



THURBER ENGINEERING LTD.



**FOUNDATION INVESTIGATION REPORT
STORMWATER MANAGEMENT POND
HIGHWAY 400 AND LLOYDTOWN-AURORA ROAD INTERCHANGE
HIGHWAY 400 WIDENING
TOWNSHIP OF KING, ONTARIO
G.W.P. 2085-13-00**

GEOCRES No. 31D-680

Report

to

WSP / MMM Group

Date: July 12, 2017
File: 12187

TABLE OF CONTENTS

PART 1: FACTUAL INFORMATION

1.	INTRODUCTION	1
2.	SITE DESCRIPTION	1
3.	INVESTIGATION PROCEDURES	2
4.	LABORATORY TESTING	3
5.	DESCRIPTION OF SUBSURFACE CONDITIONS	3
5.1	Topsoil.....	4
5.2	Surficial Clayey Silt	4
5.3	Surficial Sandy Silt.....	4
5.4	Sand and Silt Till.....	4
5.5	Sand.....	5
5.6	Sandy Silt	6
5.7	Silty Clay Till.....	6
5.8	Groundwater Conditions	7
6.	MISCELLANEOUS	8

APPENDICES

Appendix A	Record of Borehole Sheets
Appendix B	Laboratory Test Results
Appendix C	Borehole Locations and Soil Strata Drawing
Appendix D	Site Photographs

**FOUNDATION INVESTIGATION REPORT
STORMWATER MANAGEMENT POND
HIGHWAY 400 AND LLOYDTOWN-AURORA ROAD INTERCHANGE
HIGHWAY 400 WIDENING
TOWNSHIP OF KING, ONTARIO
G.W.P. 2085-13-00**

GEOGRES No. 31D-680

PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for a proposed Stormwater Management Pond (SWMP) located at the northwest quadrant of the Highway 400 and Lloydtown-Aurora Road interchange in the Township of King, Ontario. This pond is a part of the Ministry of Transportation Ontario (MTO) Highway 400 widening project that includes accommodation of 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 explore the subsurface conditions in the vicinity of the proposed SWMP and, based on the data obtained, to provide a borehole locations and soil strata drawing, records of boreholes, laboratory test results and a written description of the subsurface conditions.

Thurber carried out this investigation as a sub-consultant to WSP / MMM Group (WSP / MMM) under MTO Assignment Nos. 2015-E-0008.

2. SITE DESCRIPTION

The site is located on the west side of the Highway 400 southbound lanes (SBL) and north of Lloydtown-Aurora Road in the Township of King, Ontario. The site of the proposed SWMP is situated within agricultural lands and the terrain is relatively flat.

The approximate footprint of the proposed SWMP covered in this report is shown on the Borehole Locations and Soil Strata drawing in Appendix C.

Appendix D presents selected photographs of the observed site conditions for reference.

The project area is located within the transition zone between the physiographic regions known as the South Slope and the Oak Ridges Moraine. The South Slope is 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. The Oak Ridges Moraine is comprised of till overlying sands and gravels, sometimes with artesian conditions, in this area.

3. INVESTIGATION PROCEDURES

The field investigation for this project was carried out on May 11 and 12, 2017 and consisted of drilling and sampling three boreholes (numbered LAP-01 to LAP-03) advanced within the footprint of the proposed SWMP.

Prior to the start of drilling, the borehole locations were marked/staked in the field and utility clearances were obtained. The co-ordinates and elevations of the as-drilled boreholes were subsequently provided by WSP / MMM. The approximate locations of the boreholes are shown on Borehole Locations and Soil Strata drawings included in Appendix C. The coordinates and elevations of these boreholes are given on this drawing and on the individual Record of Borehole Sheets in Appendix A.

A track-mounted drill rig 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 depth intervals using a 50 mm diameter split spoon sampler in conjunction with the Standard Penetration Testing (SPT).

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.

Groundwater conditions were observed in the open boreholes throughout the drilling operations. Standpipe piezometers were installed in two of the boreholes (Boreholes LAP-02 and LAP-03) to permit monitoring of the groundwater levels at the site. Each standpipe piezometer consisted of a 19 mm diameter PVC pipe, with a slotted screen sealed at selected depths within the boreholes. The borehole, in which no standpipe piezometer was installed, was backfilled in general accordance with Ontario Regulation 903 (O.Reg. 903). After the final water level readings are

taken, the piezometers will be decommissioned in general accordance with O.Reg. 903. Details of the piezometer installations are summarized as follows:

Borehole Number	Piezometer Installations			Completion Details
	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Sand Filter Depth / Elevation (m)	
LAP-01	9.5 / 290.4	None installed		Borehole backfilled with bentonite holeplug and auger cuttings to surface.
LAP-02	9.5 / 291.6	9.1 / 292.0	6.0 – 9.5/ 295.1 – 291.6	Borehole backfilled with sand filter from 9.5 m to 6.0 m, bentonite holeplug from 6.0 m to 0.6 m, then bentonite holeplug and auger cuttings from 0.6 m to surface.
LAP-03	9.4 / 291.8	9.1 / 292.1	6.7 – 9.4/ 294.5 – 291.8	Borehole backfilled with sand filter from 9.4 m to 6.7 m, bentonite holeplug from 6.7 m to surface.

4. LABORATORY TESTING

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 in Appendix A and are presented on the figures included in Appendix B.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A for details of the encountered soil stratigraphy. A soil profile parallel to the long axis (generally north-south) of the pond is presented on the “Borehole Locations and Soil Strata” drawings in Appendix C. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole sheets governs any interpretation of the site conditions. It must be recognized that soil conditions may vary between and beyond borehole locations. More detailed descriptions of the individual strata are presented below.

