



THURBER ENGINEERING LTD.

MEMORANDUM

To: Carlyle Glean, P.Eng.
cc. Mark Gimpoli, P.Eng.
cc. Donald Cleghorn, PEng.
SNC Lavalin Inc.

Date: March 9, 2018

From: Rocío Palomeque Reyna, P.Eng.
Sydney Pang, P.Eng.
(Reviewed by P.K. Chatterji, P.Eng.)

File: 17265

**FOUNDATION INVESTIGATION AND ASSESSMENT MEMORANDUM
CULVERT #23 AND STORMWATER MANAGEMENT POND #1
HIGHWAY 400 WIDENING
TOWNSHIP OF KING, ONTARIO
G.W.P. 2539-04-00**

GEOCRES NO. 30M13-225

PART 1 FACTUAL INFORMATION

1 INTRODUCTION

This memorandum presents the factual data obtained from a foundation investigation carried out at the locations of a proposed culvert and a stormwater management pond to be constructed along the Highway 400 right-of-way between Kirby Road and just south of King-Vaughan Road in the Township of King, Ontario. These works are parts of a larger project involving the widening of the highway to accommodate additional lanes of traffic, but have not been included in the original and revised foundations terms of reference. It is understood that the Ministry of Transportation Ontario (MTO) requires the design to accommodate the ultimate 10-lane configuration including two HOV lanes in each direction within the current MTO right-of-way.

The purpose of this investigation was to determine the subsurface conditions near the locations of the new culvert (Culvert #23) and the new stormwater management pond (SWMP #1), and based on the data, to provide borehole location plans and soil strata drawings, records of boreholes, laboratory test results, and a generalized description of the subsurface conditions.

It is noted that this investigation was carried out after the contract was tendered. The factual information obtained is to provide reference information for the Contractor and has also been used to verify the foundation aspects of the design of these facilities as shown on the contract drawings.



Thurber Engineering Ltd. (Thurber) carried out this investigation as a sub-consultant to SNC-Lavalin Inc. (SLI) under an MTO change order.

Reference has been made to the following reports during the preparation of this memorandum.

- Thurber Engineering Ltd. report titled "Foundation Investigation and Design Report, Proposed Culvert Extensions and New Culvert, Highway 400 Widening, Major MacKenzie Drive to King Road, York Region, Ontario", G.W.P. 192-00-00 and 2539-04-00, Assignment Nos. 2005-E-0036 and -0037, GEOCRS No. 30M13-190, Report to SNC-Lavalin Inc., File: 19-92-68 dated March 7, 2012 (Reference 1).
- Thurber Engineering Ltd. report titled "Foundation Investigation and Design Report, Stormwater Management Pond #2, Highway 400 Widening, Major MacKenzie Drive to King Road, York Region, Ontario", G.W.P. 192-00-00 and 2539-04-00, Assignment Nos. 2005-E-0036 and -0037, GEOCRS No. 30M13-191, Report to SNC-Lavalin Inc., File: 19-92-68 dated March 2, 2012 (Reference 2).

2 SITE DESCRIPTION

The new Culvert #23 will be located under Highway 400 at Station 24+275, approximately 300 m south of King-Vaughan Road. The proposed SWMP#1 will be located adjacent to the east side of Highway 400 northbound lane (NBL) from approximate Stations 23+570 to 23+670.

The land use adjacent to this section of Highway 400 is largely rural and agricultural, and the terrain is generally flat. Highway 400 slopes gently upwards to the north in this vicinity. A Service Centre ONroute is located on the east side of the proposed pond. The pond will be located between Highway 400 NBL and the service centre near its entrance.

Drainage in the vicinity of the project area is largely controlled by the Humber River and its tributaries (East Humber River). Localized drainage is facilitated by the creeks flowing within the gullies.

The proposed locations of Culvert #23 and SWMP#1 are shown on the plans on the Borehole Locations and Soil Strata drawings in Appendices A and B, respectively.

The project area is located within the physiographic region known as the South Slope which comprised predominantly of the Halton till, which is an interbedded complex of clayey silt to silt till and sand. This till comprises a slightly hummocky till plain into which the surface watercourses have eroded 10 to 15 m deep gullies. Relatively recent fluvial sediments have been deposited in the gullies. The Halton till overlies bedrock at depths in the order of 100 m in the vicinity of the project area.



3 SITE INVESTIGATION, FIELD AND LABORATORY TESTING

The site investigation and field testing for this project were carried out on March 6 and 7, 2017 and consisted of drilling and sampling a total of four boreholes as follows:

- Two boreholes (numbered C17-01 and C17-02) were drilled near the new Culvert #23 location, one borehole near each end of the culvert. The boreholes were extended to 12.8m depth (Elevations 262.0 and 262.1).
- Two boreholes (numbered SWM1-01 and SWM1-02) were drilled within the area of the proposed SWMP#1. These two boreholes were terminated at 9.8 m depth (Elevations 261.0 and 260.4).

Prior to the start of drilling, the borehole locations were marked/staked in the field and utility clearances were obtained. The elevations of the as-drilled boreholes were subsequently provided by SLI. The approximate locations of the four boreholes are shown on Borehole Locations and Soil Strata drawings included in Appendices A and B. The coordinates and elevations of these boreholes are provided on these drawings and on the individual Record of Borehole sheets in Appendices A and B.

A truck-mounted CME55 drill rig, supplied and operated by Geo-Environmental Drilling, was used to drill and sample the boreholes. Solid stem augers were used to advance the boreholes until the target depth was reached. In general, 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.

Upon completion of the drilling operations, the boreholes were decommissioned in general accordance with Ontario Regulation 903 amended by Ontario Reg. 372.

The drilling and sampling operations were supervised on a full-time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing. Results of field drilling and sampling are presented on the Record of Borehole sheets in Appendices A and B.

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size analysis and Atterberg Limits testing. All the laboratory tests were carried out in accordance with MTO and/or ASTM Standards, as appropriate. The results of the laboratory testing are summarized on the Record of Borehole sheets and, are also presented on the figures included in Appendices A and B.



4 SUBSURFACE CONDITIONS

4.1 New Culvert #23

In general, the subsurface stratigraphy encountered in Boreholes C17-01 and C17-02 consisted of asphalt and sand fill overlying silty clay embankment fill which is underlain by native silty clay with organic inclusions. A deposit of silty clay till underlies the silty clay and extends to the termination depth of the boreholes. The following provides a more detailed account of the stratigraphy depicted in these boreholes.

4.1.1 Asphalt

A 150 mm thick layer of asphalt was encountered at ground surface in Borehole C17-02.

4.1.2 Pavement Granular

Brown sand fill containing trace to some gravel, some silt and trace clay, was contacted below the asphalt in Borehole C17-02, and surficially in Borehole C17-01. The thickness of the sand fill ranged between 600 mm and 650 mm. The depth to the base of the sand fill was 0.6 m and 0.8 m (Elevations 274.2 and 274.1) in Boreholes C17-01 and C17-02, respectively.

SPT 'N' values in the granular fill were 13 and 23 blows per 0.3 m of penetration indicating a compact state. Moisture contents measured in the granular fill were 11 percent and 12 percent.

4.1.3 Embankment Fill

Embankment fill consisting of brown silty clay containing trace sand and trace gravel was contacted below the granular fill in both boreholes. The thickness of the silty clay fill was 1.4 m to 1.6 m. The depth to the base of the silty clay fill was 2.2 m (Elevations 272.6 and 272.7).

SPT 'N' values in the silty clay fill ranged from 7 to 14 blows per 0.3 m of penetration, indicating a firm to stiff consistency. Moisture contents measured for the embankment fill was about 16 percent to 18 percent.

Results of grain size analyses conducted on one sample of fill are presented on the Record of Borehole sheets and illustrated on Figure A1 in Appendix A. The laboratory test results are summarized in the following table.

Soil Particles	Percentage (%)
Gravel	0
Sand	22
Silt	53
Clay	25



4.1.4 Silty Clay with Organic Inclusions

A layer of dark brown to brown native silty clay with organic inclusions, containing trace sand to sandy, trace gravel and occasional rootlets, was encountered below the embankment fill at 2.2 m depth in both boreholes. The upper 600 mm of the silty clay was black in colour in Borehole C17-02. The thickness of the silty clay layer was 2.1 m. The depth to the base of the silty clay was at 4.3 m (Elevations 270.5 and 270.6).

SPT 'N' values measured in the silty clay ranged from 4 to 7 blows per 0.3 m of penetration, indicating a firm consistency. Moisture content measured in this layer ranged from 21 percent to 23 percent.

Results of grain size analyses conducted on one sample of the silty clay are presented on the Record of Borehole sheets and illustrated on Figure A2 in Appendix A. The laboratory test results are summarized in the following table.

Soil Particles	Percentage (%)
Gravel	3
Sand	22
Silt	51
Clay	24

4.1.5 Silty Clay Till

A deposit of brown to grey silty clay till containing some sand to sandy, and trace gravel, was contacted below the silty clay in both boreholes at 4.3 m depth. The thickness of the silty clay till was 5.6 m. The underside of this till layer is at Elevations 264.9 to 265.0.

The SPT 'N' values measured in the silty clay till varied from 12 to 26 blows per 0.3 m of penetration, indicating a stiff to very stiff consistency. An SPT 'N' value of 43 blows per 0.3 m of penetration, was measured in Borehole C17-02, near Elevation 267.0, indicating a hard consistency. Moisture content in the silty clay till varied from 12% to 22%.

Results of grain size analyses conducted on silty clay till samples are presented on the Record of Borehole sheets and illustrated on Figure A3 in Appendix A. The test results are summarized in the following table.



