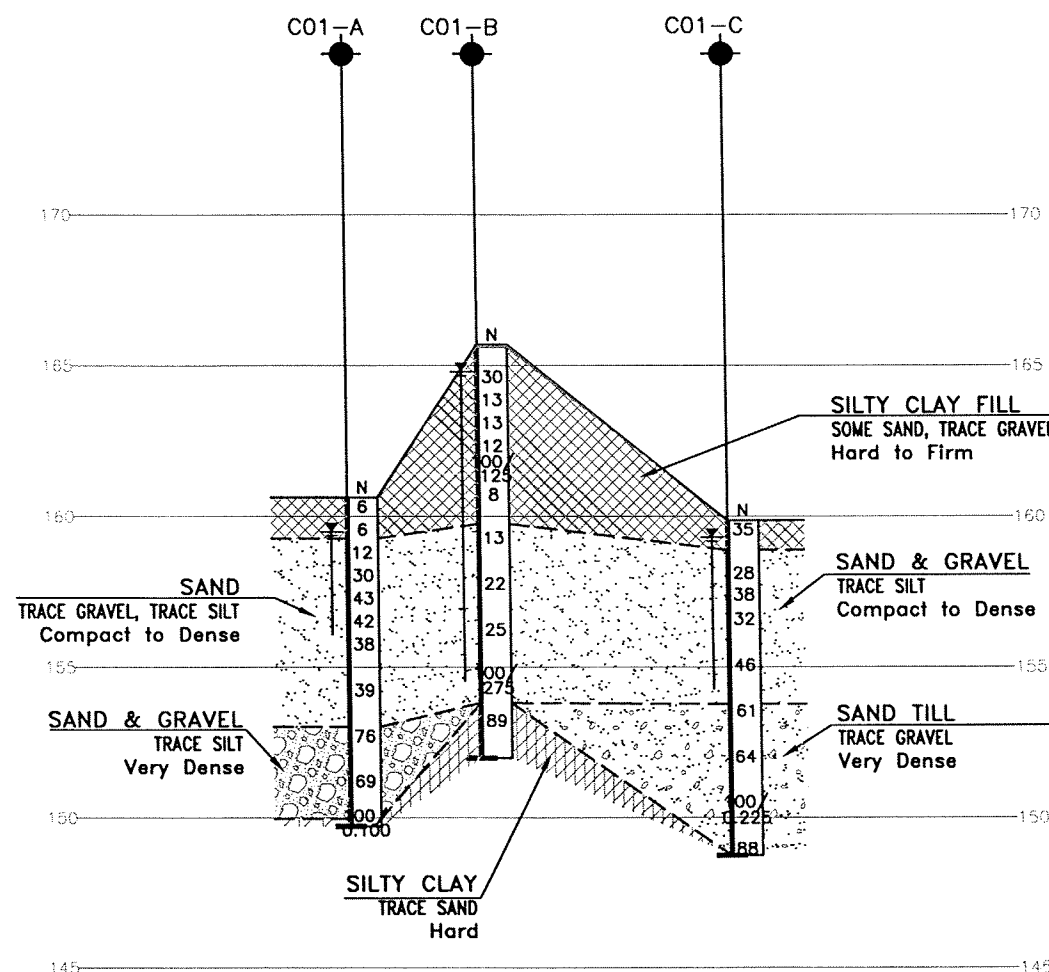
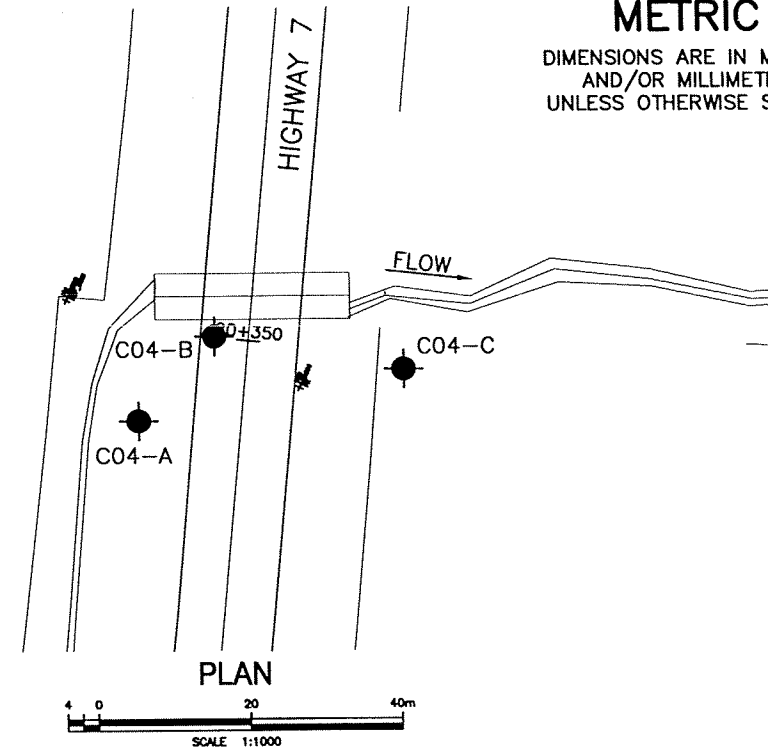
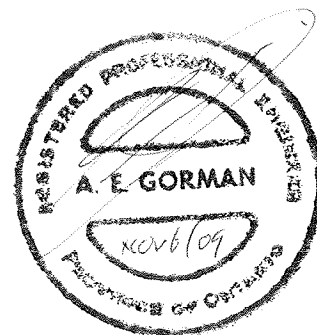
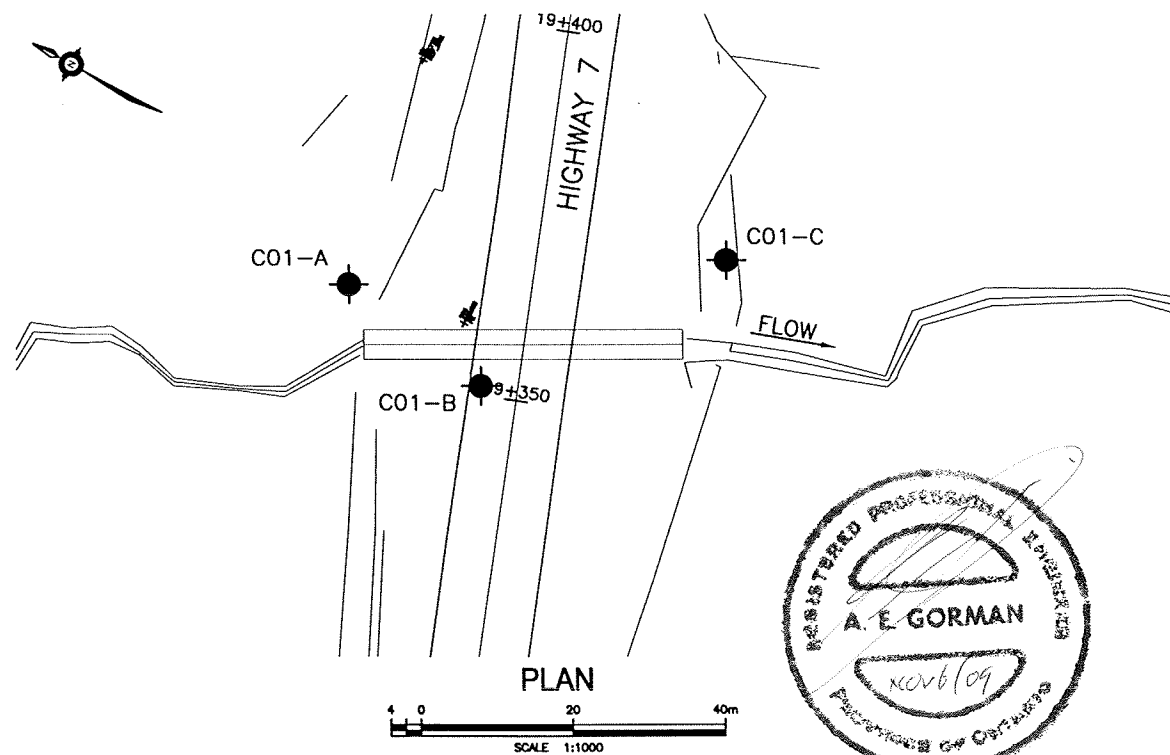
NO	ELEVATION	NORTHING	EASTING
C01-A	160.6	4 864 798.9	337 522.6
C01-B	165.7	4 864 777.3	337 518.8
C01-C	159.8	4 864 756.7	337 549.1
C04-A	147.5	4 865 110.6	338 447.6
C04-B	148.3	4 865 106.2	338 462.1
C04-C	147.2	4 865 081.7	338 468.7

-NOTES-

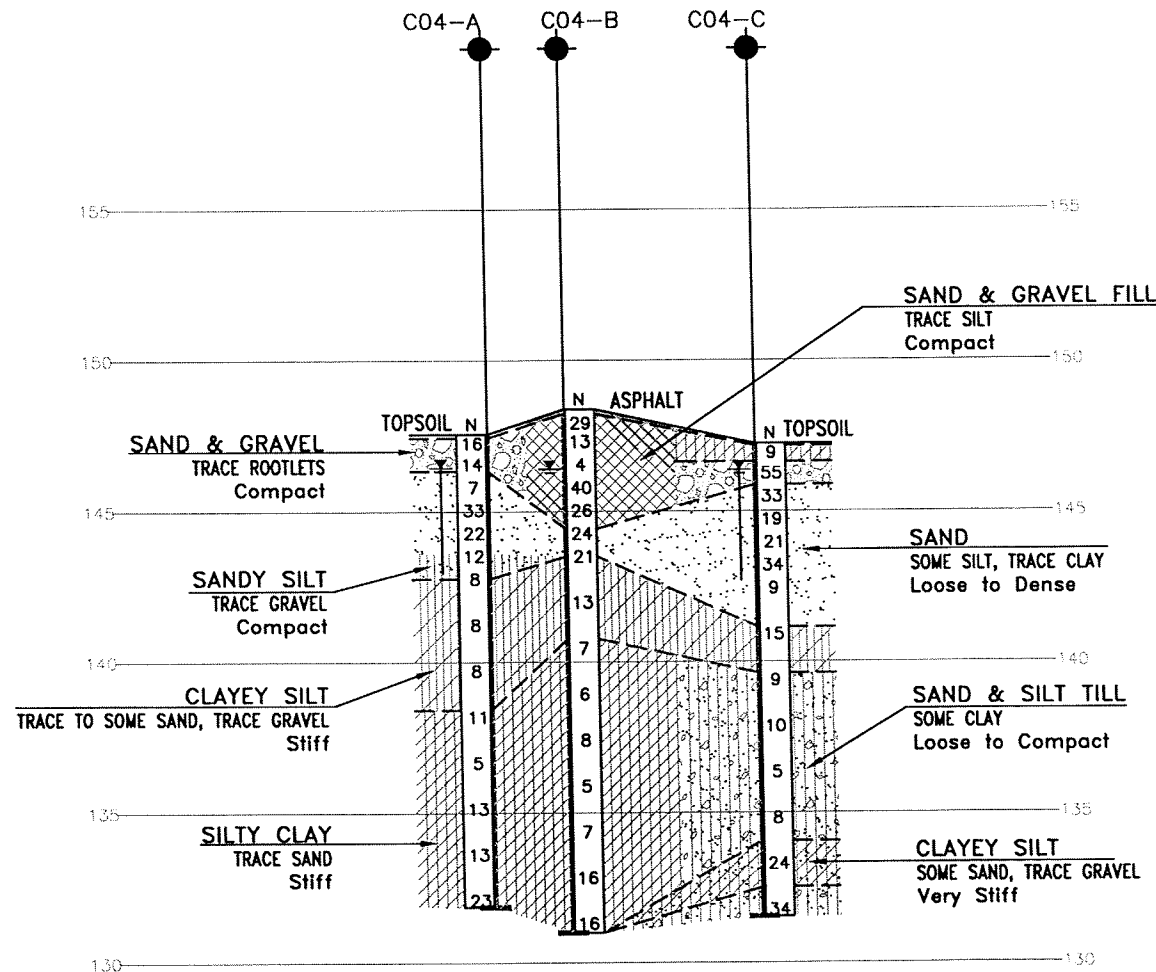
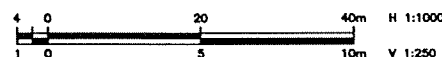
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 30M14-319