In general, the subsurface conditions encountered in the boreholes consisted of topsoil overlying surficial layers of native clayey silt and sandy silt. Sand and silt till was contacted immediately below the surficial soils. Layers of sand and sandy silt were encountered below the cohesionless till. A cohesive silty clay glacial till deposit was encountered below the sands and silts.

5.1 Topsoil

A 50 mm thick veneer of topsoil was encountered surficially in all boreholes. The thickness of the topsoil may vary between and beyond borehole locations.

5.2 Surficial Clayey Silt

A 650 mm thick layer of brown clayey silt containing some sand and occasional organics was contacted below the topsoil in Borehole LAP-01.

An SPT 'N' value measured in the clayey silt was 7 blows per 0.3 m penetration indicating a firm consistency. A moisture content of 22 percent was measured for a sample.

5.3 Surficial Sandy Silt

A surficial layer of sandy silt containing trace clay, trace gravel and occasional organics, was contacted below the topsoil in Boreholes LAP-02 and LAP-03. The thickness of this soil was 650mm.

SPT 'N' values measured in the surficial sandy silt were 8 and 10 blows per 0.3 m penetration, indicating a loose to compact state. Moisture contents measured in the surficial sandy silt were 17% and 26%.

5.4 Sand and Silt Till

A deposit of brown to grey sand and silt till containing some clay and trace gravel was contacted in the three boreholes immediately below the surficial soils. The thickness of the sand and silt till ranged from 2.2 m to 2.3 m. The depth to the base of the sand and silt till varied from 2.9 m to 3.0m (Elevations 297.0 to 298.2).

SPT 'N' values measured in the sand and silt till typically ranged from 13 to 46 blows per 0.3 m of penetration indicating a compact to dense state. One 'N' value of 51 blows measured in Borehole LAP-02 indicated a very dense zone. The moisture content in the sand and silt till varied from 9 percent to 18 percent.

The results of grain size distribution analyses carried out on selected samples of the sand and silt till are presented on the Record of Borehole sheets included in Appendix A and on Figure B1 of Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Percentage (%)
Gravel	0 to 1
Sand	51 to 53
Silt	35 to 44
Clay	4 to 13

Glacial tills inherently contain cobbles and boulders.

5.5 Sand

A deposit of brown to grey sand containing trace to some silt and trace clay was contacted below the sand and silt till in the three boreholes. The thickness of the sand layer varied between 1.1m in Boreholes LAP-03 and 6.1 m in Borehole LAP-02. The depths to the base of the sand were 5.2 m and 4.1 m (Elevations 294.7 and 297.1) in Boreholes LAP-01 and LAP-03, respectively; and 9.1 m (Elevation 292.0) in Borehole LAP-02.

A lower layer of sand was contacted in Borehole LAP-01 at 8.7 m depth. Borehole LAP-01 was terminated within this layer at 9.5 m depth (Elevation 290.4).

SPT 'N' values obtained in the sand layers ranged between 49 blows per 0.3 m penetration to greater than 100 blows for less than 0.3 m of penetration indicating dense to very dense conditions. An SPT 'N' value of 27 blows per 0.3 m of penetration, indicating a compact state, was measured in Borehole LAP-03 near Elevation 297.8. Measure moisture contents in the sand were between 16 percent and 20 percent.

The results of grain size distribution analyses carried out on selected samples of the sand are presented on the Record of Borehole sheets included in Appendix A and on Figure B2 of Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Percentage (%)
Gravel	0
Sand	88 to 91
Silt	7 to 10
Clay	2

5.6 Sandy Silt

A layer of brown sandy silt containing some clay was contacted below the sand, at 4.1 m depth in Borehole LAP-03. The thickness of the sandy silt was 3.1 m. The depth to the base of the sandy silt was at 7.2 m (Elevation 294.0).

SPT 'N' values measured in the sandy silt were 64 and 93 blows per 0.3 m penetration, indicating a very dense condition. Measure moisture contents in the sandy silt were 17 percent and 19 percent.

The results of grain size distribution analyses carried out a sample of the sandy silt are presented on the Record of Borehole sheets included in Appendix A and on Figure B3 of Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Percentage (%)
Gravel	0
Sand	23
Silt	65
Clay	12

5.7 Silty Clay Till

Grey silty clay till with sand was encountered below the soils described above at depths ranging from 5.2 m to 9.1 m. The thickness of the silty clay till was 3.5 m in Borehole LAP-01. The depth to the base of the silty clay till was at 8.7 m (Elevation 291.2) in Borehole LAP-01. Boreholes LAP-02 and LAP-03 were terminated within the silty clay till at 9.5m and 9.4 m depths (Elevations 291.6 and 291.8), respectively.

SPT 'N' values obtained in the silty clay till typically ranged from 96 blows for 0.3 m penetration to greater than 100 blows for less than 0.3 m of penetration indicating a hard consistency. An SPT 'N' value of 25 blows per 0.3 m of penetration, indicating a very stiff consistency, was measured in Borehole LAP-03 near Elevation 293.3. Moisture contents of the silty clay till ranged from 11 percent to 16 percent.

The results of grain size analyses conducted on a silty clay till sample are presented on the Record of Borehole sheets in Appendix A, and are illustrated in Figure B4 of Appendix B. The laboratory test results are summarized in the following table.

Soil Particle	Percentage (%)
Gravel	0
Sand	33
Silt	43
Clay	24

The results of Atterberg Limits tests conducted on a sample of the silty clay till are provided on the Record of Borehole sheets in Appendix A and illustrated in Figure B5 of Appendix B. The results are summarized as follows:

Index Property	Percentage (%)
Plasticity Index	11
Liquid Limit	24

The results of the Atterberg Limits testing indicate that this till is of low plasticity with a group symbol CL.

Glacial tills inherently contain cobbles and boulders.