Soil Particles	Percentage (%)
Gravel	0
Sand	15 to 26
Silt	32 to 54
Clay	26 to 40

Results of Atterberg Limits tests conducted on two samples of the silty clay till are provided on the Record of Borehole sheets and illustrated on Figure A5 in Appendix A. The results are summarized as follows:

Index Property	Percentage (%)
Liquid Limit	27 to 31
Plasticity Index	13 to 15

The results of the Atterberg Limits tests show that the silty clay till is of low plasticity with a group symbol of CL.

Glacial till inherently contains cobbles and boulders.

4.1.5 Clayey Silt Till

Grey clayey silt till containing some sand to sandy and trace gravel, was contacted below the silty clay till in both boreholes, at 9.9 m depth (Elevations 264.9 and 265.0). Both boreholes were terminated within the clayey silt till at 12.8 m depth (Elevations 262.0 and 262.1).

Typically SPT 'N' values measured in the clayey silt till ranged from 17 to 18 blows per 0.3 m of penetration indicating a very stiff consistency. Some 'N' values of 43 to 55 blows per 0.3m of penetration were measured indicating the presence of hard zones within the till. Moisture content measured in the clayey silt till ranged from 10 percent to 18 percent.

Results of grain size analyses conducted on two clayey silt till samples are presented on the Record of Borehole sheets and illustrated on Figure A4 in Appendix A. The test results are summarized in the following table.

Soil Particles	Percentage (%)
Gravel	0 to 5
Sand	23 to 29
Silt	48 to 59
Clay	18



Results of Atterberg Limits tests conducted on two samples of the clayey silt till are provided on the Record of Borehole sheets and illustrated on Figure A6 in Appendix A. The results are summarized as follows:

Index Property	Percentage (%)
Liquid Limit	16 to 17
Plasticity Index	5 to 6

The results of the Atterberg Limits tests show that the clayey silt till is slightly plastic with a group symbol of CL-ML.

Glacial till inherently contains cobbles and boulders.

4.1.6 Groundwater Conditions

The water levels in the boreholes were observed during the drilling operations and measured upon completion of drilling. A groundwater level was measured at 10.1 m depth (Elevation 264.7) in Borehole C17-01. Cave-in was noted at 11.6 m depth (Elevation 263.3) in Borehole C17-02. These are short term observations and the groundwater level is subject to seasonal fluctuations and climatic changes.

4.2 STORMWATER MANAGMENT POND (SWMP) # 1

The subsurface stratigraphy encountered within the footprint of SWMP #1 consisted of clayey silt with organics and occasional roots and rootlets, overlying an extensive deposit of silty clay till. An interlayer of sand was encountered within the silty clay till in one borehole. The following provides a more detailed account of the stratigraphy depicted in the boreholes.

4.2.1 Clayey Silt with organics

Clayey silt mixed with organics was encountered surficially in both boreholes. The thickness of this layer ranged between 600 mm and 800 mm. Moisture content measured in this soil ranged from 29 percent to 38 percent.

4.2.2 Silty Clay

Native, brown to grey silty clay containing some sand, trace gravel, was contacted at 0.6 m depth and 0.8 m depth in Boreholes SWM1-01 and SWM1-02, respectively. The thickness of the silty clay layer was 1.4 m to 1.5 m. The depth to the base of the silty clay was at 2.1 m and 2.2 m (Elevations 268.7 and 268.0) in Boreholes SWM1-01 and SWM1-02, respectively.



SPT 'N' values measured in the silty clay ranged from 11 to 14 blows per 0.3 m of penetration indicating a stiff consistency. Moisture contents measured in the silty clay varied between 15 percent and 18 percent.

4.2.3 Silty Clay Till

An extensive deposit of brown to grey silty clay till containing some sand to sandy, and trace gravel, was contacted below the silty clay in both boreholes. Boreholes SWM1-01 and SWM1-02 were terminated within the silty clay till at 9.8 m depth (Elevations 261.0 and 260.4).

The SPT 'N' values measured in the silty clay till varied from 13 to 24 blows per 0.3 m of penetration, indicating a stiff to very stiff consistency. Moisture contents measured in the silty clay till ranged from 11 percent to 18 percent.

A 600 mm thick interlayer of sand was contacted within the silty clay till at 4.0 m depth in Borehole SWM1-01.

Results of grain size analyses conducted on silty clay till samples are presented on the Record of Borehole sheets and illustrated on Figure B1 in Appendix B. The test results are summarized in the following table.

Soil Particles	Percentage (%)
Gravel	0
Sand	15 to 23
Silt	41 to 49
Clay	29 to 44

Results of Atterberg Limits tests conducted on samples of the silty clay till are provided on the Record of Borehole sheets and illustrated on Figure B2 in Appendix B. The results are summarized as follows:

Index Property	Percentage (%)
Liquid Limit	24 to 27
Plasticity Index	11 to 13

The results of the Atterberg Limits tests show that the silty clay till is of low plasticity with a group symbol of CL.

Glacial tills inherently contains cobbles and boulders.



4.2.5 Groundwater Conditions

The water levels in the boreholes were observed during the drilling operations and measured upon completion of drilling. Groundwater level was measured at 8.5 m and 5.3 m depth (Elevations 262.3 and 264.9), SWM1-01 and SWM1-02, respectively. These are short term observations and the groundwater level is subject to seasonal fluctuations and climatic changes.



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CULVERT #23 AND STORMWATER MANAGEMENT POND #1
HIGHWAY 400 WIDENING
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GEOCRES NO. 30M13-225

PART 2 ENGINEERING DISCUSSION AND RECOMMENDATIONS

5 GENERAL

Based on an interpretation of the geotechnical data in Part 1 Factual Information, Part 2 presents results of a foundation assessment for the proposed Culvert #23 and the proposed SWMP#1. This assessment has been based on the relevant contract drawings and updated information provided by SLI. It is understood that the updates will be made where required and the revised drawings included in an addendum to the tender.

6 CULVERT #23

Sheet 256 Miscellaneous Details X in Book 2 of 5 of the contract drawings provide design details for Culvert #23. It is understood that this culvert will comprise precast concrete boxes to be installed in open cuts in two stages under Highway 400 at Station 24+275. Information from SLI indicates an overall culvert length of 76.5 m, with an outside span width up to 2.7 m and an outside height up to 1.5 m. The approximate heights of fill to be placed above the culvert are 1.1 m and 2.2 m at the inlet and outlet, respectively. The design invert elevations at the inlet and outlet are 272.68 and 271.62, respectively.

6.1 Culvert Foundation

Based on the results of Boreholes C17-01 and C17-02 and a typical invert slab thickness of approximately 0.25 m and a 0.3 m granular bedding, the culvert base would be founded on firm silty clay overlying very stiff silty clay till, at or below approximate Elevations 272.1 and 271.1 near the inlet and outlet, respectively.

Information provided by SLI indicates that a minimum 300 mm thick layer of bedding material conforming to OPSS.PROV 1010 Granular A requirements will be provided under the base of the box culvert, similar to that shown on OPSD 803.010. The bedding material should be placed on the prepared subgrade as soon as practicable following its inspection and approval. No construction and personnel traffic, and ponding water should be allowed on the prepared subgrade. The subgrade preparation should be carried out in the dry.



It is also understood that the prepared surface to support the box units has been designed to have a 75 mm minimum thickness top levelling course consisting of uncompacted Granular A as per OPSS 422. Construction equipment should not be allowed to travel on the bedding or the prepared subgrade, which should be protected from disturbance during construction.

SLI has indicated that Sheet 256 in the contract drawings will be updated to show the granular pad and the levelling course discussed above.

A factored geotechnical resistance at the Ultimate Limit State (ULS) of 225 kPa and a geotechnical resistance at Serviceability Limit State (SLS) of 150 kPa may be assumed for a 2.7m wide box culvert founded on 300 mm of compacted granular bedding placed at or below Elevations 272.1 and 271.1 near the inlet and outlet, respectively, on firm silty clay overlying very stiff silty clay subgrade.

Placement of new fill up to about 2.2 m in height will induce foundation settlement. It is anticipated that this settlement would not exceed 25 mm and be completed by the end of construction.

Provided that the foundation subgrade is prepared as recommended in this report, the new fill consists of either Select Subgrade Material (SSM) or granular material, and the embankments are built with a slope inclination not steeper than 2H : 1V, no global stability issues are anticipated in the vicinity of Culvert #23.

Boreholes C17-01 and C17-02 drilled in the vicinity of the new culvert revealed silty clay embankment fill overlying firm silty clay underlain by very stiff silty clay till. The presence of alluvial and organic deposits should also be expected near watercourses. Topsoil, organics, fill and soft/loose soils must be sub-excavated to expose undisturbed native soils, and replaced with well compacted granular fill.

Excavation, groundwater and surface water control, culvert backfill and erosion control requirements provided in Reference 1 should be followed. The design of any dewatering system that may be required is the responsibility of the Contractor, and the Contract Documents must alert him to this responsibility and the need to engage a dewatering specialist.

Roadway protection (temporary shoring) will be required during staged construction. It is recommended that an item titled "Protection System" as per OPSS.PROV 539 should be included in the contract documents to include a Performance Level 2 requirement. The design of roadway protection should be the responsibility of the Contractor.

7 STORMWATER MANAGEMENT POND #1

Sheets 237 to 239 in Book 2 of 5 of the contract drawings provide design details for SWMP #1. Based on this information, the base of the permanent pool is designed to be at approximate



Elevation 265.65 m, some 4.6 m to 5.2 m below the existing ground surface, and the base of the forebay is designed to be at Elevation 267.1. The pond is irregularly shaped with a longitudinal dimension of approximately 88 m (north - south), and a transverse dimension of about 28 m. A berm, which will separate the permanent pool from the forebay, will also support a maintenance road connecting the east and west perimeters of the pond. The perimeter sideslopes of the pond is designed to have an inclination of 3H : 1V within the upper zone, and steepening to 2H : 1V below approximate Elevation 267.1. Along the west side, the edge of the pond will be about 6.5m from the proposed toe of the widening embankment of the highway.