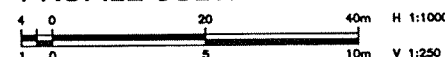
REVISIONS	DATE	BY	DESCRIPTION
DESIGN	DEE	CHK PKC	CODE
DRAWN	AN	CHK AEG	SITE
		LOAD	DATE
		STRUCT	NOV. 2009
		DWG	1



PROFILE CULVERT C-01



PROFILE CULVERT C-04



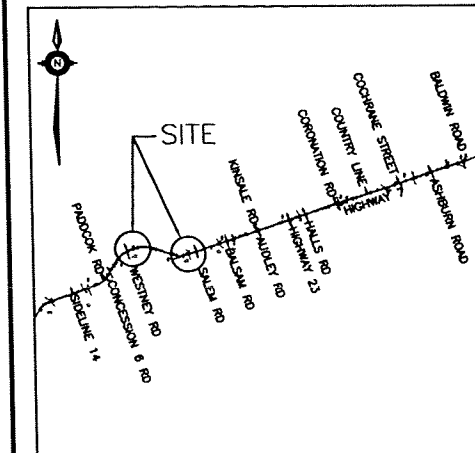
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HIGHWAY 7
CONT No
GWP No 2075-08-00



HWY 7
BROCK STREET TO HWY12
CULVERTS C-05 & C-07
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEYPLAN

LEGEND

- Borehole
- ⊙ Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- W Water Level
- HA Head Artesian Water
- PZ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

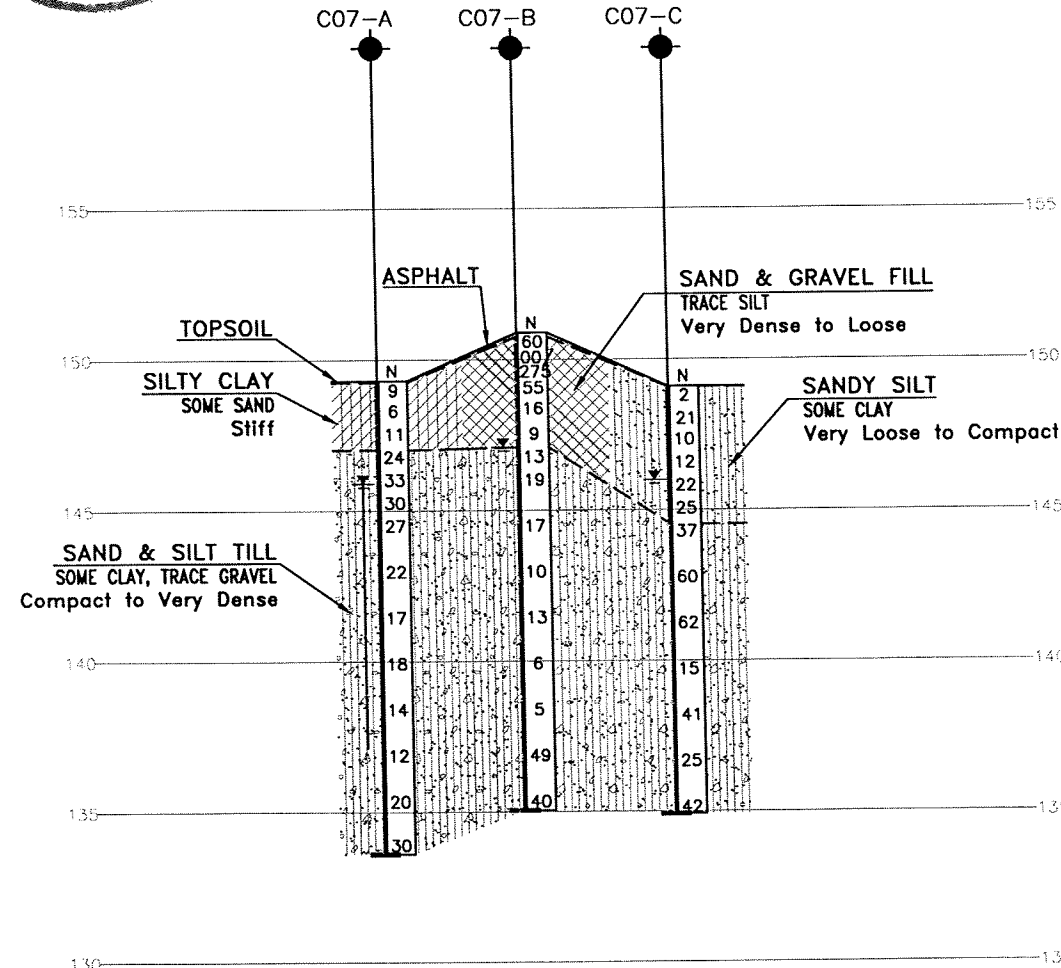
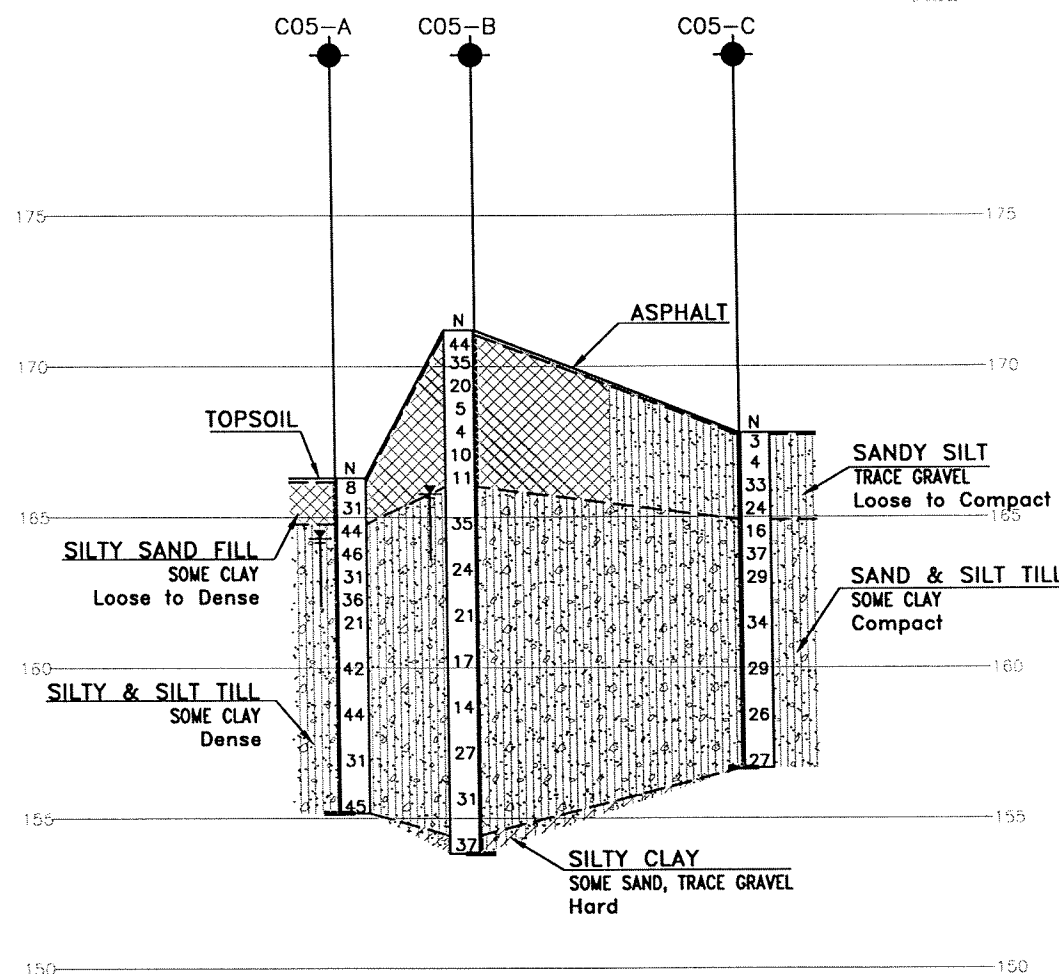
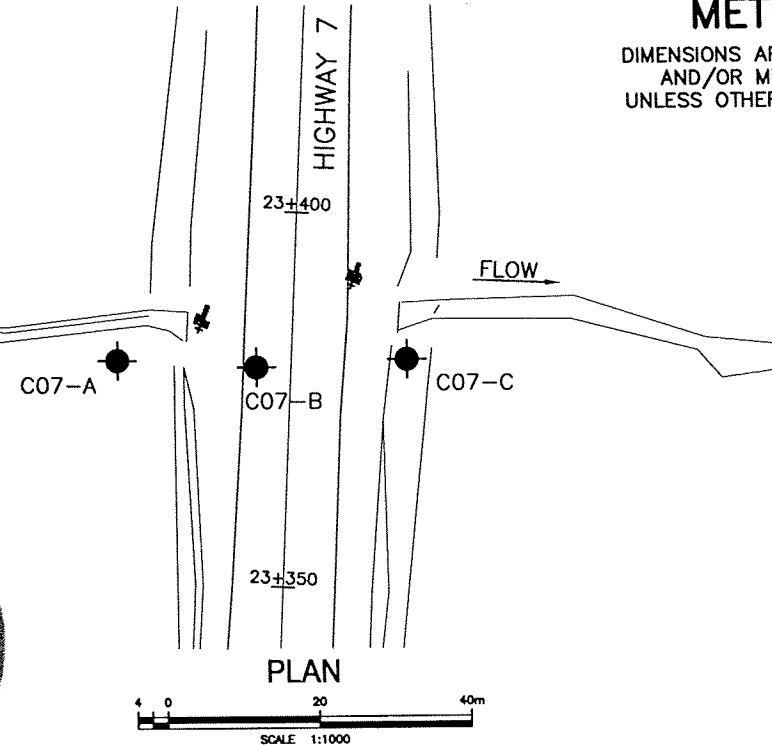
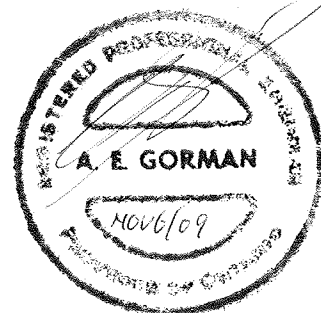
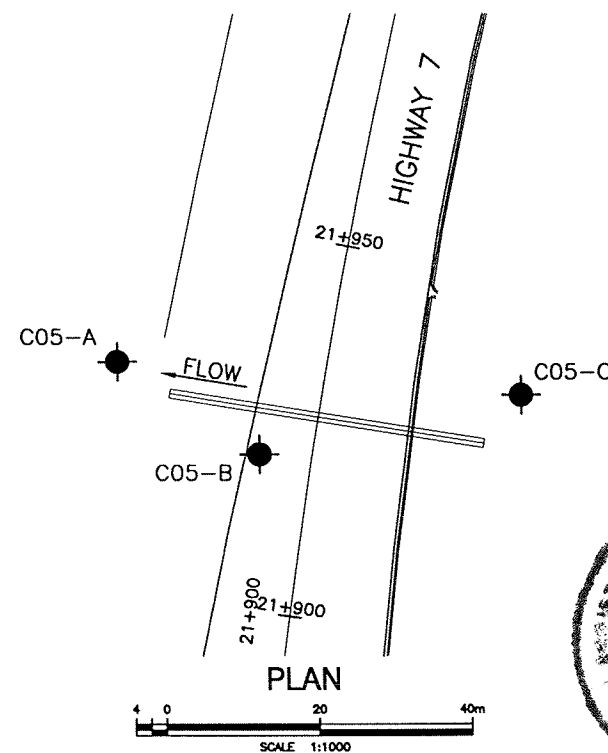
NO	ELEVATION	NORTHING	EASTING
C05-A	166.3	4 866 125.2	339 607.9
C05-B	171.2	4 866 102.9	339 606.2
C05-C	167.8	4 866 075.4	339 629.3
C07-A	149.3	4 865 973.7	341 012.7
C07-B	150.9	4 865 956.2	341 018.4
C07-C	149.1	4 865 938.1	341 026.5