5.8 Groundwater Conditions

Groundwater conditions were observed during drilling operations and groundwater levels were measured in the open boreholes upon completion of drilling. Standpipe piezometers were installed in Boreholes LAP-02 and LAP-03 to monitor the groundwater level at the site. The groundwater levels measured upon completion of drilling and in the standpipe piezometers are summarized below

Table 5-1. Measured Groundwater Levels

Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
LAP-01	May 11, 2017	2.3	297.6	Open borehole
LAP-02	May 12, 2017	3.7	297.4	Open borehole Piezometer
	May 19, 2017	2.0	299.1	
	June 23, 2017	1.4	299.7	
LAP-03	May 11, 2017	3.4	297.8	Open borehole Piezometer
	May 19, 2017	2.4	298.8	
	June 23, 2017	2.2	299.0	

The groundwater levels above are short-term readings and seasonal fluctuations of the groundwater levels are to be expected. In particular, the groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation.

6. MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. WSP / MMM provided the northing and easting coordinates and ground surface elevations.

DBW Drilling Ltd. of Ajax, Ontario supplied and operated the drilling, sampling and in-situ testing equipment for the field investigation. The field investigation was supervised on a full time basis by Mr. Abdul Nasri of Thurber. Overall supervision of the field program was provided by Mr. Stephane Loranger, CET.

Routine laboratory testing was carried out at Thurber's geotechnical laboratory. Overall project management was provided by Dr. Sydney Pang, P.Eng. Interpretation of the field data and preparation of this report was completed by Ms. R. Palomeque Reyna, P. Eng. and Dr. Sydney Pang, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



Thurber Engineering Ltd.

Rocio Palomeque Reyna, P.Eng.
Geotechnical Engineer



Sydney Pang, P.Eng.
Associate, Senior Foundations Engineer



P.K. Chatterji, P.Eng.
Review 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.

EXPLANATION OF ROCK LOGGING TERMS


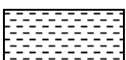

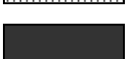

ROCK WEATHERING CLASSIFICATION

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			

RECORD OF BOREHOLE No LAP-01

1 OF 2

METRIC

GWP# 2085-13-00 LOCATION SWM Pond North of Lloydtown-Aurora Rd. N 4 873 687.8 E 297 692.6 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.11 - 2017.05.11 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			SHEAR STRENGTH kPa										
299.9	GROUND SURFACE							20	40	60	80	100						
0.0	TOPSOIL: (50mm) Clayey SILT , some sand, occasional organics Firm Brown Moist		1	SS	7		299											
299.2																		
0.7	SAND and SILT , some clay, trace gravel Compact to Dense Brown to Grey Moist (TILL) Wet		2	SS	29		298											1 51 35 13
			3	SS	33													
			4	SS	38													
297.0							297											
2.9	SAND , trace silt, trace clay Very Dense Brown to Grey Wet		5	SS	72		296											0 91 7 2
			6	SS	100/ 0.150		295											
294.7																		
5.2	Silty CLAY , with sand Hard Grey Moist (TILL)		7	SS	100/ 0.225		294											
							293											
			8	SS	96		292											0 33 43 24
291.2																		
8.7	SAND , trace silt Very Dense Brown Wet		9	SS	100/ 0.250		291											
290.4																		
9.5	END OF BOREHOLE AT 9.5m. WATER LEVEL AT 2.3m UPON COMPLETION																	

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No LAP-01

2 OF 2

METRIC

GWP# 2085-13-00 LOCATION SWM Pond North of Lloydtown-Aurora Rd. N 4 873 687.8 E 297 692.6 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.11 - 2017.05.11 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					
	Continued From Previous Page																
	BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.																

ONTMT4S MTO-12187.GPJ 2017TEMPLATE(MTO).GDT 17/7/12

RECORD OF BOREHOLE No LAP-02

1 OF 2

METRIC

GWP# 2085-13-00 LOCATION SWM Pond North of Lloydtown-Aurora Rd. N 4 873 636.7 E 297 699.7 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.12 - 2017.05.12 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						
301.1	GROUND SURFACE							20	40	60	80	100		
0.0	TOPSOIL: (50mm)						301							
300.4	Sandy SILT , trace clay, trace gravel, occasional organics		1	SS	8									
0.7	Loose Brown Moist													
	SAND and SILT , some clay Compact to Very Dense		2	SS	17		300							
	Brown Moist (TILL)													
	Grey		3	SS	51		299							0 53 36 11
			4	SS	46									
298.1							298							
3.0	SAND , trace to some silt, trace clay Very Dense		5	SS	64									
	Brown Wet													
297.0							297							
4.1			6	SS	49		296							0 88 10 2
	Dense													
295.5			7	SS	52/ 0.150		295							
5.6	Very Dense						294							
			8	SS	61/ 0.125		293							
	Brown to Grey													
292.0							292							
9.1	Silty CLAY , with sand		9	SS	100/ 0.200									
291.6	Hard													
9.5	Grey Moist (TILL)													

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No LAP-02

2 OF 2

METRIC

GWP# 2085-13-00 LOCATION SWM Pond North of Lloydtown-Aurora Rd. N 4 873 636.7 E 297 699.7 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.12 - 2017.05.12 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					
	Continued From Previous Page END OF BOREHOLE AT 9.5m. WATER LEVEL AT 3.7m 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) 2017.05.19 2.0 299.1 2017.06.23 1.4 299.7																