7.1 Pond Design and Construction

Results of Boreholes SWM1-01 and SWM1-02 indicate that the subsurface condition consists of surficial clayey silt with organics overlying stiff silty clay underlain by typically very stiff silty clay till containing sand interlayers. The groundwater level at the time of the investigation is estimated to be at about 5 m below existing ground surface.

Major pond design criteria include global stability of the pond sideslopes and hydraulic conductivities of soils in the pond area which relate to water retention. It is understood that a geosynthetic clay liner has been incorporated into the pond design.

Stability analysis results indicate that the sideslopes will satisfy global stability requirements for both drained and undrained conditions with Factors of Safety greater than 2. For the most critical event of rapid drawdown that could result in near horizontal hydraulic gradients at the pond slopes, the analysis yield a Factor of Safety of 1.4 (see Figure B1). These results indicate that the pond sideslopes will satisfy global stability requirements for short and long term conditions.

Construction of the pond will require excavation through the stiff silty clay into the very stiff silty clay till. Although only encountered within the till deposit in one borehole, it is anticipated that water-bearing sand and silt interlayers and/or lenses could be encountered elsewhere. Glacial tills inherently contain cobbles and boulders and, as such, the contractor should be equipped to handle and/or remove such obstructions.

Existing borehole information indicates that these cohesive soils have relatively low hydraulic conductivity and the percolation rate is therefore expected to be very low. The sands and silts have higher percolation rates and, if encountered, will be causes of leakage. For design purposes, the following hydraulic conductivities may be assumed:

- Silty clay till ($< 10^{-6}$ cm/s)
- Sands and silts (10^{-3} to 10^{-5} cm/s)



It is understood that SWM Pond #1 is designed to be a wet pond. Therefore, a head of water will need to be maintained in the pond at all times. It is probable that sands and silts are present at the pond base or on the sideslopes. The geosynthetic clay liner included in the current design is expected to minimize the risk of water leakage from the pond.

A concrete weir structure is to be founded at approximate Elevation 267.87 m on the very stiff silty clay till near the south end of the pond. A factored geotechnical resistance at ULS of 250kPa and a geotechnical resistance at SLS of 175 kPa may be used for foundation design.

Excavation, grading and compaction should be carried out with reference to the requirements of OPSS.PROV 206 and OPSS.PROV 501. Any dewatering that may be required during pond construction is the responsibility of the Contractor.

Erosion protection should be provided for selected surfaces of the sideslopes of the pond as required. Design of the erosion protection measures must consider hydrologic and hydraulic concerns. Typically, rip-rap should be provided in areas of high velocity or concentrated water flow. Other surfaces may be treated with vegetation, hydroseeding and/or erosion control blanket as required. Reference should be made to OPSS.PROV 804 for erosion protection requirements.

8 CLOSURE

The above presented an assessment relating to aspects of foundation design and construction of Culvert #23 and SWMP#1 as shown on the contract drawings. Updates to the drawings that are required have been discussed with SLI. It is anticipated that the revised drawings will be issued as part of an addendum.

This memorandum was prepared by Ms. Rocío Palomeque Reyna, P.Eng. and Dr. Sydney Pang, P.Eng., and was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



THURBER

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Attachments

- Appendix A Culvert #23 – Records of Boreholes, Laboratory Test Results and Borehole Locations and Soil Strata Drawing
- Appendix B SWMP #1 – Records of Boreholes, Laboratory Test Results, Borehole Locations and Soil Strata Drawing, and Selected Slope Stability Output

Client: SNC-Lavalin Inc.

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SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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

 Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

EXPLANATION OF ROCK LOGGING TERMS


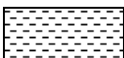



ROCK WEATHERING CLASSIFICATION

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

DISCONTINUITY SPACING

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

SYMBOLS

	CLAYSTONE
	SILTSTONE
	SANDSTONE
	COAL
	BEDROCK

STRENGTH CLASSIFICATION

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

TERMS

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

UNIFIED SOILS CLASSIFICATION

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



Appendix A

Culvert #23

Record of Borehole Sheets (C17-01 and C17-02)

Laboratory Test Results


Drawing titled "Borehole Locations and Soil Strata"

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

METRIC

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	w _P	w	w _L	GR	SA		SI	CL		
9.9	Continued From Previous Page Clayey SILT , some sand to sandy, trace gravel Very Stiff Grey Moist (TILL)		10	SS	18							41				0	23	59	18			
262.0	Hard		11	SS	55							○										
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE OPEN AND WATER LEVEL AT 10.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.																					

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No C17-02

1 OF 2

METRIC

GWP# 2539-04-00 LOCATION Culvert #23, Sta. 24+275 N 4 862 218.1 E 299 906.9 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.03.06 - 2017.03.06 CHECKED BY RPR

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 (%)					
274.9	GROUND SURFACE							20	40	60	80	100						
0.0	ASPHALT: (150mm)							20	40	60	80	100						
0.2	SAND, some silt, trace clay and gravel Compact Brown Moist (FILL)		1	SS	13									○				
274.1																		
0.8	Silty CLAY, trace sand and gravel Stiff to Firm Brown Moist (FILL)		2	SS	10		274							○				
			3	SS	7		273							○			0 22 53 25	
272.7																		
2.2	Silty CLAY, with organic inclusions, trace to some sand, trace gravel, occasional rootlets Firm Dark Brown to Black Moist		4	SS	5		272							○				
			5	SS	7		271							○				
270.6																		
4.3	Silty CLAY, some sand Very Stiff Brown Moist (TILL)		6	SS	25		270										0 15 49 36	
							269											
			7	SS	19		268							○				
	With sand Hard to Very Stiff Wet		8	SS	43		267							○			0 28 32 40	
							266											
	Grey Moist		9	SS	17		265							○				
265.0																		

Continued Next Page


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

RECORD OF BOREHOLE No C17-02

2 OF 2

METRIC

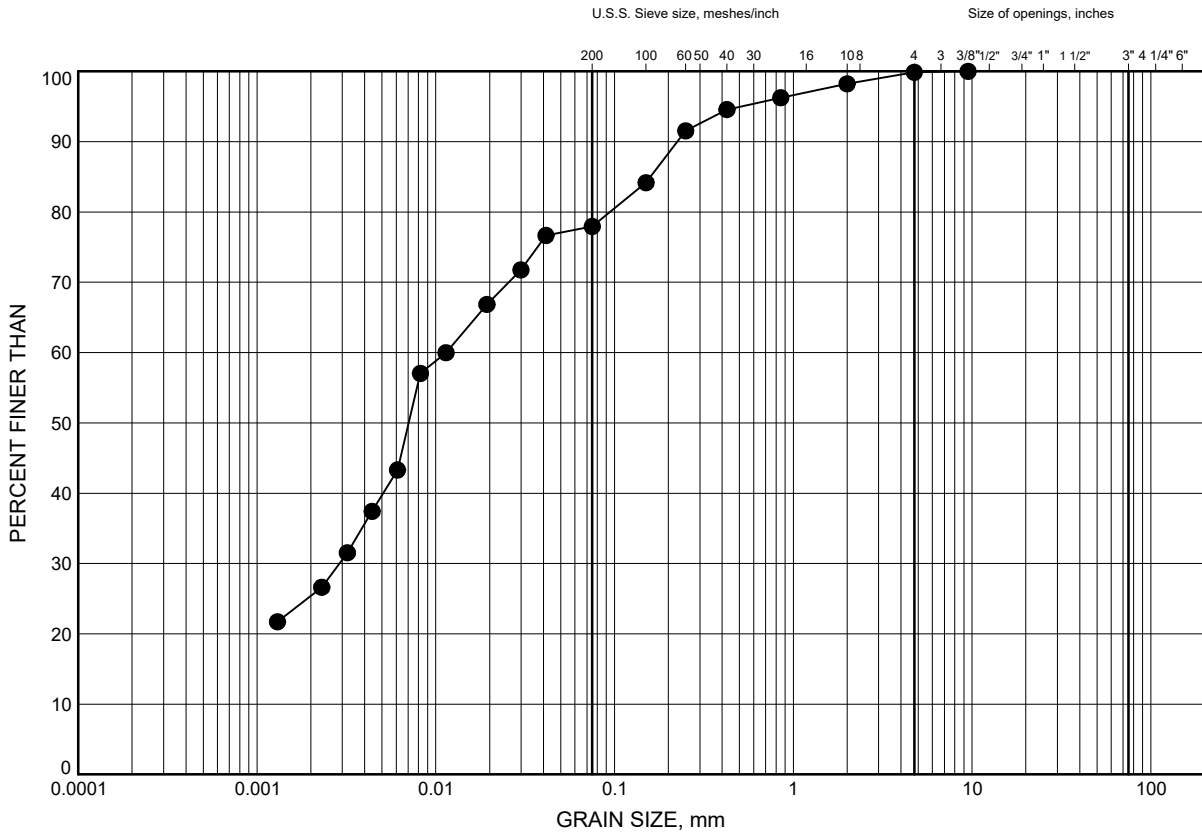
GWP# 2539-04-00 LOCATION Culvert #23, Sta. 24+275 N 4 862 218.1 E 299 906.9 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.03.06 - 2017.03.06 CHECKED BY RPR

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							PLASTIC LIMIT W _P NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)			
	Continued From Previous Page							20	40	60	80	100						
9.9	Clayey SILT , sandy, trace gravel Very Stiff Grey Moist (TILL)		10	SS	17		264								φ-H			5 29 48 18
								263										
262.1	Hard		11	SS	44									○				
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE CAVED IN TO 11.6m DEPTH UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.																	