-NOTES-

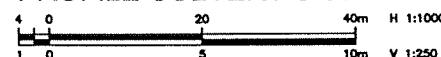
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 30M14-319

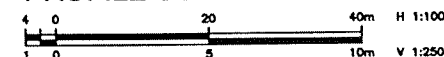
REVISIONS	DATE	BY	DESCRIPTION
DESIGN	DEE	CHK PKC	CODE
DRAWN	AN	CHK AEG	SITE
			STRUCT
			DWG 2

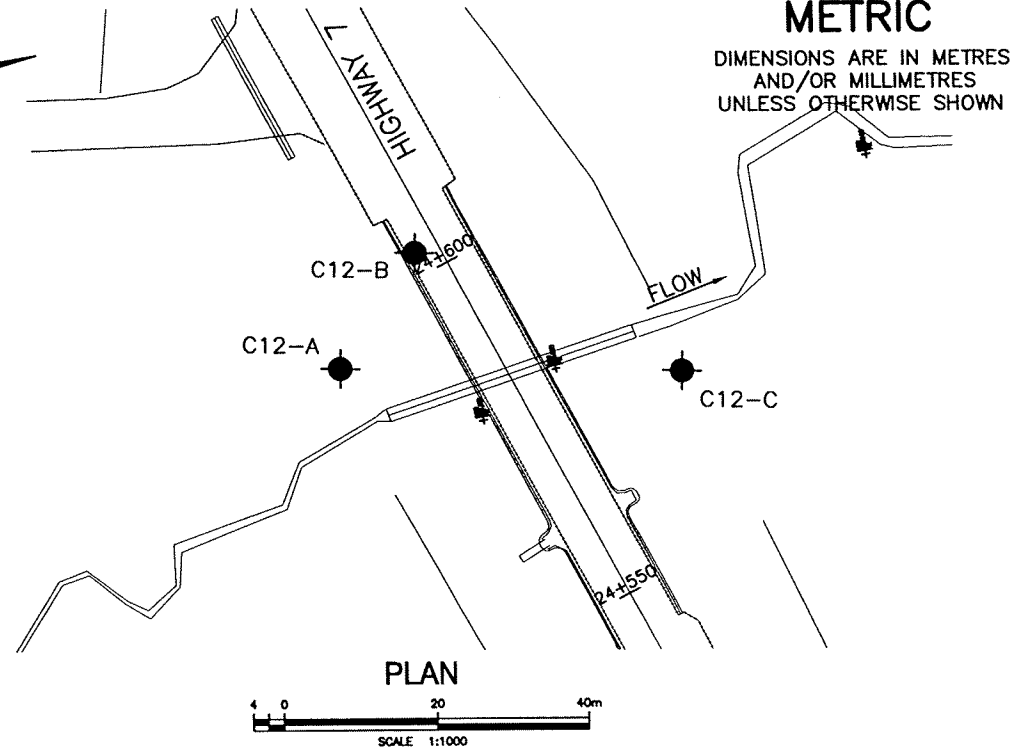
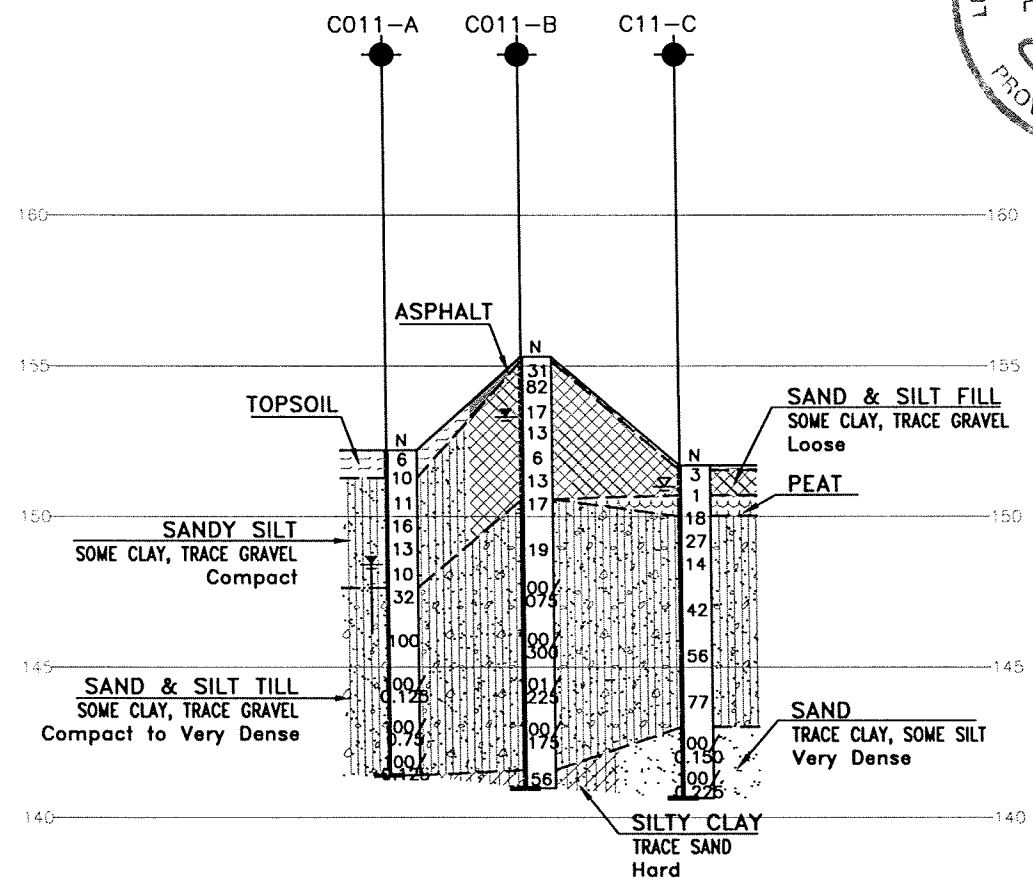
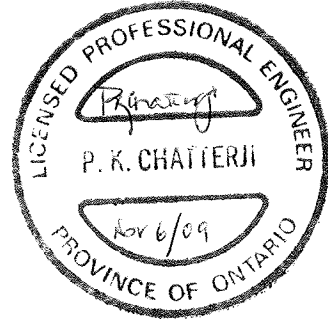
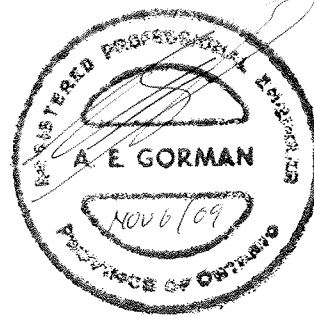
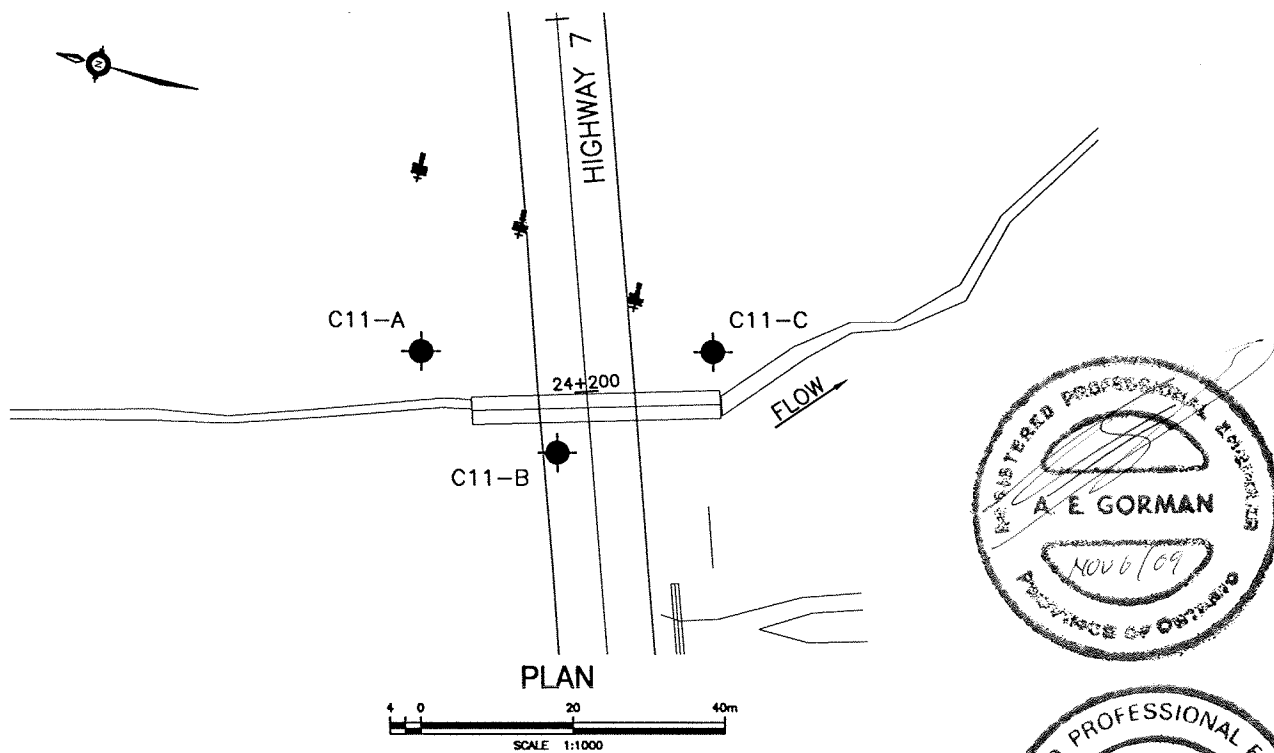