RECORD OF BOREHOLE No LAP-03

1 OF 2

METRIC

GWP# 2085-13-00 LOCATION SWM Pond North of Lloydtown-Aurora Rd. N 4 873 705.8 E 297 752.0 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.11 - 2017.05.11 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			SHEAR STRENGTH kPa						
301.2	GROUND SURFACE							20	40	60	80	100		
0.0	TOPSOIL: (50mm)													
300.5	Sandy SILT , trace clay, occasional organics Compact Brown Moist		1	SS	10		301							
0.7	SAND and SILT , trace clay Compact to Dense Brown Moist (TILL)		2	SS	13		300							
	Wet		3	SS	20		299							
298.2			4	SS	36		298							0 52 44 4
3.0	SAND , trace to some silt. trace clay Compact Brown Wet		5	SS	27		297							
297.1	Sandy SILT , some clay Very Dense Brown Wet		6	SS	64		296							
			7	SS	93		295							0 23 65 12
294.0	Silty CLAY , with sand Very Stiff to Hard Grey Moist (TILL)		8	SS	25		294							
7.2			9	SS	100/ 0.125		293							
291.8	END OF BOREHOLE AT 9.4m. WATER LEVEL AT 3.4m UPON COMPLETION. Piezometer installation consists of						292							
9.4														

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No LAP-03

2 OF 2

METRIC

GWP# 2085-13-00 LOCATION SWM Pond North of Lloydtown-Aurora Rd. N 4 873 705.8 E 297 752.0 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.11 - 2017.05.11 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)	
								20	40	60	80	100		20	40	60		GR SA SI CL	
	Continued From Previous Page 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.05.19 2.4 298.8 2017.06.23 2.2 299.0																		



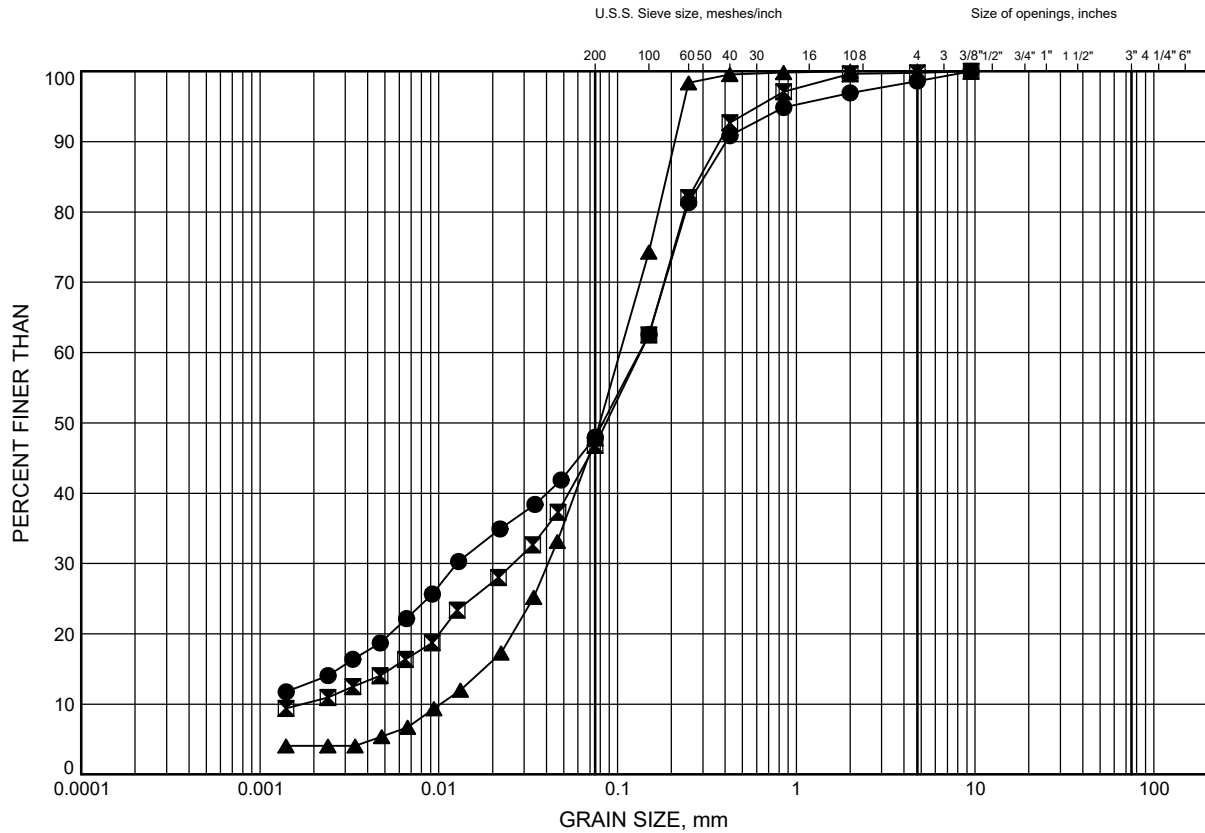
Appendix B

Laboratory Test Results

SWM Pond North of Lloydtown-Aurora Rd. GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND and SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LAP-01	1.1	298.8
⊠	LAP-02	1.8	299.3
▲	LAP-03	2.6	298.6