Culvert #23, Sta. 24+275
GRAIN SIZE DISTRIBUTION

FIGURE A1

Silty CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C17-02	1.83	273.07

Date April 2017
 GWP# 2539-04-00

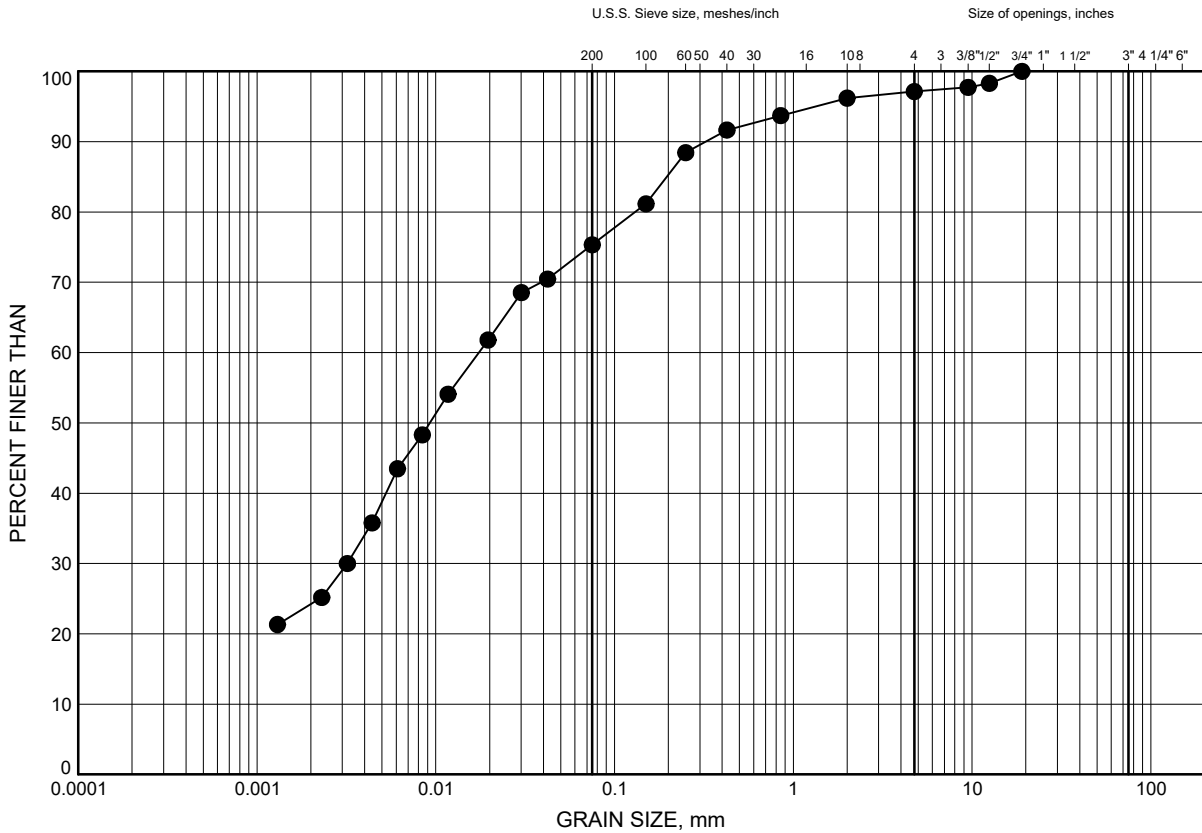


Prep'd AN
 Chkd. RPR

Culvert #23, Sta. 24+275
GRAIN SIZE DISTRIBUTION

FIGURE A2

Silty CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C17-01	2.59	272.21

Date April 2017
 GWP# 2539-04-00

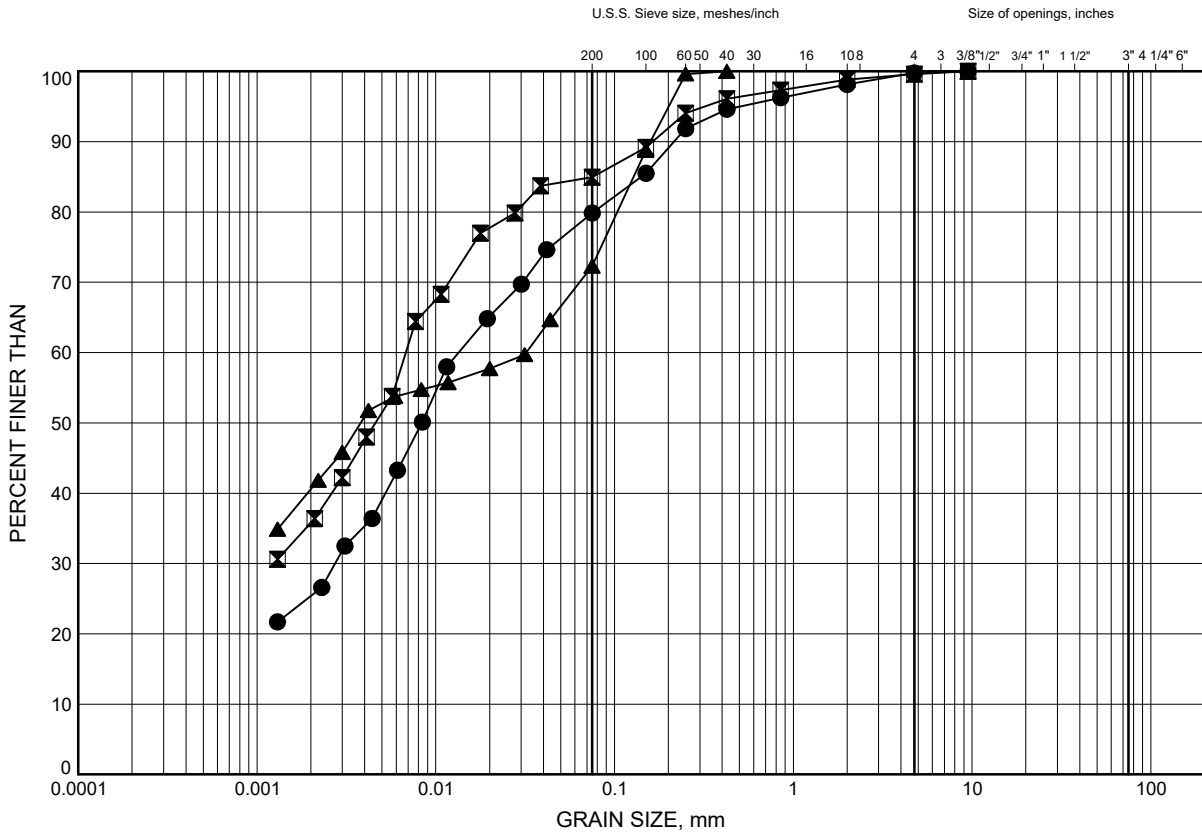


Prep'd AN
 Chkd. RPR

Culvert #23, Sta. 24+275
GRAIN SIZE DISTRIBUTION

FIGURE A3

Silty CLAY TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C17-01	4.88	269.92
⊠	C17-02	4.88	270.02
▲	C17-02	7.92	266.98

Date April 2017
 GWP# 2539-04-00

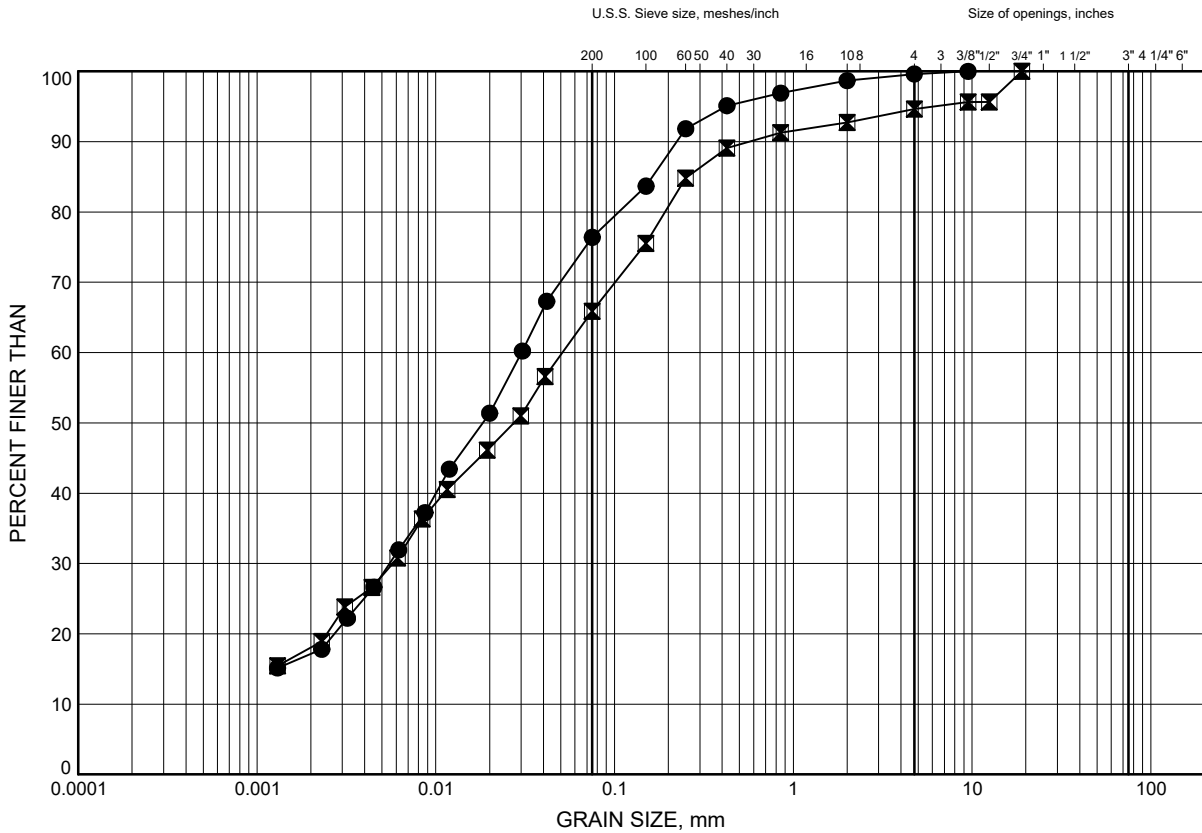


Prep'd AN
 Chkd. RPR

Culvert #23, Sta. 24+275
GRAIN SIZE DISTRIBUTION

FIGURE A4

Clayey SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C17-01	10.97	263.83
⊠	C17-02	10.97	263.93