PROFILE CULVERT C-05

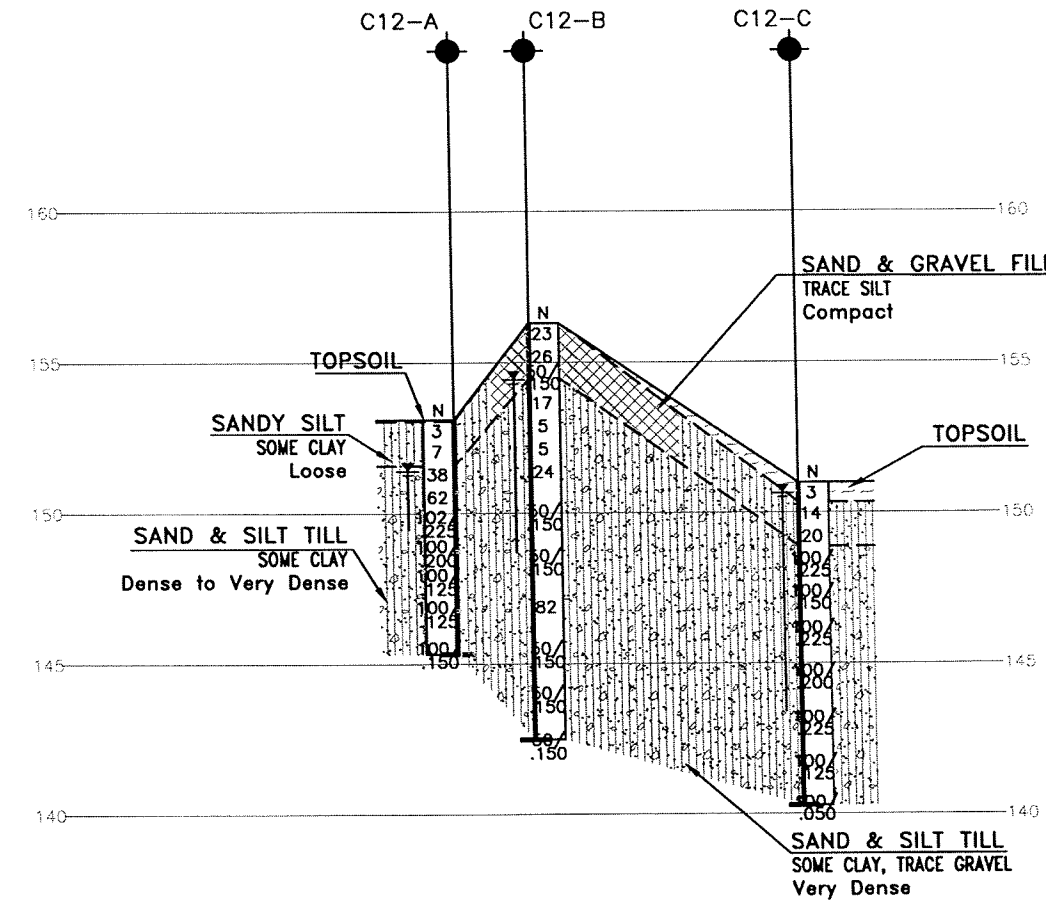


PROFILE CULVERT C-07





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

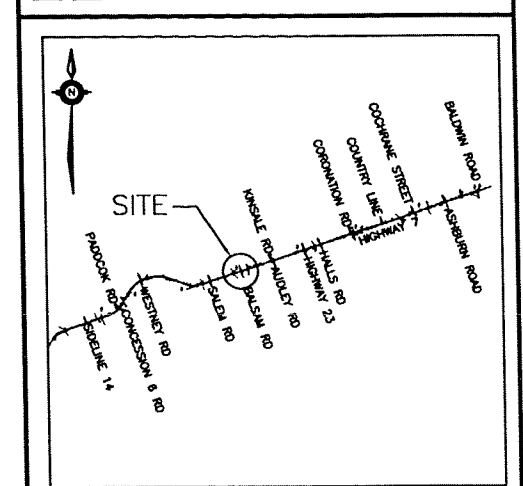


HIGHWAY 7
CONT No
GWP No 2075-08-00

HWY 7
BROCK STREET TO HWY 12
CULVERTS C-11 & C-12
BOREHOLE LOCATIONS AND SOIL STRATA

MMM GROUP

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



LEGEND				
	Borehole			
	Borehole and Cone			
N	Blows /0.3m (Std Pen Test, 475J/blow)			
CONE	Blows /0.3m (60° Cone, 475J/blow)			
PH	Pressure, Hydraulic			
	Water Level			
	Head Artesian Water			
	Piezometer			
90%	Rock Quality Designation (RQD)			
A/R	Auger Refusal			
NO	ELEVATION	NORTHING	EASTING	
C11-A	152.2	4 866 230.5	341 799.5	
C11-B	155.3	4 866 210.0	341 790.9	
C11-C	151.7	4 866 193.2	341 808.9	
C12-A	153.1	4 866 347.4	342 168.4	
C12-B	156.3	4 866 334.9	342 182.4	
C12-C	152.0	4 866 303.2	342 160.7	

-NOTES-

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

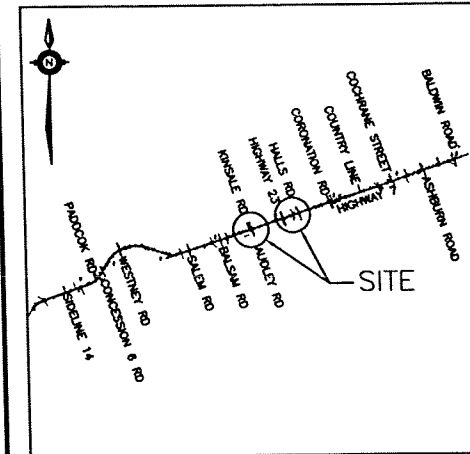
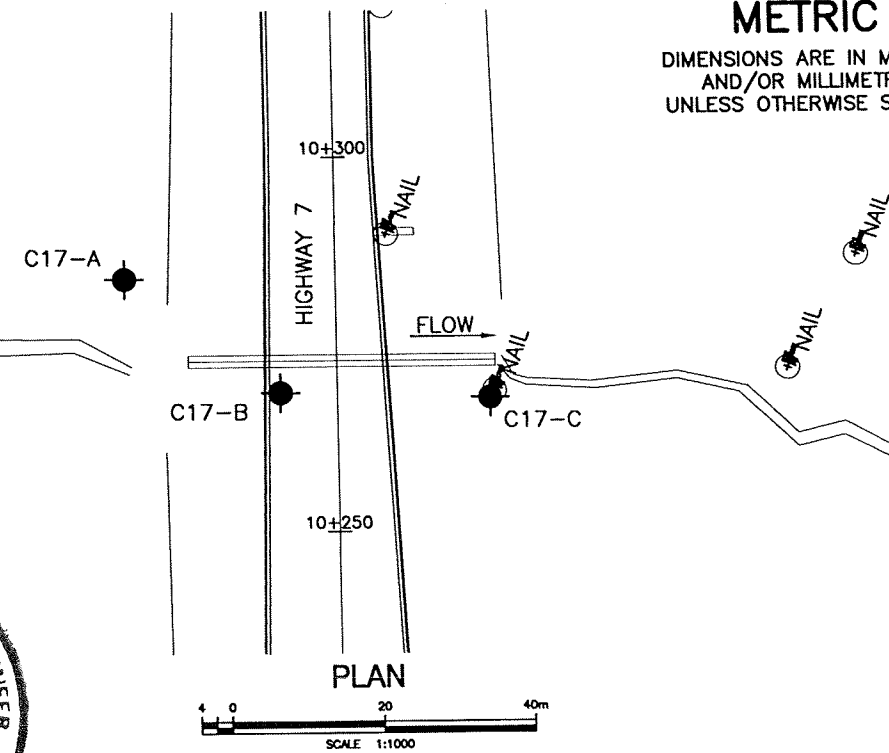
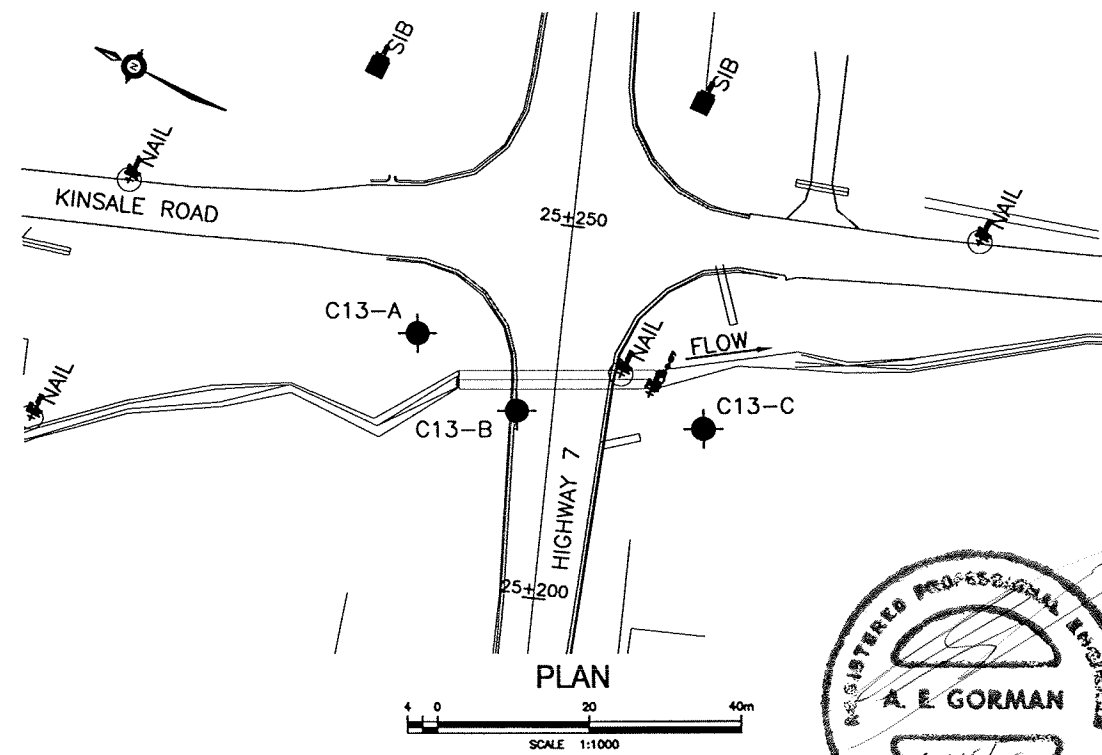
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 30M14-319

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	DEE	CHK PKC	CODE
DRAWN	AN	CHK AEG	SITE
			LOAD
			DATE
			NOV. 2009
			STRUCT
			DWG 3

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

HIGHWAY 7 CONT No GWP No 2075-08-00		SHEET
HWY 7 BROCK STREET TO HWY 12 CULVERTS C-13 & C-17 BOREHOLE LOCATIONS AND SOIL STRATA		
THURBER ENGINEERING LTD. GEOTECHNICAL • ENVIRONMENTAL • MATERIALS		