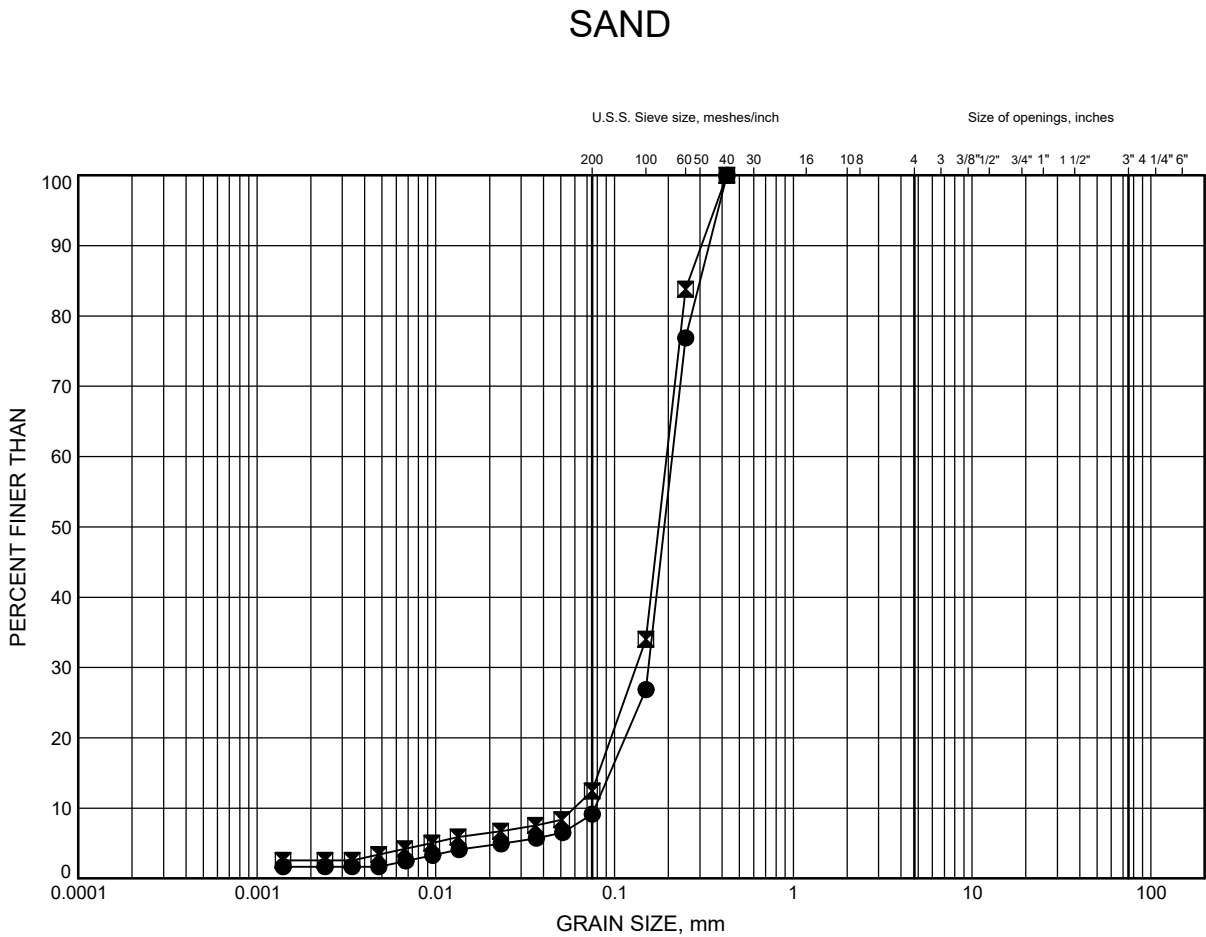
Date July 2017
GWP# 2085-13-00



Prep'd AN
Chkd. RPR

SWM Pond North of Lloydtown-Aurora Rd.
GRAIN SIZE DISTRIBUTION

FIGURE B2



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LAP-01	3.4	296.5
⊠	LAP-02	4.9	296.2

Date July 2017
GWP# 2085-13-00

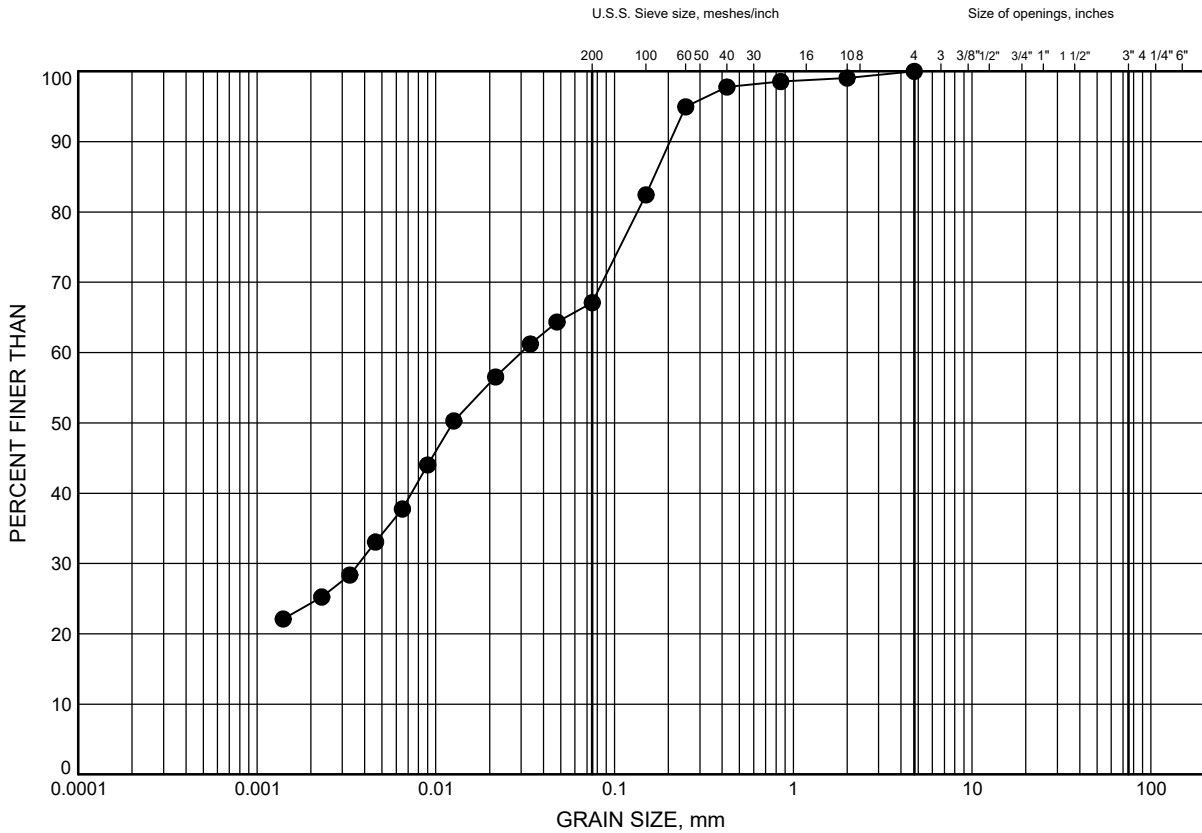


Prep'd AN
Chkd. RPR

SWM Pond North of Lloydtown-Aurora Rd.
GRAIN SIZE DISTRIBUTION

FIGURE B3

Silty CLAY, with SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LAP-01	7.9	292.0