Date April 2017
 GWP# 2539-04-00



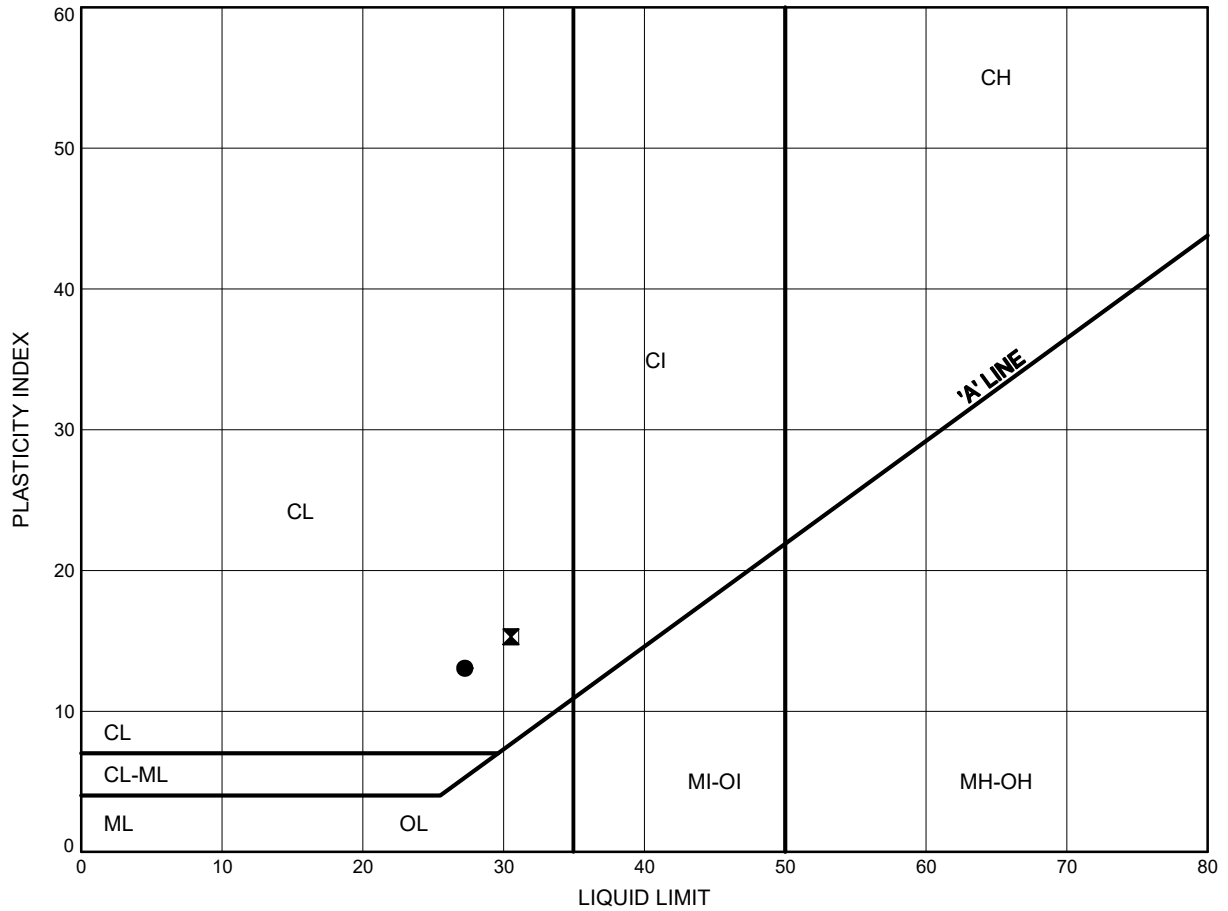
Prep'd AN
 Chkd. RPR

Culvert #23, Sta. 24+275

ATTERBERG LIMITS TEST RESULTS

FIGURE A5

Silty CLAY TILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C17-01	4.88	269.92
⊠	C17-02	4.88	270.02