KEYPLAN LEGEND

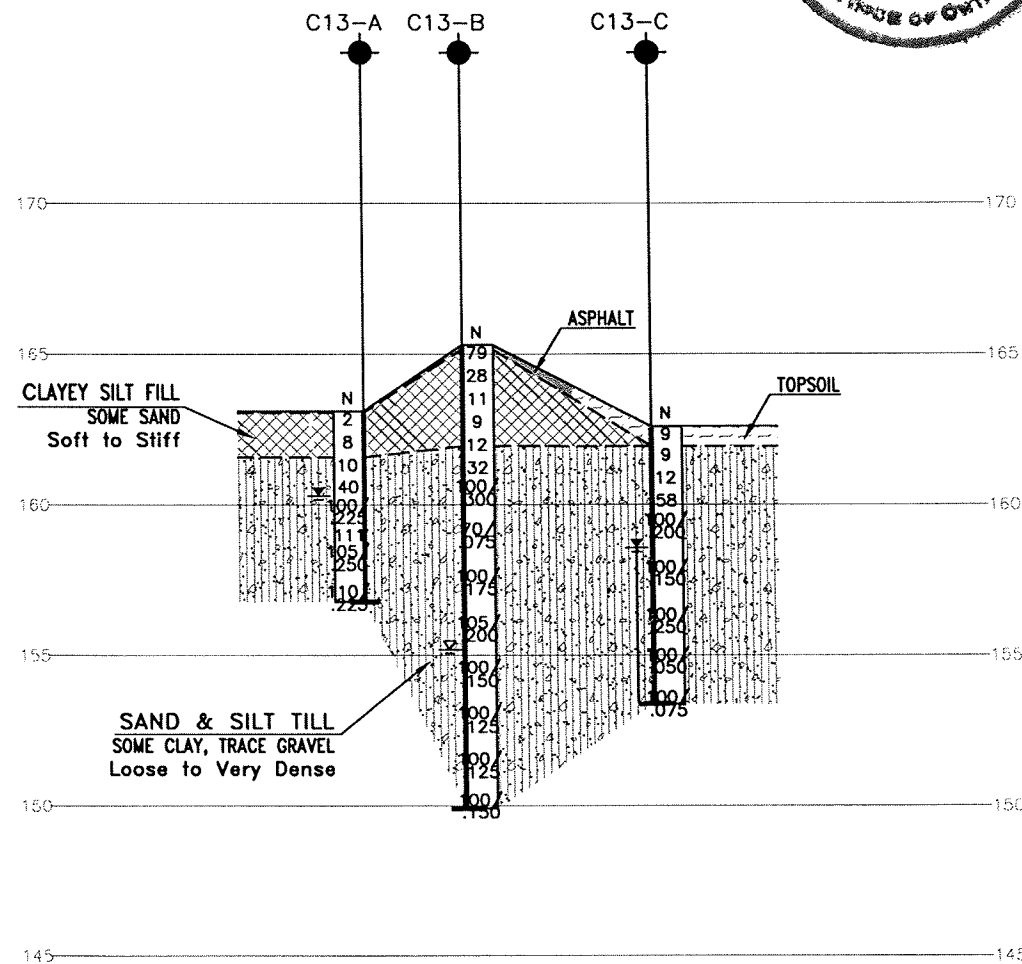
- Borehole
- Borehole and Cone
- Blows /0.3m (Std Pen Test, 475J/blow)
- Blows /0.3m (60° Cone, 475J/blow)
- Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- Rock Quality Designation (RQD)
- Auger Refusal

NO	ELEVATION	NORTHING	EASTING
C13-A	163.1	4 866 553.9	342 773.4
C13-B	165.3	4 866 537.6	342 769.8
C13-C	162.6	4 866 514.4	342 778.3
C17-A	170.5	4 866 924.5	343 836.7
C17-B	175.1	4 866 900.4	343 828.6
C17-C	168.9	4 866 873.8	343 836.7

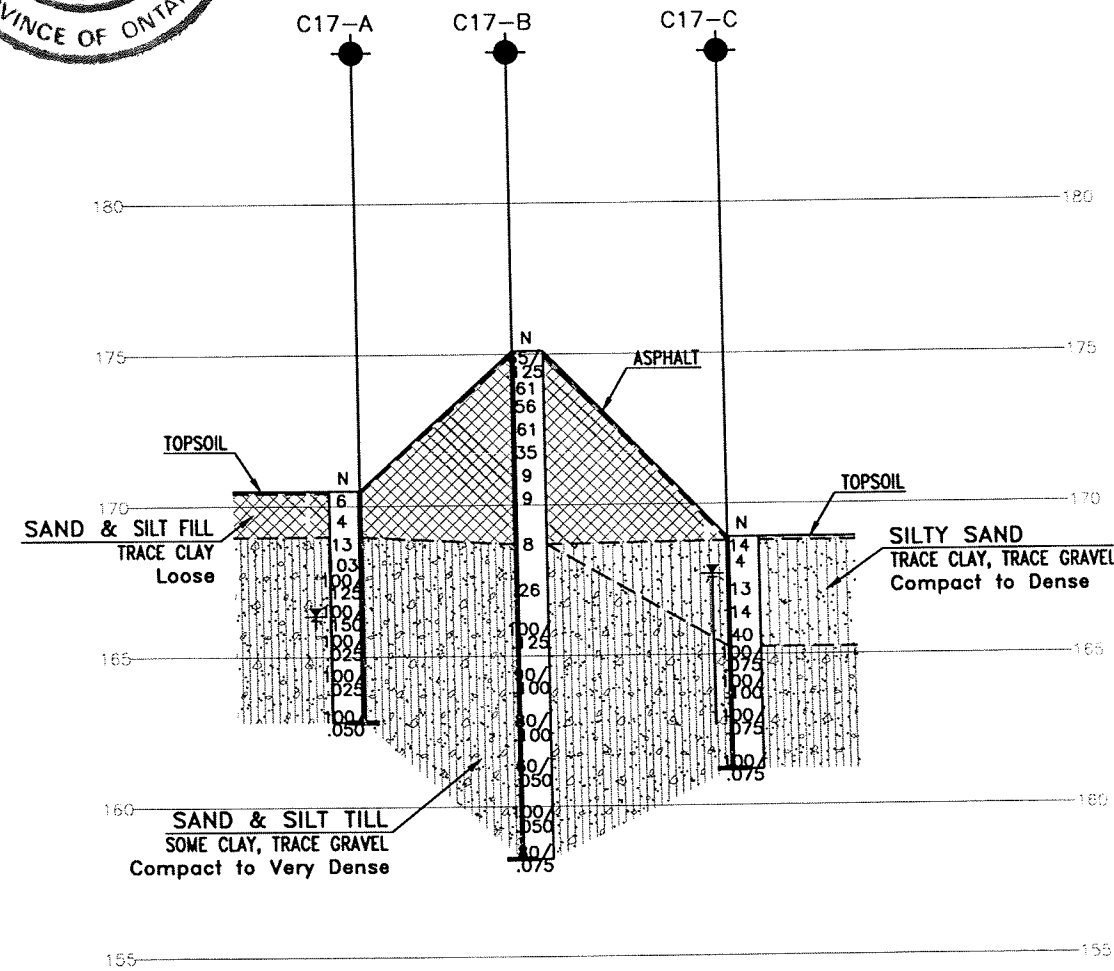
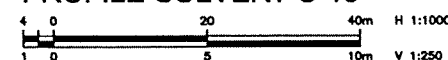
-NOTES-

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

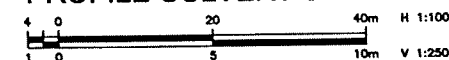
GEOCRES No. 30M14-319



PROFILE CULVERT C-13



PROFILE CULVERT C-17



REVISIONS	DATE	BY	DESCRIPTION
DESIGN 5	CHK PKC	CODE	LOAD
DRAWN MFA	CHK AEG	SITE	STRUCT
			DWG 4

DATE NOV. 2009

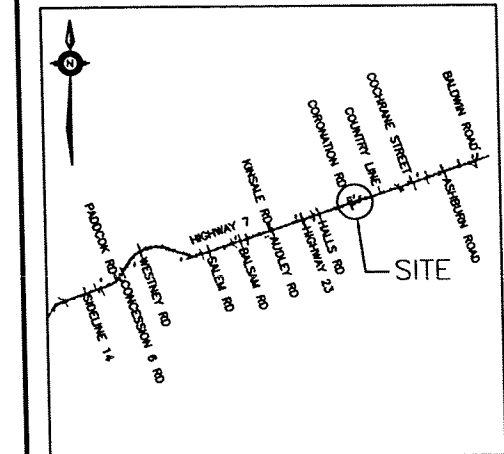
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HIGHWAY 7
CONT No
GWP No 2075-08-00



SHEET

HWY 7
BROCK STREET TO HWY 12
CULVERTS C-18 & C-19
BOREHOLE LOCATIONS AND SOIL STRATA



KEYPLAN

LEGEND

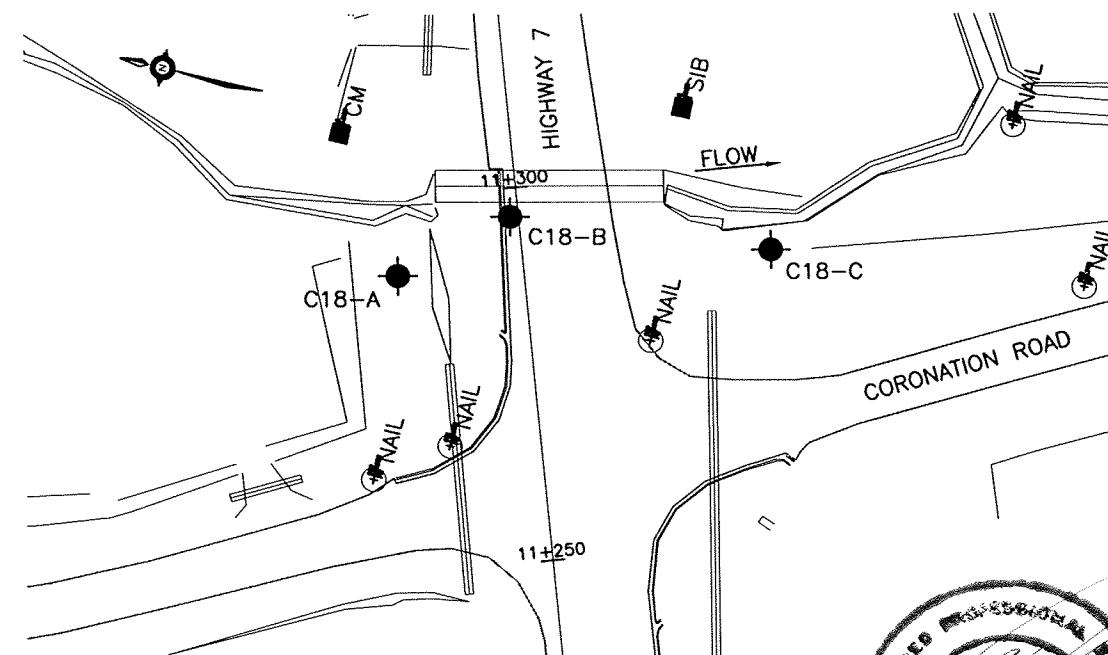
- Borehole
- ⊙ Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- W Water Level
- HA Head Artesian Water
- P Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
C18-A	146.2	4 867 238.3	344 792.2
C18-B	147.8	4 867 225.6	344 803.3
C18-C	144.9	4 867 191.3	344 806.8
C19-A	145.2	4 867 309.3	345 026.9
C19-B	147.8	4 867 292.2	345 009.0
C19-C	145.3	4 867 272.3	345 016.0