Date July 2017
 GWP# 2085-13-00

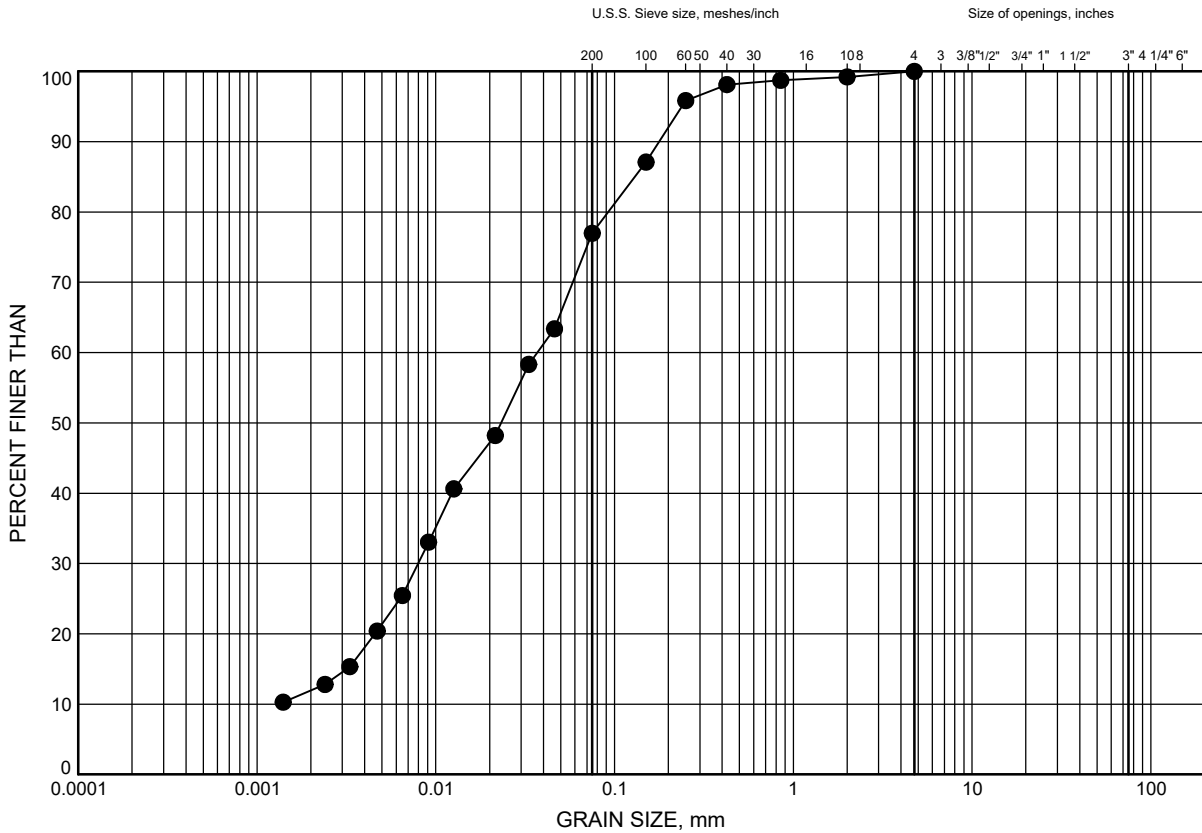


Prep'd AN
 Chkd. RPR

SWM Pond North of Lloydtown-Aurora Rd.
GRAIN SIZE DISTRIBUTION

FIGURE B4

Sandy SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LAP-03	6.4	294.8

Date July 2017
GWP# 2085-13-00

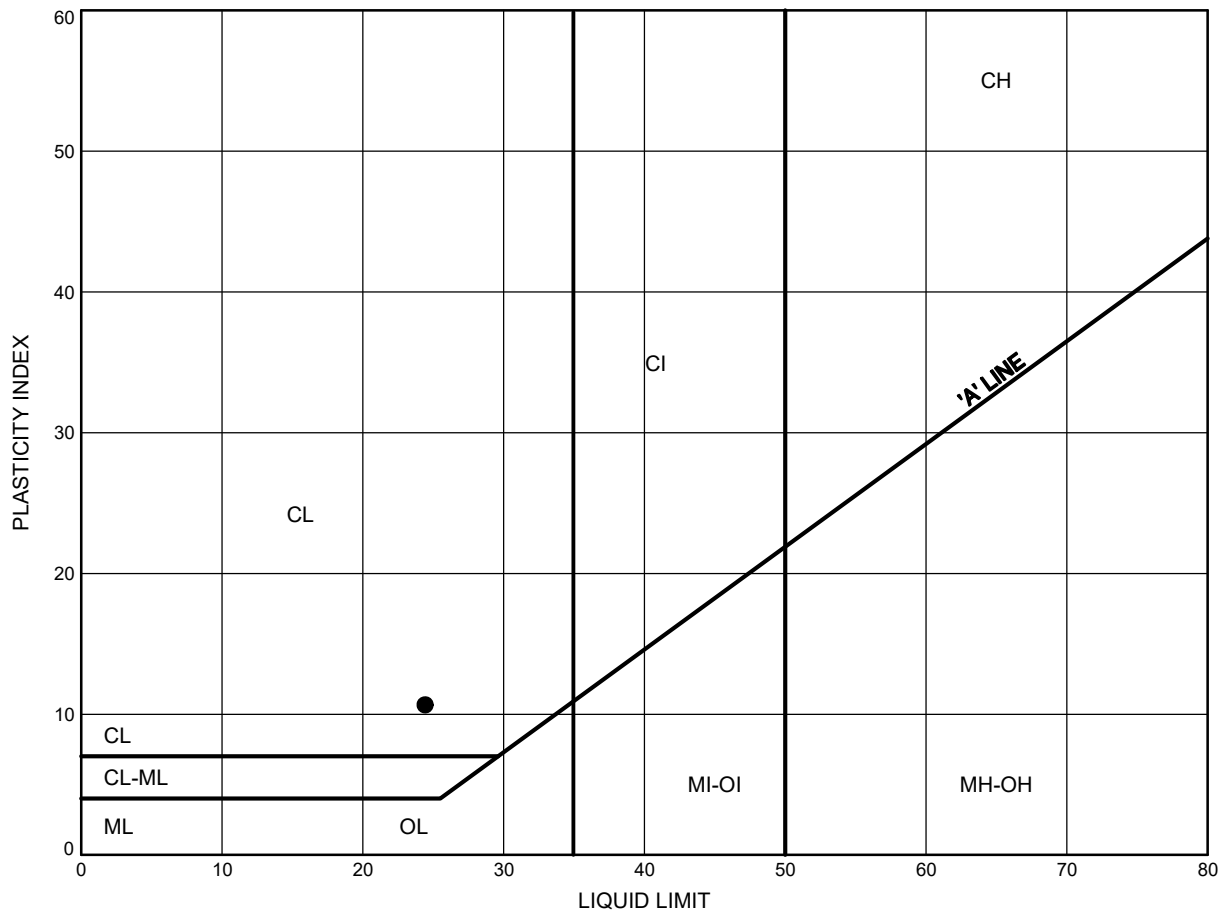


Prep'd AN
Chkd. RPR

SWM Pond North of Lloydtown-Aurora Rd.
ATTERBERG LIMITS TEST RESULTS

FIGURE B5

Silty CLAY, with SAND TILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LAP-01	7.9	292.0