Date April 2017
GWP# 2539-04-00



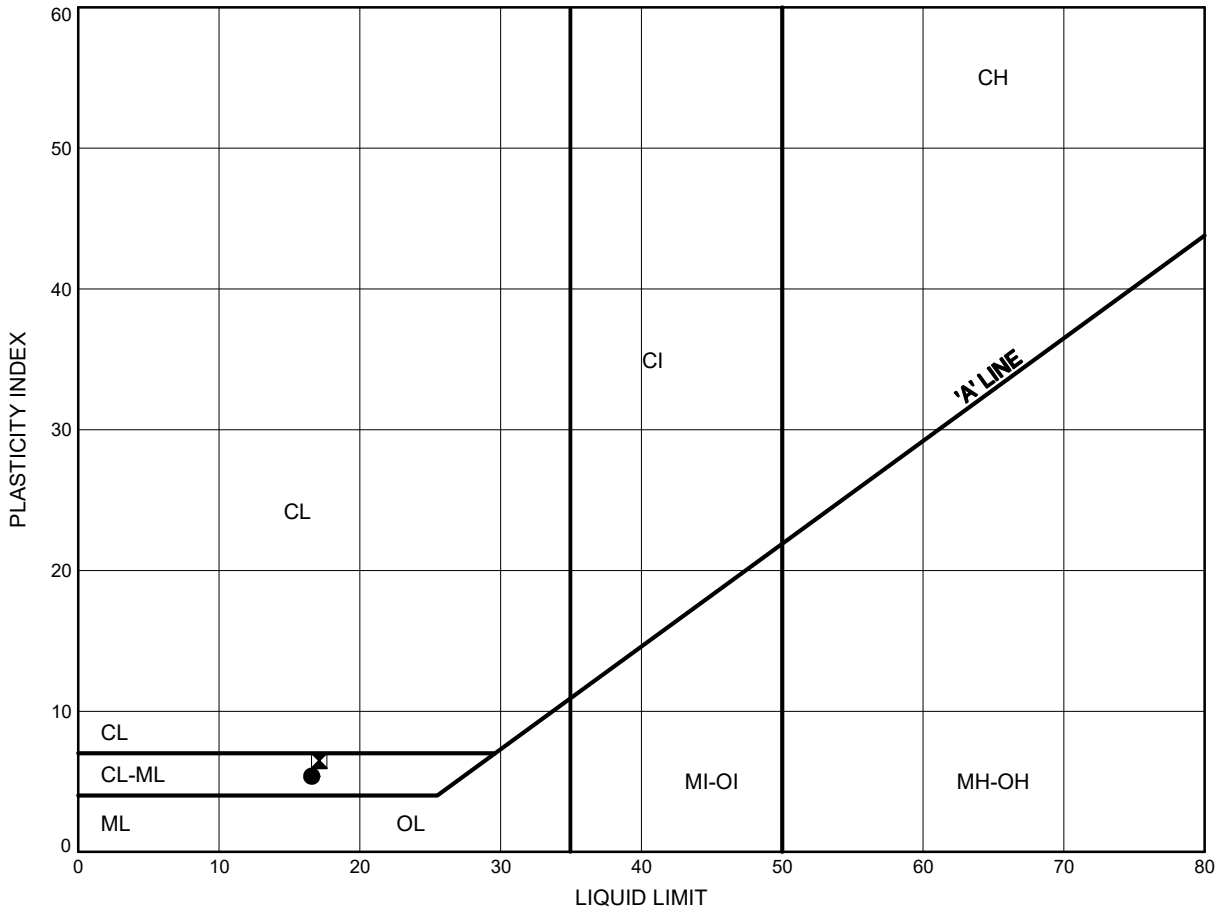
Prep'd AN
Chkd. RPR

Culvert #23, Sta. 24+275

ATTERBERG LIMITS TEST RESULTS

FIGURE A6

Clayey SILT TILL



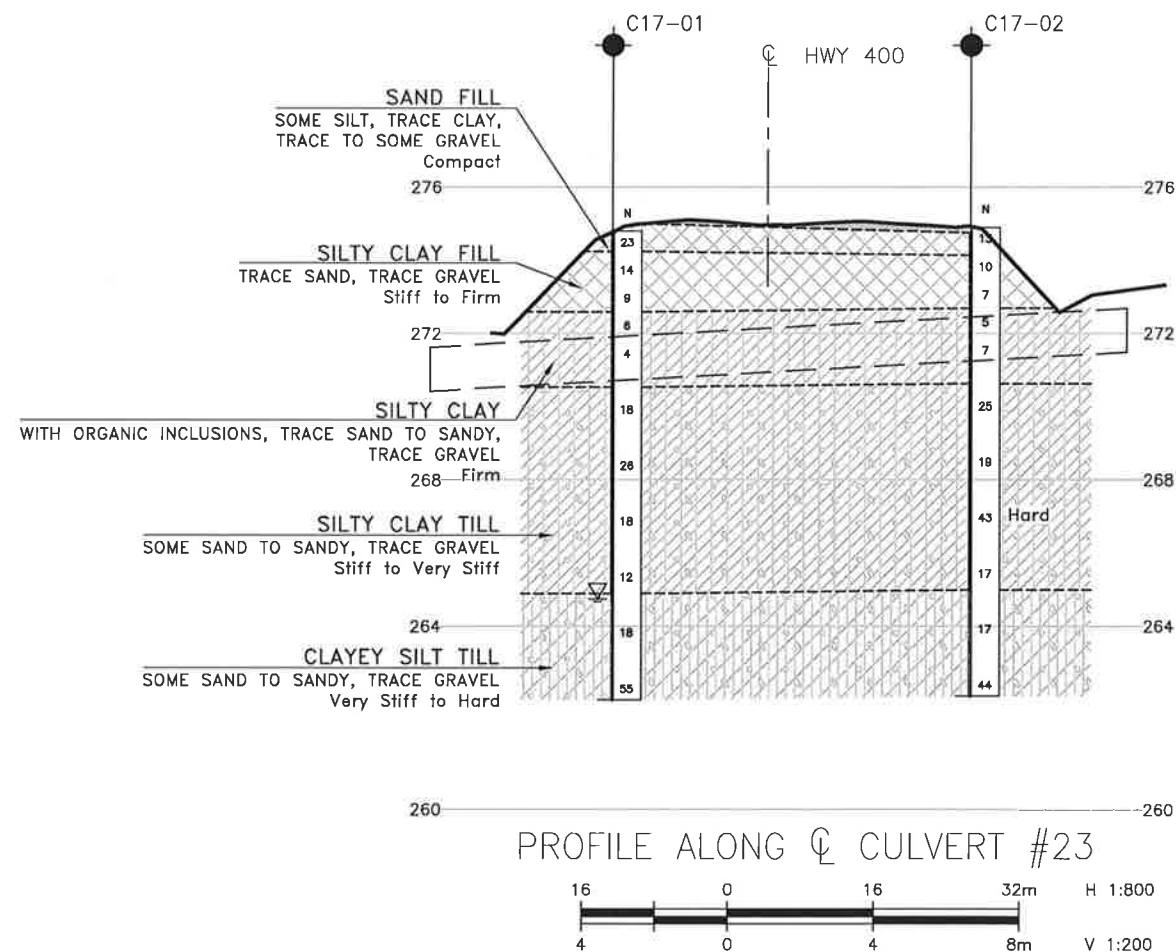
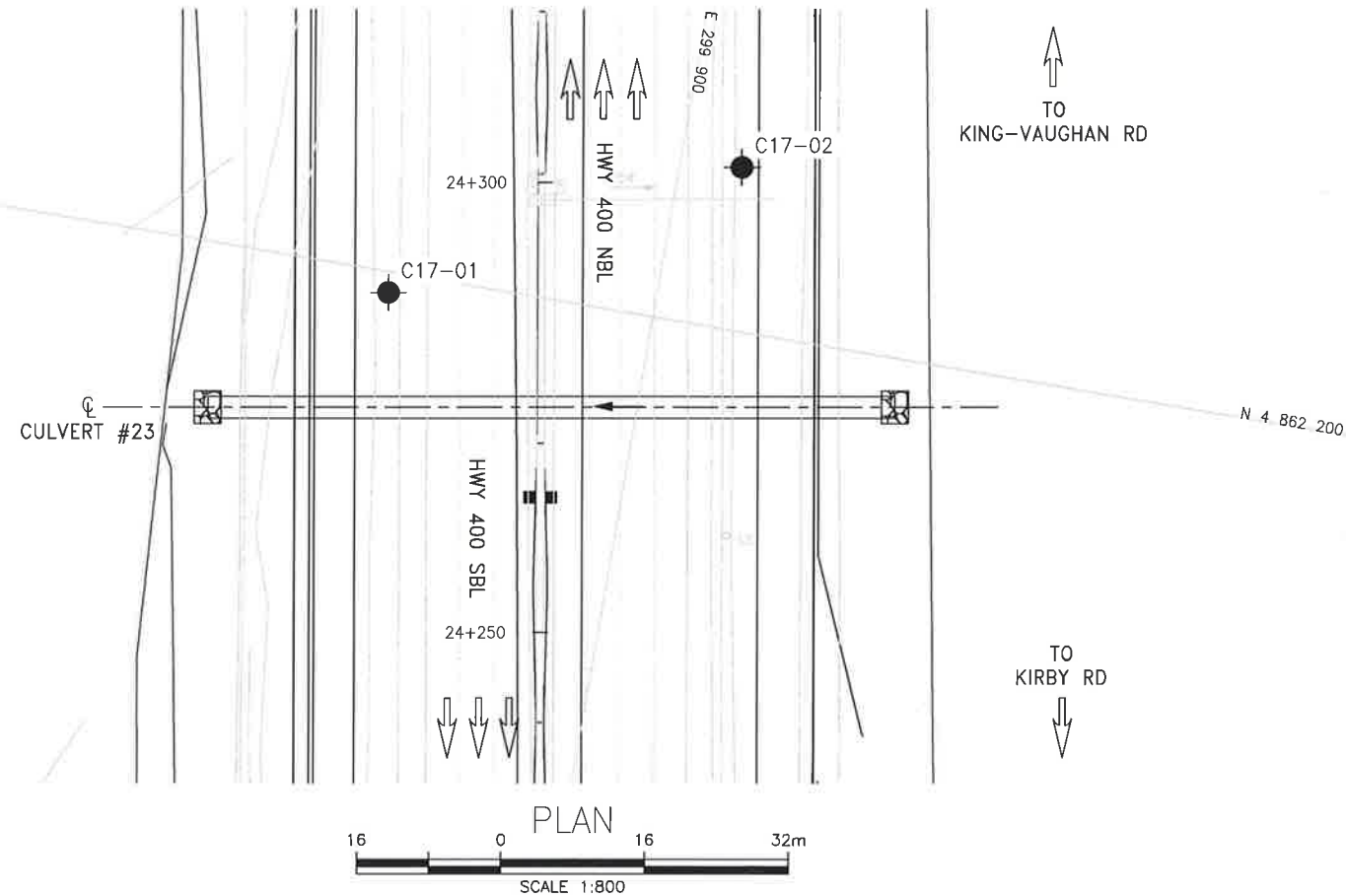
LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C17-01	10.97	263.83
⊠	C17-02	10.97	263.93

Date April 2017
GWP# 2539-04-00



Prep'd AN
Chkd. RPR



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

CONT No
WP No 2539-04-00

HIGHWAY 400
CULVERT #23
STATION 24+275
BOREHOLE LOCATIONS AND SOIL STRATA

SNC-LAVALIN



THURBER ENGINEERING LTD.



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
C17-01	274.8	4 862 197.8	299 870.5
C17-02	274.9	4 862 218.1	299 906.9

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.

GEORES No. 30M13-225



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	RPR	CHK SKP	ICODE
DRAWN	AN	CHK RPR	SITE
			STRUCT
			DWG 1



Appendix B

SWMP #1

Record of Borehole Sheets (SWMP1-01 and SWMP1-02)

Laboratory Test Results

Drawing titled “Borehole Locations and Soil Strata”


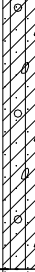
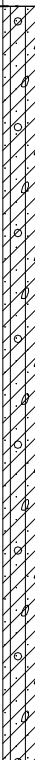
Figure B1 Selected Slope Stability Output

RECORD OF BOREHOLE No SWM1-01

1 OF 2

METRIC

GWP# 2539-04-00 LOCATION Storm Water Management Pond #1 N 4 861 553.4 E 300 044.9 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.03.07 - 2017.03.07 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			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%)					
270.8	GROUND SURFACE							20	40	60	80	100					
0.0	Clayey SILT , with organics, occasional roots and rootlets Firm Dark Brown Moist		1	SS	4												
270.2																	
0.6	Silty CLAY , some sand, trace gravel, oxide staining Stiff Brown to Grey Moist		2	SS	11												
			3	SS	14												
268.7																	
2.1	Silty CLAY , some sand, trace gravel Stiff to Very Stiff Brown Moist (TILL)		4	SS	13												
				5	SS	16											
266.8																	
4.0	SAND , trace silt and gravel (600mm)																
266.2																	
4.6	Grey		6	SS	21												
				7	SS	18											
			8	SS	23												
			9	SS	24												
261.0																	
9.8	END OF BOREHOLE AT 9.8m.																

Continued Next Page

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

RECORD OF BOREHOLE No SWM1-01

2 OF 2

METRIC

GWP# 2539-04-00 LOCATION Storm Water Management Pond #1 N 4 861 553.4 E 300 044.9 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.03.07 - 2017.03.07 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			SHEAR STRENGTH kPa									
	Continued From Previous Page BOREHOLE CAVED TO 9.0m AND WATER LEVEL AT 8.5m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.																

ONTMT4S MTO-17265.GPJ 2015TEMPLATE(MTO).GDT 4/26/17

RECORD OF BOREHOLE No SWM1-02

1 OF 2

METRIC

GWP# 2539-04-00 LOCATION Storm Water Management Pond #1 N 4 861 508.3 E 300 048.1 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.03.07 - 2017.03.07 CHECKED BY RPR

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%) w _p w w _L				GR	SA	SI	CL
270.2	GROUND SURFACE							20	40	60	80	100							
0.0	Clayey SILT , with organics, occasional roots and rootlets Firm Dark Brown Moist		1	SS	4		270								○				
269.4															○				
0.8	Silty CLAY , some sand, trace gravel, oxide staining Stiff Brown to Grey Moist		2	SS	11		269												
			3	SS	11										○				
268.0							268												
2.2	Silty CLAY , some sand to sandy, trace gravel Very Stiff Brown Moist (TILL)		4	SS	15										○				
			5	SS	18		267								○				
															○				
							266												
	Grey		6	SS	20		265								○				
							264								○				
			7	SS	15														
							263												
	Wet		8	SS	18		262								○				
							261								○				
260.4			9	SS	18														
9.8	END OF BOREHOLE AT 9.8m.																		