-NOTES-

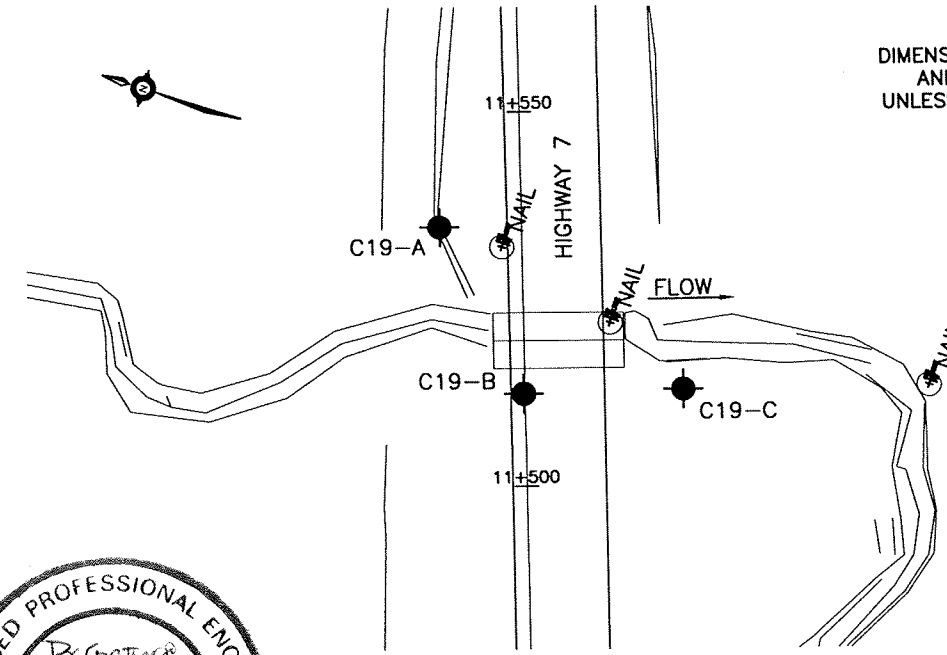
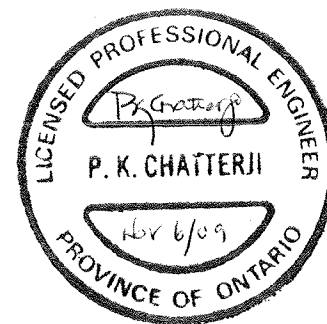
- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCREs No. 30M14-319



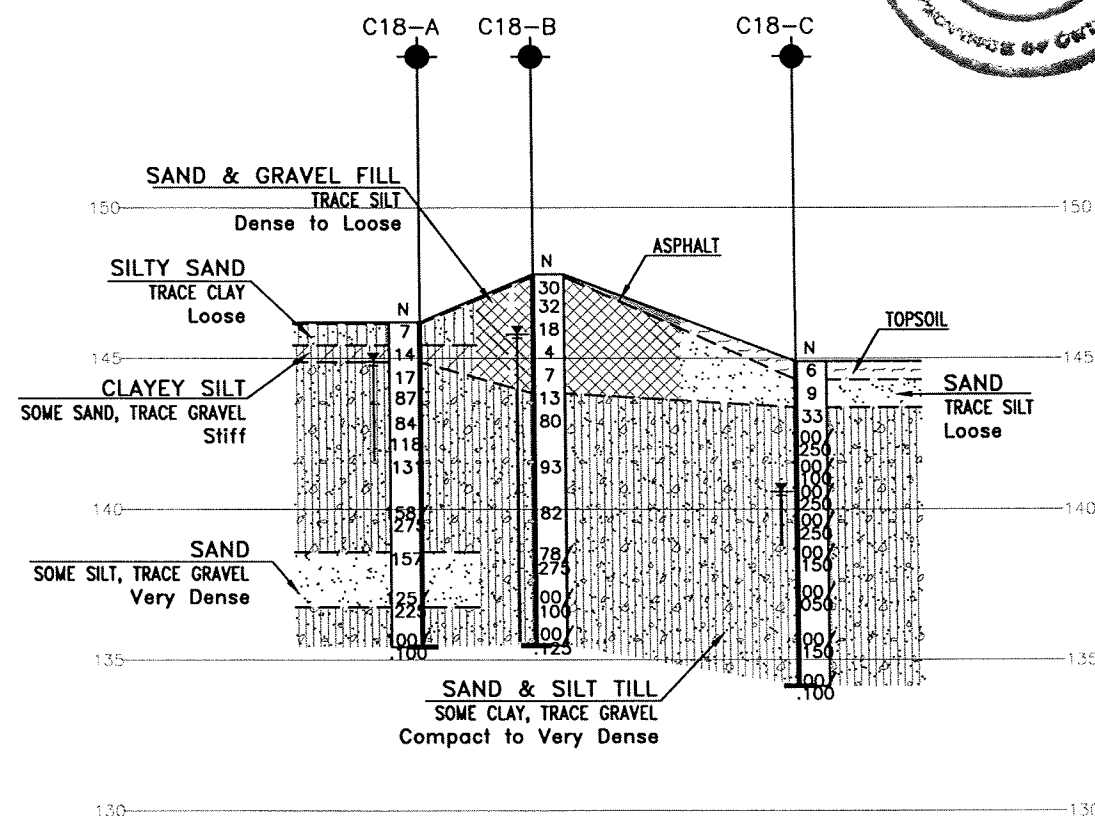
PLAN

SCALE 1:1000



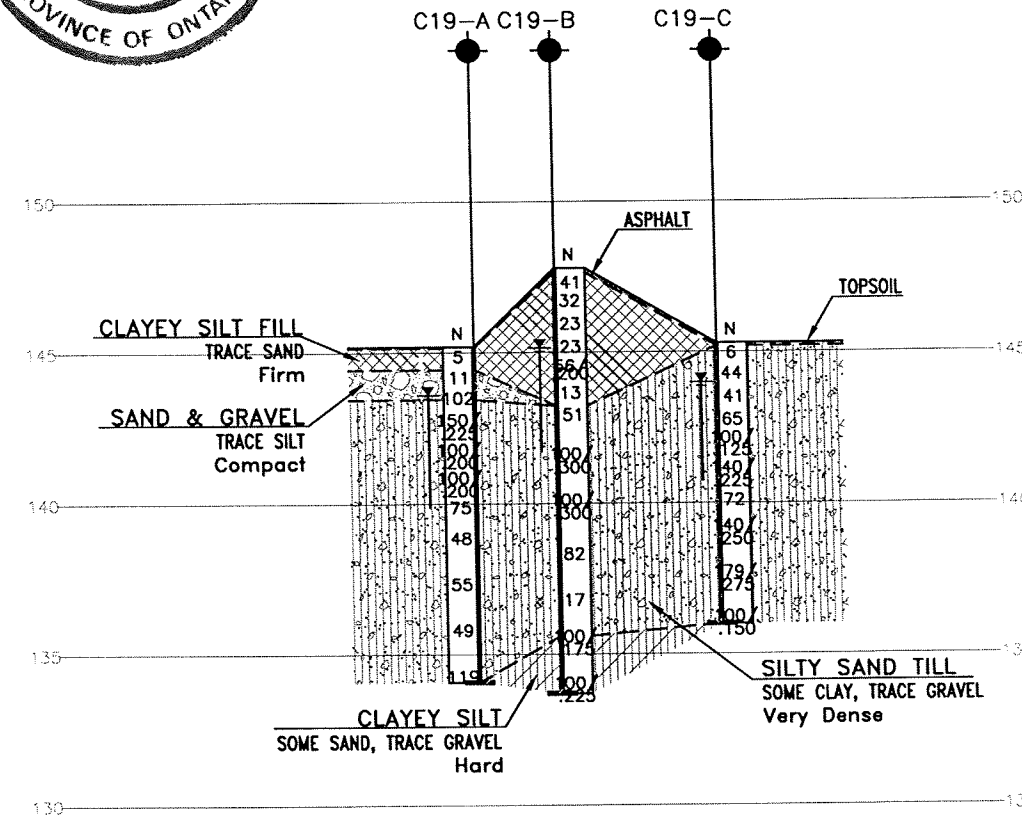
PLAN

SCALE 1:1000



PROFILE CULVERT C-18

SCALE 1:1000
H 1:1000
V 1:250



PROFILE CULVERT C-19

SCALE 1:1000
H 1:1000
V 1:250

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	DEE	CHK PKC	CODE
DRAWN	MFA	CHK AEG	SITE
			STRUCT
			DWG 5
			DATE NOV. 2009

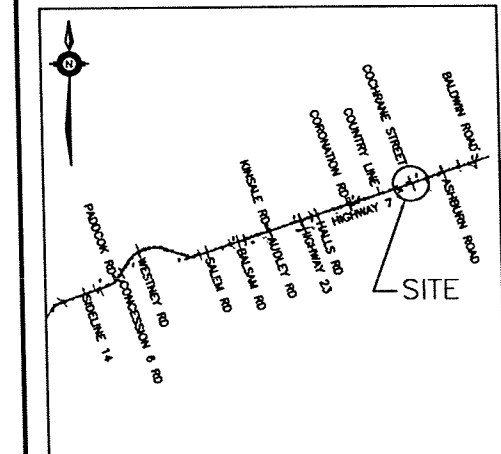
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HIGHWAY 7
CONT No
GWP No 2075-08-00