Date July 2017
 GWP# 2085-13-00

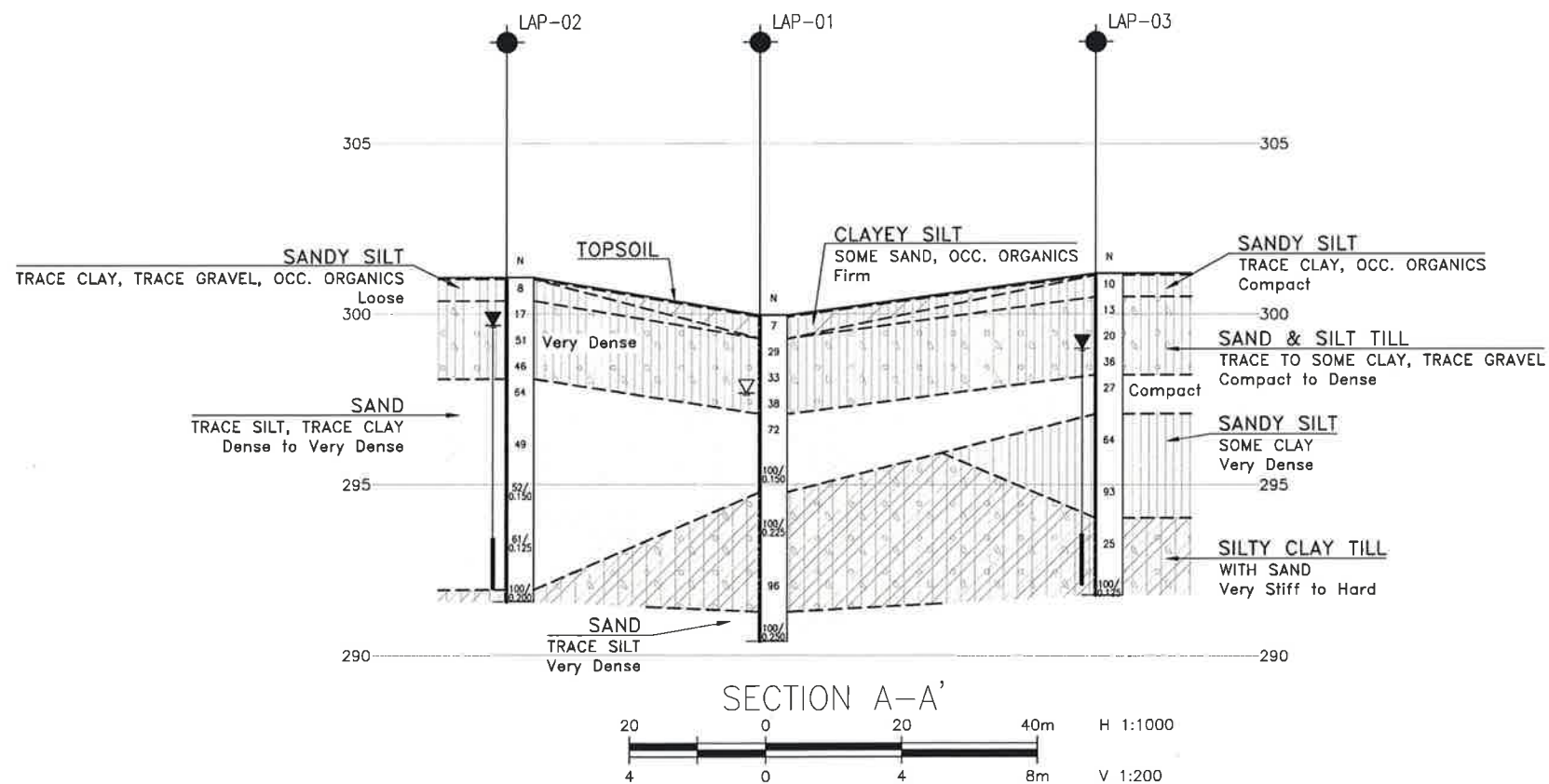
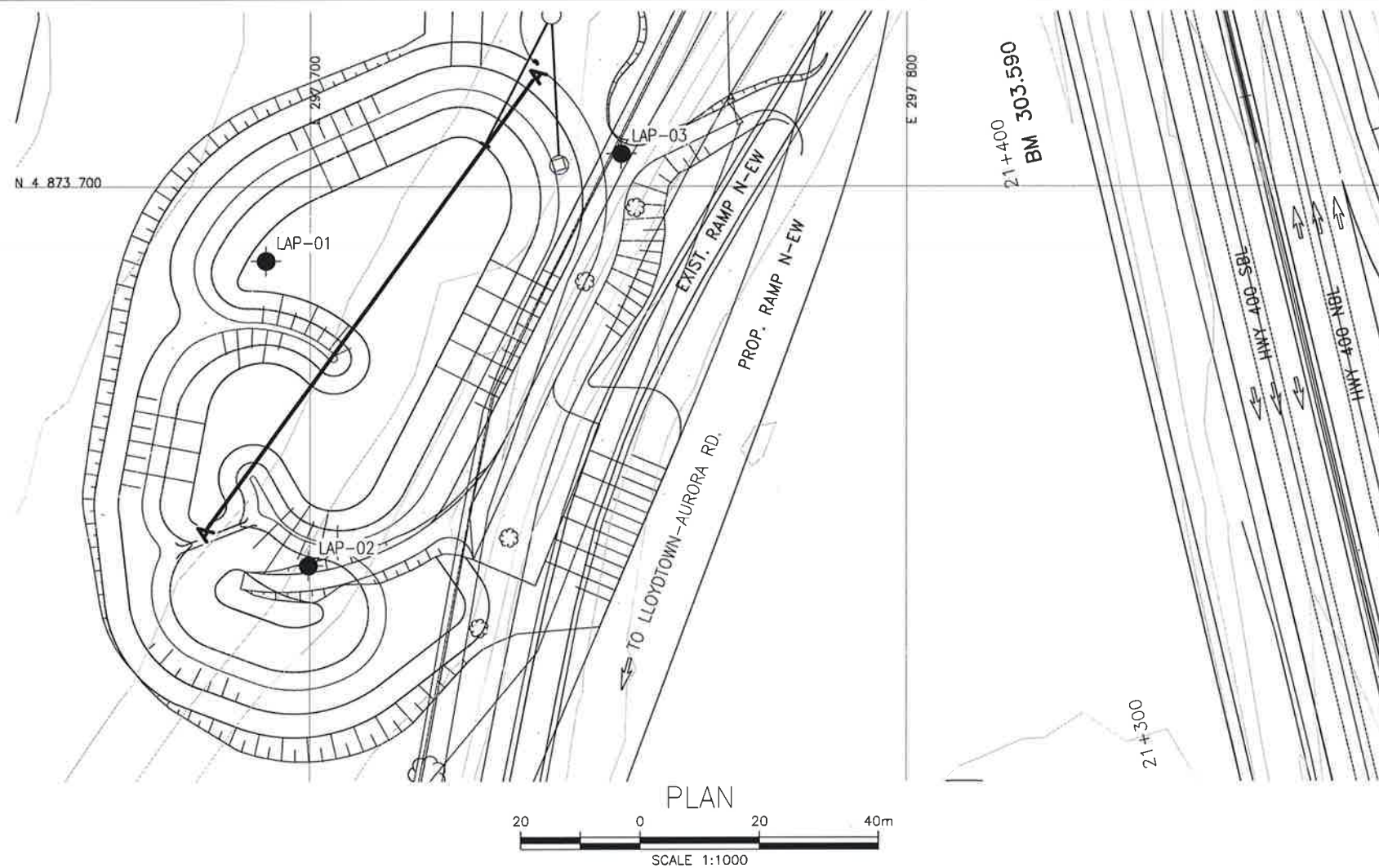


Prep'd AN
 Chkd. RPR



Appendix C

Borehole Locations and Soil Strata Drawing



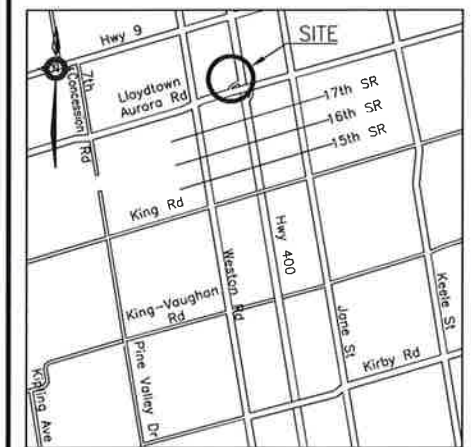
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
GWP No 2085-13-00

HIGHWAY 400
SWM POND NORTH OF
LLOYDTOWN-AURORA ROAD
BOREHOLE LOCATIONS AND SOIL STRATA



THURBER ENGINEERING LTD.



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
LAP-01	299.9	4 873 687.8	297 692.6
LAP-02	301.1	4 873 636.7	297 699.7
LAP-03	301.2	4 873 705.8	297 752.0

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. 31D-680



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



Appendix D

Site Photographs



Photo 1. – North end of the proposed SWMP



Photo 2. – Middle portion of the proposed SWMP



Photo 3. – South end of the proposed SWMP