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SWM1-02 2 OF 2 METRIC

GWP# 2539-04-00 LOCATION Storm Water Management Pond #1 N 4 861 508.3 E 300 048.1 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.03.07 - 2017.03.07 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			SHEAR STRENGTH kPa									
	Continued From Previous Page BOREHOLE CAVED TO 8.8m AND WATER LEVEL AT 5.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.																

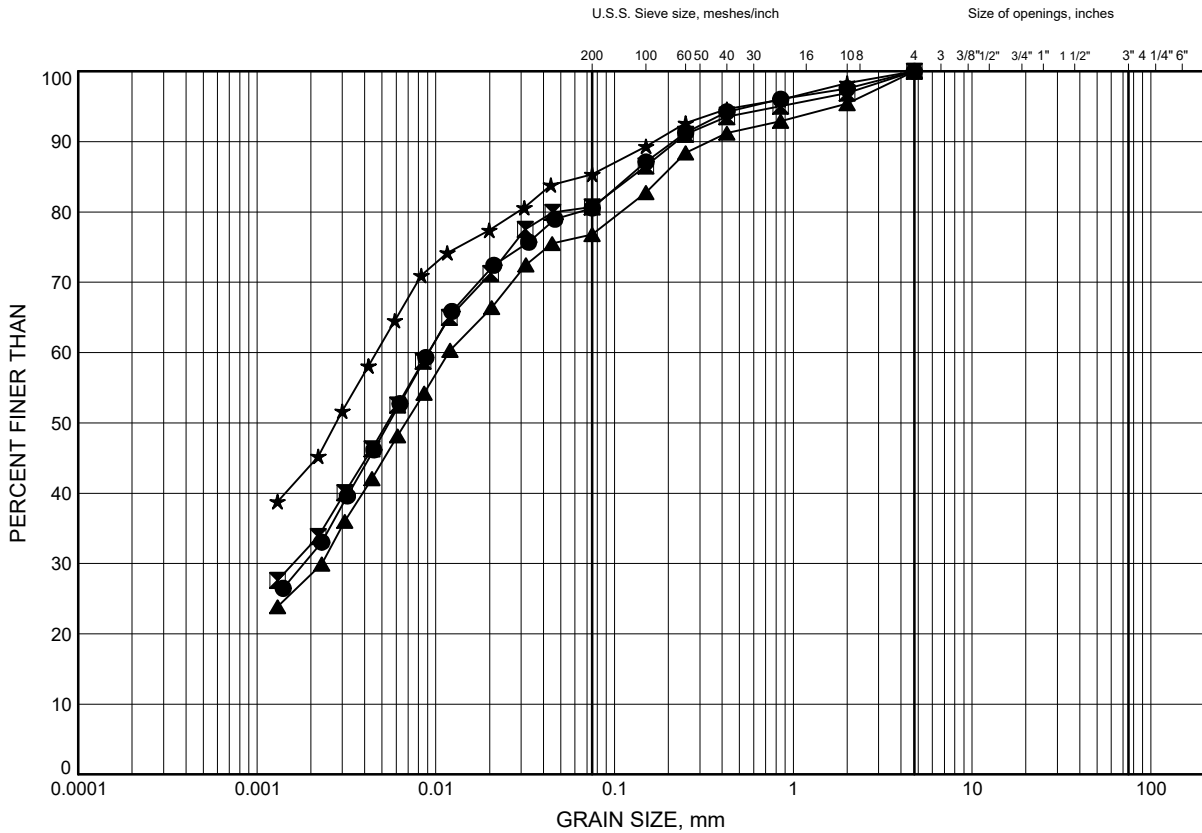
ONTMT4S MTO-17265.GPJ 2015TEMPLATE(MTO).GDT 4/26/17

Storm Water Management Pond #1

GRAIN SIZE DISTRIBUTION

FIGURE B1

Silty CLAY TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SWM1-01	2.59	268.21
■	SWM1-01	6.40	264.40
▲	SWM1-02	3.35	266.85
★	SWM1-02	7.92	262.28