SHEET

HWY 7
BROCK STREET TO HWY 12
CULVERTS C-20 & C-21
BOREHOLE LOCATIONS AND SOIL STRATA



KEYPLAN

LEGEND

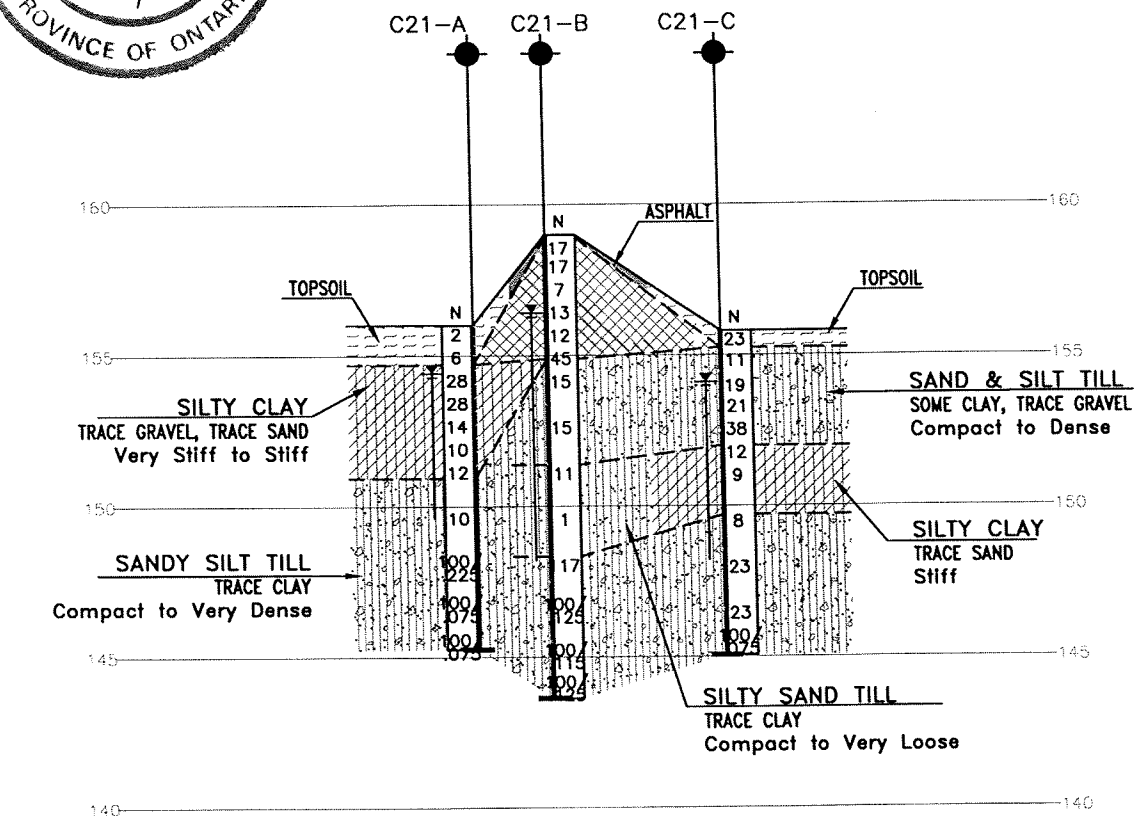
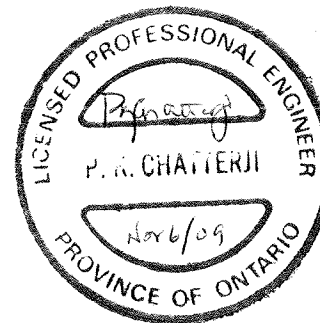
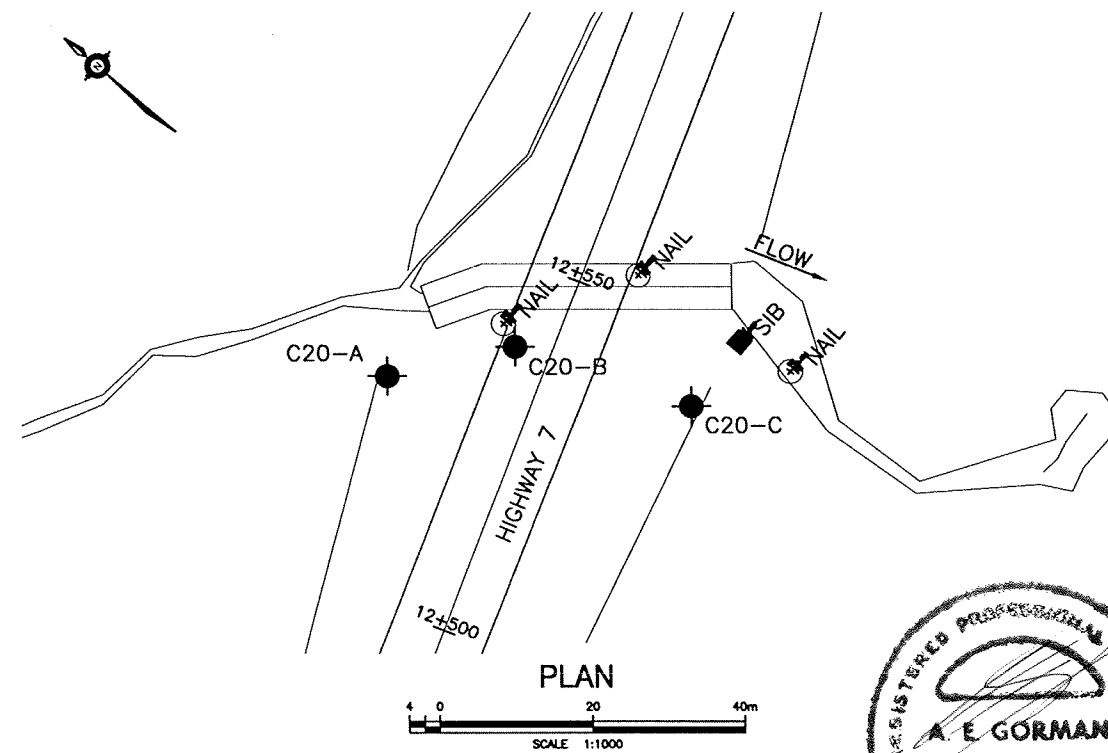
- | | |
|---|---------------------------------------|
|  | Borehole |
|  | Borehole and Cone |
| N | Blows /0.3m (Std Pen Test, 475J/blow) |
| CONE | Blows /0.3m (60° Cone, 475J/blow) |
| PH | Pressure, Hydraulic |
|  | Water Level |
|  | Head Artesian Water |
|  | Piezometer |
| 90% | Rock Quality Designation (RQD) |
| A/R | Auger Refusal |

NO	ELEVATION	NORTHING	EASTING
C20-A	146.5	4 867 621.6	345 970.3
C20-B	148.8	4 867 611.4	345 984.3
C20-C	145.8	4 867 588.8	345 993.4
C21-A	156.0	4 867 876.7	346 701.8
C21-B	159.0	4 867 864.1	346 694.2
C21-C	155.8	4 867 836.5	346 683.9

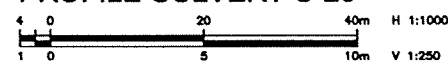
-NOTES-

- 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.

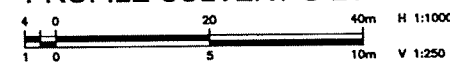
GEOCRES No. 30M14-319



PROFILE CULVERT C-20



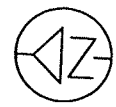
PROFILE CULVERT C-21



REVISIONS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
-----------	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

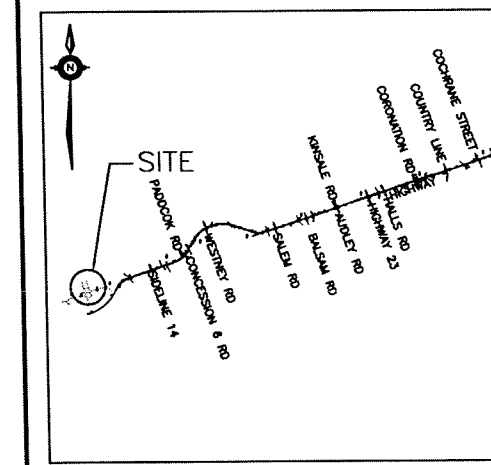
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HIGHWAY 7
CONT No
GWP No 2075-08-00



HWY 7
BROCK STREET TO HWY 12
CULVERTS C-24 & C-25
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEYPLAN

LEGEND

- ◆ Borehole
- ◆ Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- W Water Level
- W Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

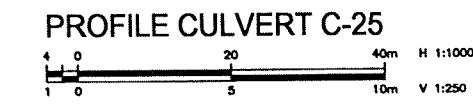
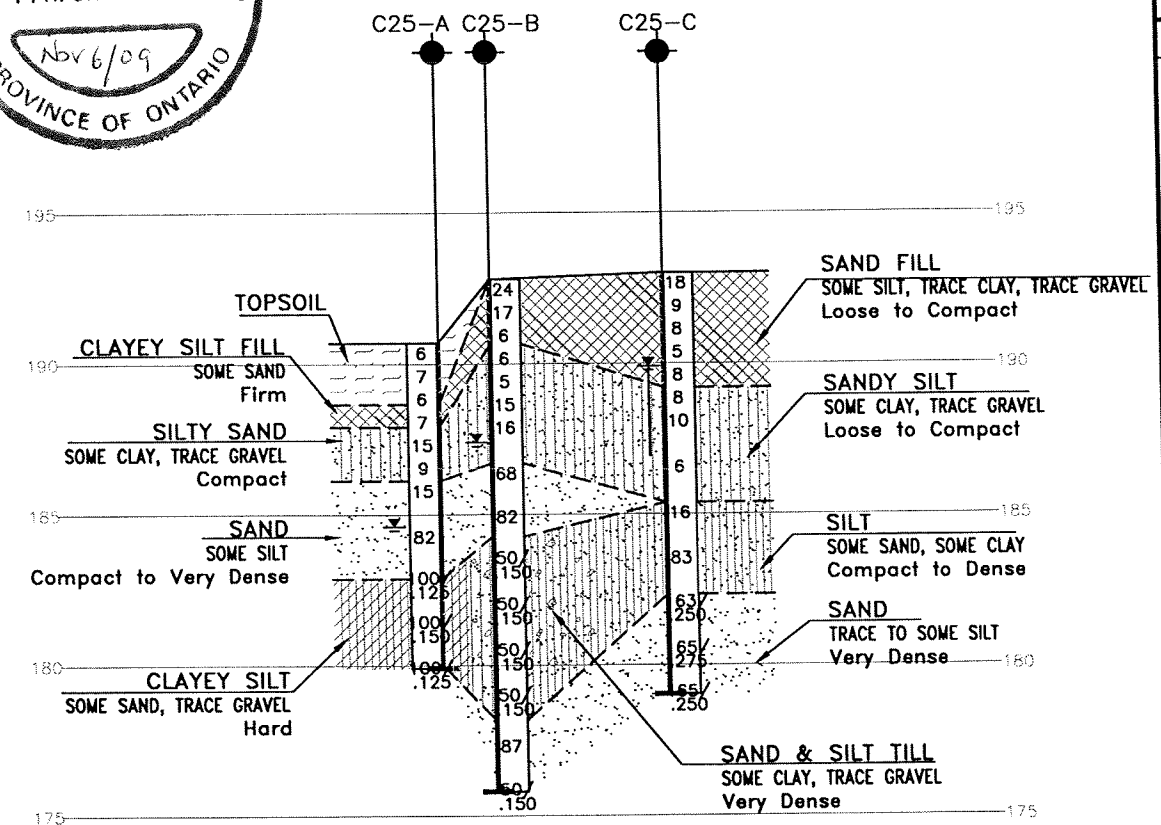
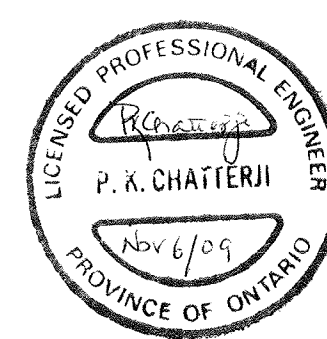
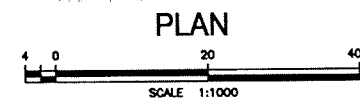
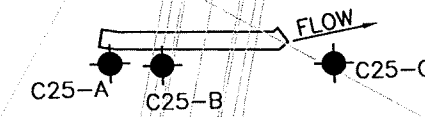
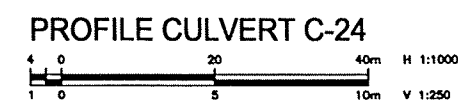
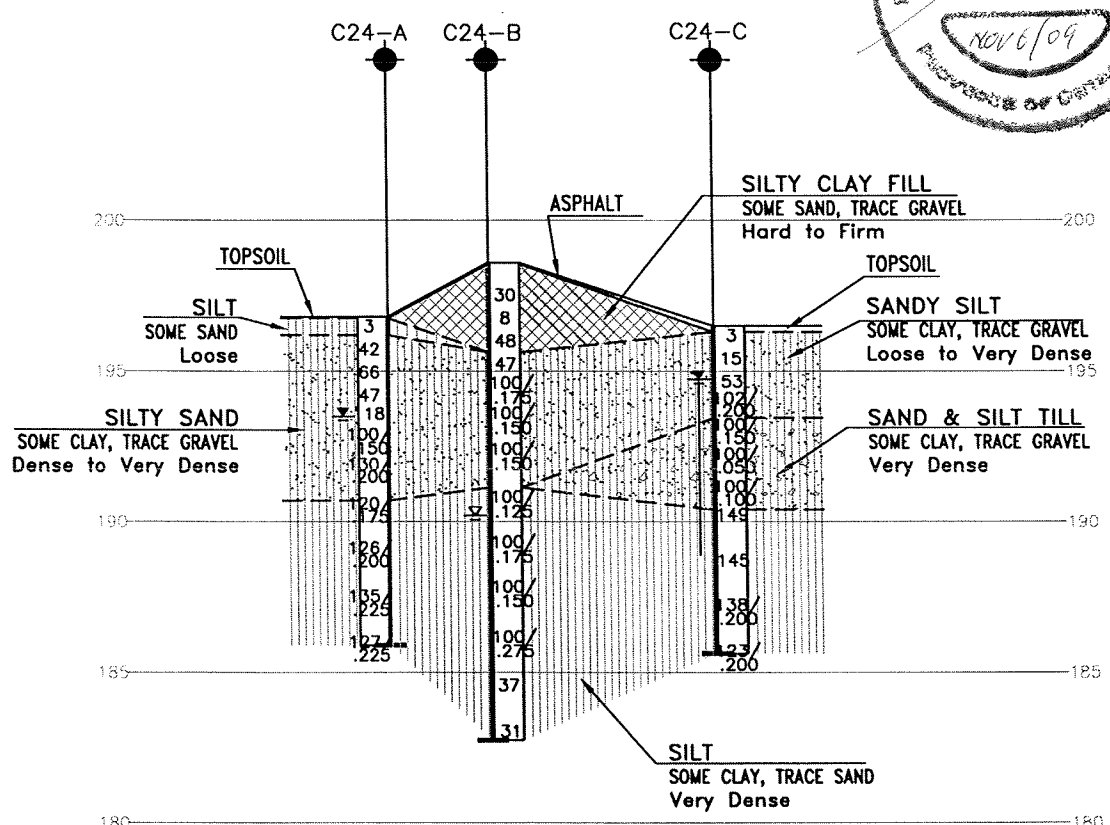
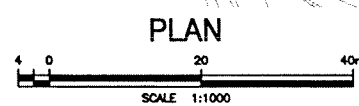
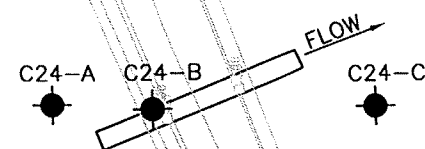
NO	ELEVATION	NORTHING	EASTING
C24-A	196.8	4 864 365.3	336 284.3
C24-B	198.6	4 864 352.2	336 283.2
C24-C	196.5	4 864 322.7	336 282.1
C25-A	190.7	4 864 492.2	336 685.6
C25-B	192.8	4 864 484.7	336 689.6
C25-C	193.0	4 864 464.9	336 700.7

-NOTES-

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

GEOCRES No. 30M14-319

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	DEE	CHK PKC	CODE
DRAWN	AN	CHK AEG	SITE
			LOAD
			STRUCT
			DWG 7
			DATE NOV. 2009



Appendix E

Culvert and Foundation Comparison

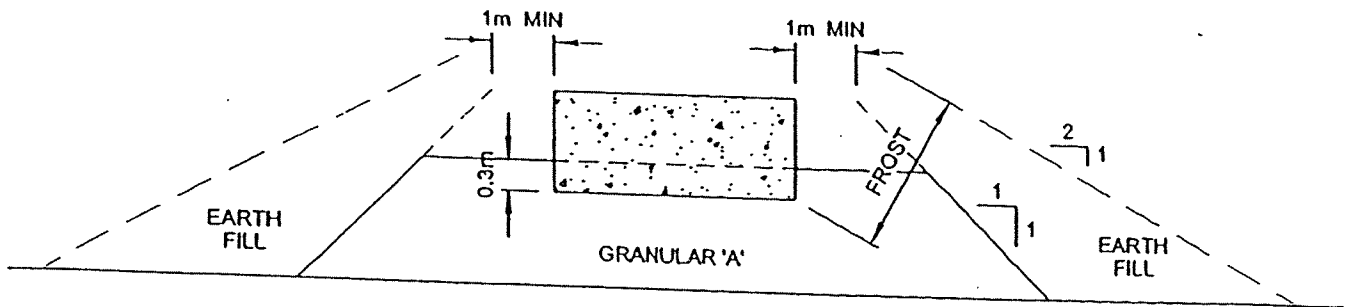
Highway 7 Culvert Replacements
Brock Road to Highway 12

Comparison of Culvert and Foundation Alternatives
Highway 7: Brock Road to Highway 12

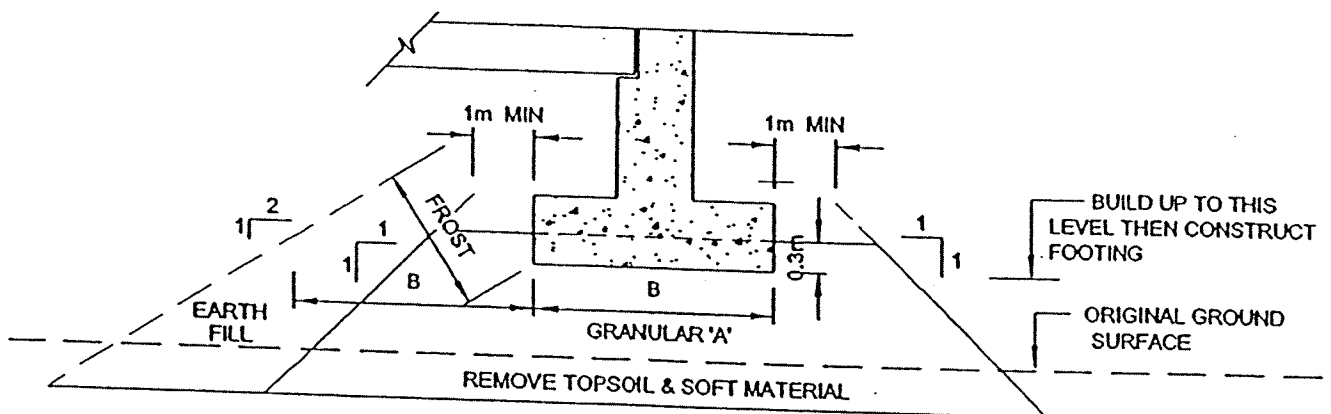
Open Footing Culvert on Native Soil	Open Footing Culvert on Engineered Fill	Box Culvert
<p><i>Advantages:</i></p> <ol style="list-style-type: none"> 1. Lower cost than deep foundation 2. Potentially requires less excavation of creek bed 3. Ease of construction <p><i>Disadvantages:</i></p> <ol style="list-style-type: none"> 1. Subexcavation of organic and soft soils required where encountered to reach competent footing subgrade 2. Temporary culvert or creek diversion may be required to work in the dry 3. Sheet pile enclosure and dewatering may be required for footing construction 4. Potential settlement due to embankment load 	<p><i>Advantages:</i></p> <ol style="list-style-type: none"> 1. Would permit use of higher geotechnical resistance 2. Founding level is not governed by soil conditions 3. Lower cost than deep foundation <p><i>Disadvantages:</i></p> <ol style="list-style-type: none"> 1. Cost of engineered fill construction 2. Subexcavation of organic and soft soils required where encountered 3. Requires complete excavation of creek bed 4. Temporary culvert or creek diversion may be required to work in the dry 5. Sheetpile enclosure and dewatering may be required for engineered fill and footing construction 	<p><i>Advantages:</i></p> <ol style="list-style-type: none"> 1. Ease of construction 2. Minimizes differential settlement 3. Applies lower bearing pressures on foundation soils 4. Lower cost than deep foundation <p><i>Disadvantages:</i></p> <ol style="list-style-type: none"> 1. Requires subexcavation of soft or organic material from streambed where encountered 2. Requires complete excavation of creek bed 3. May require dewatering prior to subexcavation at sites with cohesionless soils and high water table 4. Temporary culvert or creek diversion may be required to work in the dry 5. Potential settlement due to embankment loading; must be addressed in culvert design
RECOMMENDED WHERE APPLICABLE FOR FISHERIES ISSUES	FEASIBLE	RECOMMENDED WHERE APPLICABLE
NOTE: Where possible, use of precast culvert segments are preferred for all of the above options since they reduce installation time		

Appendix F

Figure 1



CROSS-SECTION



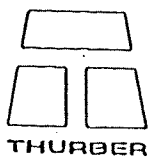
LONGITUDINAL SECTION
NOT TO SCALE

NOTES:

1. REMOVE TOPSOIL AND OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' AND EARTH FILL.
2. PLACE GRANULAR 'A' AND EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO O.P.S.S. 501.
3. CONSTRUCT CONCRETE FOOTING.
4. PLACE REMAINDER OF GRANULAR 'A' AND EARTH FILL AS REQUIRED.
5. SOURCE M.T.C. 1982.

ENGINEER	AEG
DRAWN	SS
DATE	April, 2004
APPROVED	PKC
SCALE	NTS

ABUTMENT ON COMPACTED FILL SHOWING
GRANULAR A CORE



DWG. NO.

FIGURE 1

Appendix G

SPs and NSSPs

List of Special Provisions and OPSS Documents Referenced in this Report

- SP 902 S01
- SP 105 S10
- SP 206 S03
- SP 572 S01
- SP 105 S19
- SP 903S01
- OPSD 803.01
- OPSD 810.010
- OPSD 208.010
- OPSD 3000.100
- OPSS 1010
- OPSS 501
- OPSS 1004
- OPSS 1205

OPSS 206, as amended by Special Provision “Amendment to OPSS 206, December 1993”, dated November 2006.

1. Suggested text for a Nssp on Dewatering

The soils underlying the sites are cohesionless in nature and the observed groundwater levels at the culverts ranges from 0.5 to 4.0 m below the existing ground surface. Artesian pressure was noted at Culvert C07 in BH C07-A. Beyond the highway embankment, the groundwater level is expected to be governed by water levels in the creek.

Excavations below the groundwater level are not recommended without prior dewatering. Selection and design of appropriate dewatering methods is the responsibility of the contractor and should be designed by a specialist experienced in the field of dewatering. Dewatering measures may range from use of sumps and pumps for minor excavation (< 0.5 m deep) below groundwater level to use of well points or construction within a sheet pile enclosure for deeper excavation below groundwater. Dewatering in conjunction with surface water diversion such as use of temporary culverts or creek diversions should be anticipated for maintaining a dry excavation for footing and culvert construction.

2. Suggested text for a NSSP on Subgrade Inspection and Approval

(This must be addressed in both, the contract and the C.A. agreement)

The footing subgrade for each culvert should be inspected by a qualified Geotechnical Engineer retained by the Contract Administrator to confirm that the footings are being placed on native undisturbed compact to dense soils. Any remaining organics or soft subgrade soils should be subexcavated as directed by the geotechnical engineer and backfilled with well compacted granular backfill or 3 to 5 MPa lean mix concrete.

3. Suggested text for a NSSP on Cobbles and Boulders in Glacial Till

Glacial tills inherently contains cobbles and boulders. Excavation in these tills may encounter cobbles and boulders and contractor's equipment must be capable of removing such obstruction.