Date April 2017
GWP# 2539-04-00

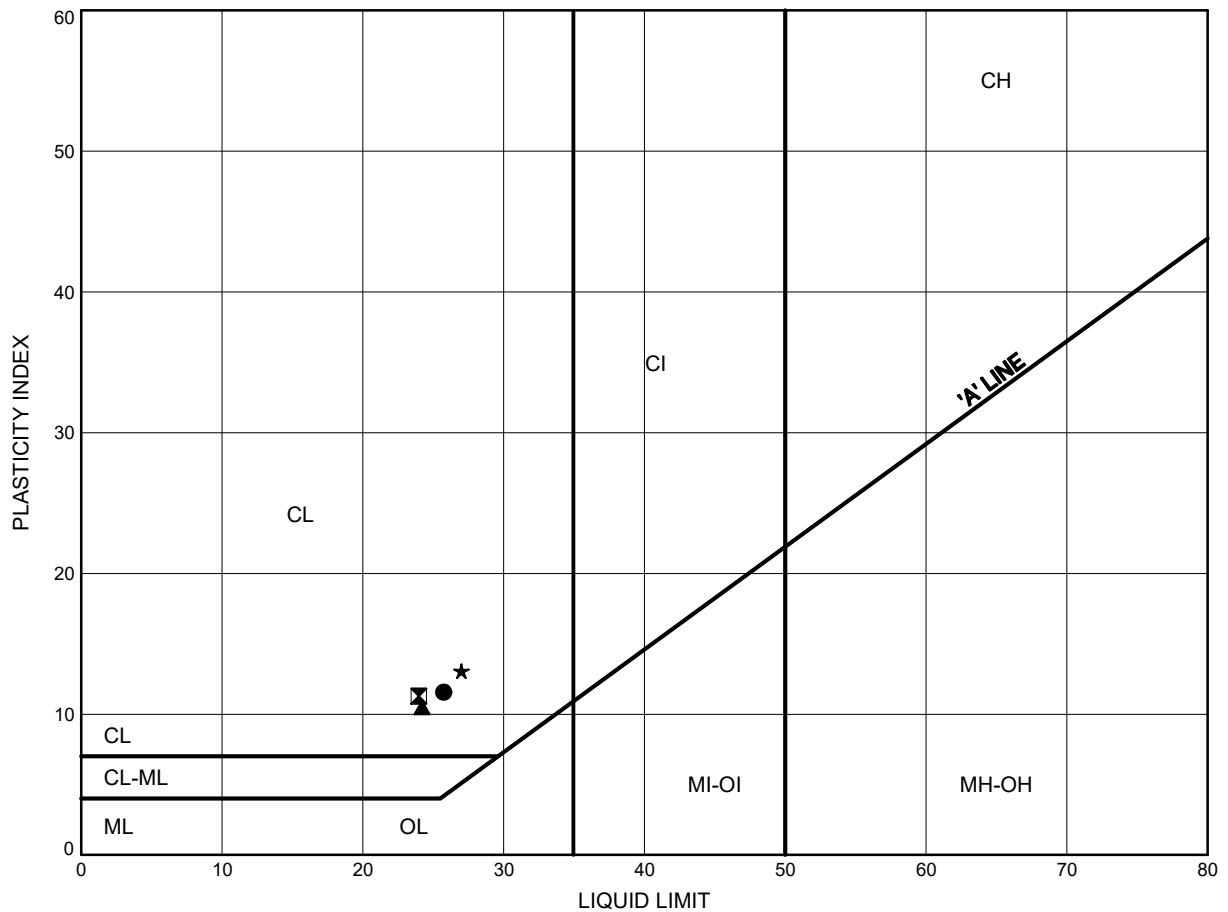


Prep'd AN
Chkd. RPR

Storm Water Management Pond #1
ATTERBERG LIMITS TEST RESULTS

FIGURE B2

Silty CLAY TILL



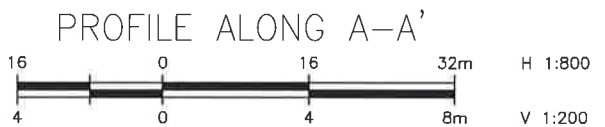
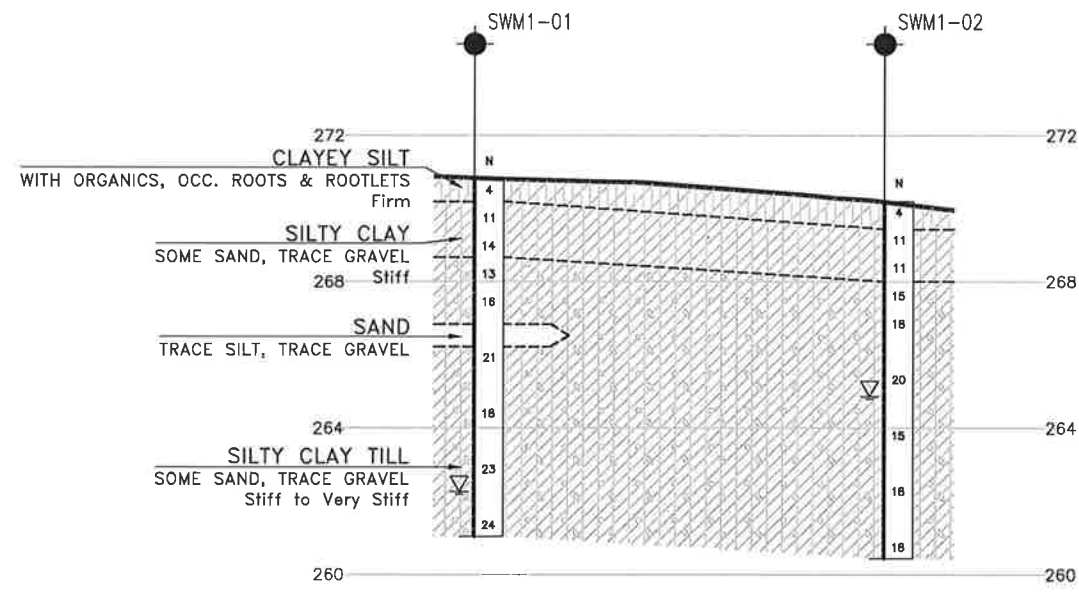
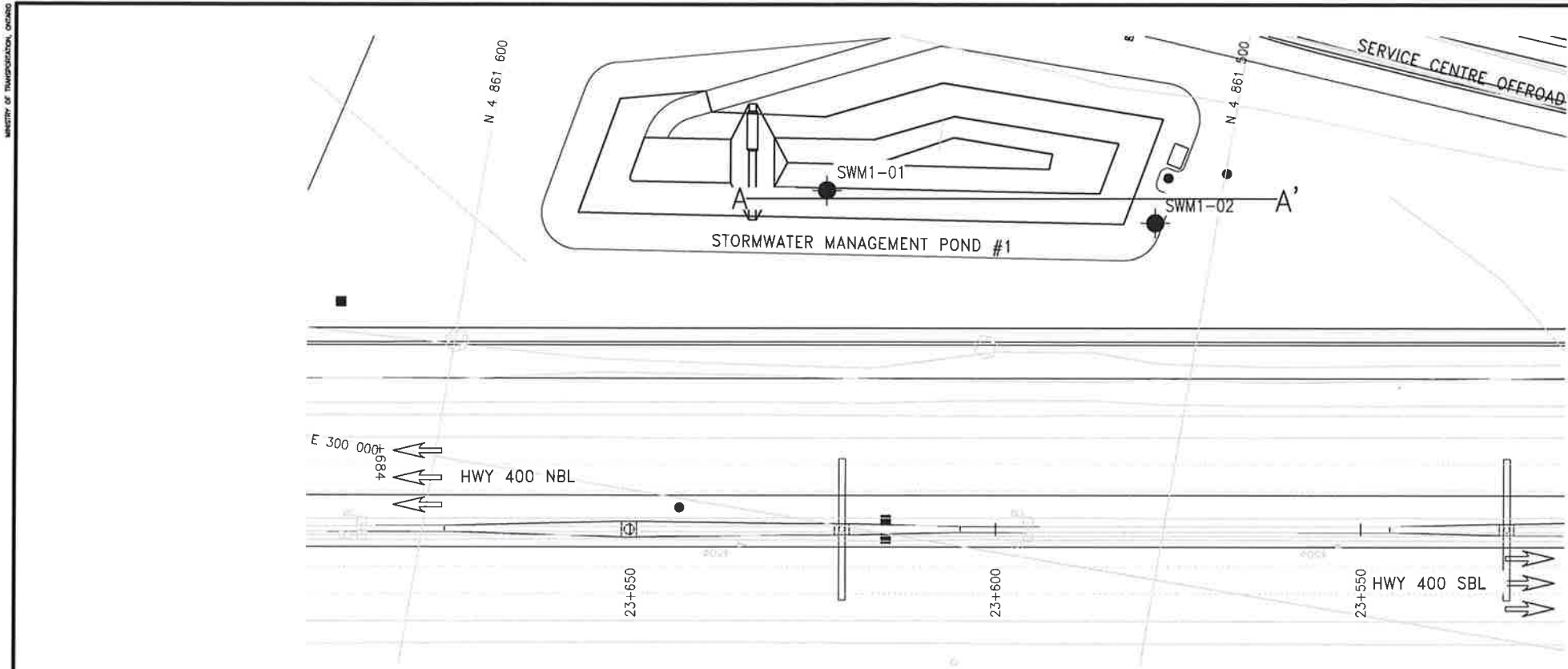
LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SWM1-01	2.59	268.21
⊠	SWM1-01	6.40	264.40
▲	SWM1-02	3.35	266.85
★	SWM1-02	7.92	262.28

Date April 2017
 GWP# 2539-04-00



Prep'd AN
 Chkd. RPR



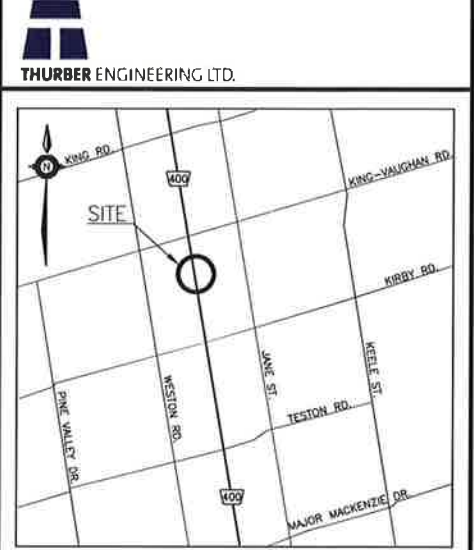
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 2539-04-00

HIGHWAY 400
STORMWATER MANAGEMENT
POND #1
BOREHOLE LOCATIONS AND SOIL STRATA

SNC-LAVALIN

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
SWM1-01	270.8	4 861 553.4	300 044.9
SWM1-02	270.2	4 861 508.3	300 048.1

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. 30M13-225

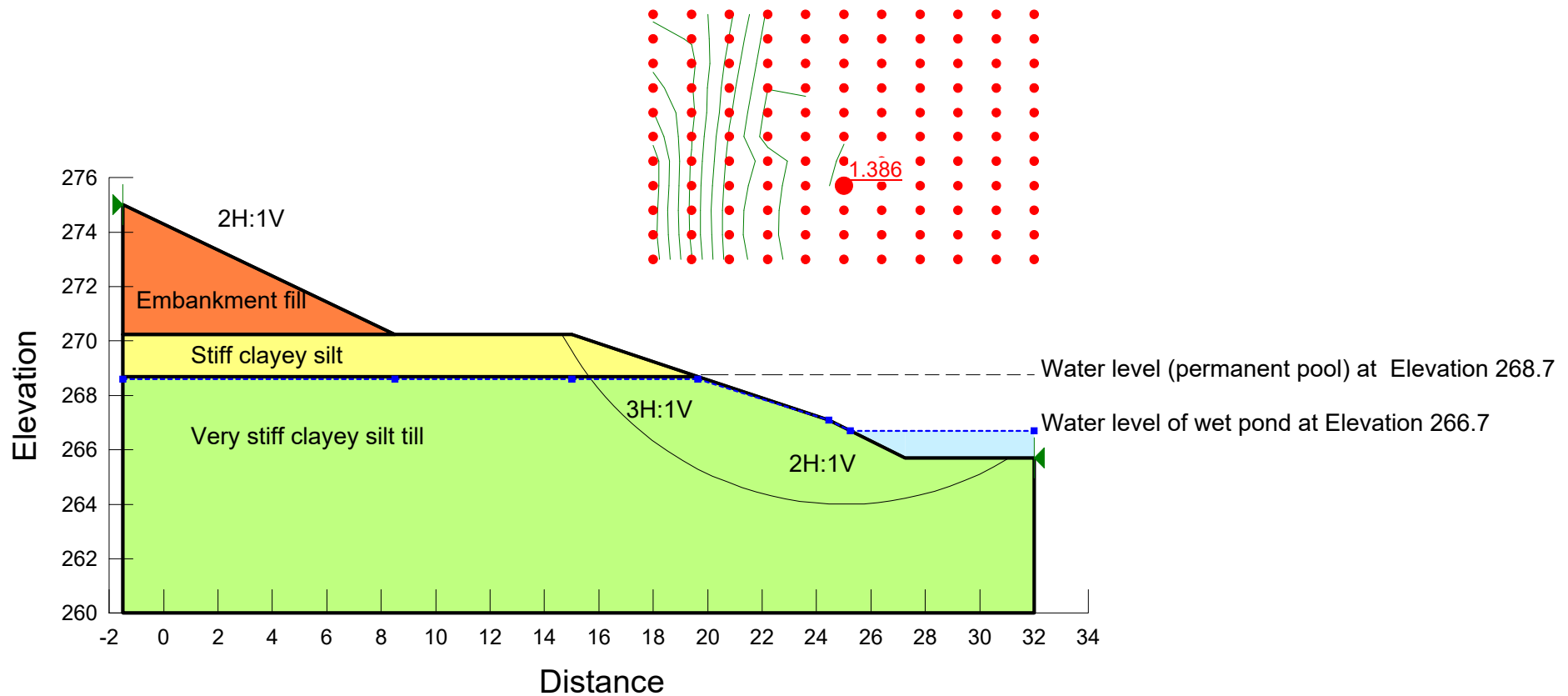


REVISIONS	DATE	BY	DESCRIPTION
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DRAWN	AN	CHK RPR	SITE
			STRUCT
			DWG 1
			DATE MAR 2018

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PLOTDATE: 3/5/2018 2:52 PM

Project Number: 17265
 Highway 400 Widening
 Stormwater Management Pond #1
 Station 23+500
 Rapid Drawdown Stability - Saturated Pond Slopes

Name: Clayey Silt Unit Weight: 19 kN/m³ Cohesion: 0 kPa Phi: 28 ° Phi-B: 0 ° Piezometric Line: 1
 Name: Clayey Silt Till Unit Weight: 20 kN/m³ Cohesion: 0 kPa Phi: 30 ° Phi-B: 0 ° Piezometric Line: 1
 Name: Embankment Fill Unit Weight: 20 kN/m³ Cohesion: 0 kPa Phi: 30 ° Phi-B: 0 ° Piezometric Line: 1



Directory: H:\17000-17999\17265 Highway 400 Widening - SWM Pond #3\Reports and Memos\Memo Culvert 23 and SWMP #1\Analysis Pond 1\ File Name: Pond 1- drained- rapid drawdown b - Final.gs
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Figure B1