THURBER ENGINEERING LTD.

PRELIMINARY GEOTECHNICAL INVESTIGATION
HIGHWAY 404 NORTH COLLECTOR ROADS
ENVIRONMENTAL ASSESSMENT STUDY
MARKHAM, REGION OF YORK

Report Submitted

To

CIMA+

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March 13, 2020
File: 18189

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REPORT APPENDICES

1.0 INTRODUCTION

This report presents the results of a preliminary geotechnical investigation carried out by Thurber Engineering Ltd. (Thurber) in support of the Highway 404 North Collector Roads Environmental Assessment (EA) Study presently being undertaken by CIMA+ for the City of Markham.

The purpose of this investigation was to obtain subsurface information along the conceptual alignments of collector roads, and based on this information, to provide preliminary comments and recommendations regarding pavement structure design, subgrade preparation, and municipal service installation.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

2.0 PROJECT AND SITE DESCRIPTION

An Environmental Assessment (EA) study is being undertaken to confirm the final alignment of the new north-south and east-west collector roads in the Highway 404 North Planning District in Markham, Ontario. The study area extends from approximately 400 m north of 19th Avenue to 600 m north of Elgin Mills Road, between Highway 404 and Woodbine Avenue.

The project area is located within the physiographic region known as the Peel Plain. The Peel Plain is characterized by a surficial till sheet which generally consists of silty clay to clayey silt, with occasional sand to silt zones. The till is locally modified by a veneer of clay. Bedrock is expected to exist at a depth in the order of 100 m.

The general topography of this region consists of level to gently rolling terrain, sloping gradually southward towards Lake Ontario. The study area is comprised of rural farmlands and commercial properties with residential subdivisions present south of the site.

3.0 INVESTIGATION PROCEDURES

3.1 Field Investigation

The field investigation was carried out on July 11 and 12, 2019, at which time five boreholes, designated BH-01 to BH-05, were advanced to 5.2 m depth at selected locations along the proposed roadway alignments. The approximate locations of the boreholes are shown on the Borehole Location Plan in Appendix A.

The borehole locations were established in the field by Thurber using a portable GPS receiver and verified relative to existing site features. The ground surface elevations at the borehole locations were interpreted from a base plan provided by CIMA.

All borehole locations were cleared of utilities prior to commencement of drilling.

The boreholes were drilled using a Diedrich D25 track-mounted drill rig supplied and operated by Walker Drilling of Utopia, Ontario. Solid stem augers were used to advance the boreholes and soil samples were obtained at selected intervals in conjunction with the Standard Penetration Test (SPT).

The field investigation was carried out under the full-time supervision of a representative of Thurber's technical staff. All boreholes were logged in the field. Soil samples were identified, placed in labelled containers and transported back to Thurber's laboratory for further examination and testing. Groundwater conditions were observed in the open boreholes during drilling. Standpipe piezometers (25 mm diameter) were installed and enclosed in filter sand in the boreholes to permit groundwater level monitoring.

The results of the field program are presented on the Record of Borehole sheets in Appendix B.

3.2 Laboratory Testing

Geotechnical laboratory testing consisted of natural moisture content determinations, visual classification and description of all soil samples. Grain size distribution analyses were carried out on selected samples of the subgrade soils. Selected samples were subjected to Atterberg Limits testing.

The results of the geotechnical laboratory testing are presented on the Record of Borehole sheets in Appendix B and on the figures in Appendix C.

4.0 SUMMARY OF SUBSURFACE CONDITIONS

Reference should be made to the Record of Borehole sheets in Appendix B. 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. The stratigraphic boundaries shown on the borehole records are inferred observations of drilling progress and from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

In general, the subsurface stratigraphy encountered in the boreholes consisted of a topsoil layer over compact to very dense sandy silt till.

A more detailed description of the individual strata encountered in the boreholes is provided in the following sections.

4.1 Topsoil

Topsoil was encountered in all boreholes with the exception of Borehole BH-05. The measured thickness of topsoil ranged from 200 mm to 350 mm in the boreholes. The topsoil thickness may vary in other areas of the site as this limited data is not sufficient to estimate topsoil quantity.

4.2 Sandy Silt Till

A deposit of brown to grey sandy silt till, some clay to clayey, trace gravel, was encountered underlying the topsoil or from ground surface in all boreholes advanced at the site. The boreholes were terminated in this deposit at a depth of 5.2 m (Elev. 235.7 to 229.9 m)

The SPT “N” values measured within the sandy silt till generally increased with depth, ranging from 18 blows per 0.3 m of penetration to 75 blows for 0.125 m of penetration, indicating a compact to very dense condition. “N” values of 7 to 17 blows per 0.3 m (loose to compact) were obtained in tests advanced partially within the topsoil layer at the ground surface. The natural water content measured in recovered samples ranged from 5% to 21% with the higher values generally obtained near ground surface.

The results of grain size distribution tests carried out on samples of the sandy silt till are shown on Figure C1 in Appendix C. The results are summarized below:

Soil Particle	Percentage (%)
Gravel	2 to 7
Sand	29 to 39
Silt	41 to 59
Clay	10 to 17

Atterberg limits testing was carried out on two samples of the sandy silt till exhibiting plasticity, and measured liquid limits of 15% and 18%, plastic limits of 12%, and corresponding plasticity indices of 3% and 6%. These results, which are plotted on Figure C2 in Appendix C, indicate that the deposit is of slight to low plasticity (ML to CL-ML).

Till soils frequently contain cobbles and boulders, and these should be anticipated when excavating during construction.

4.3 Groundwater

Groundwater was measured at 3.9 m depth (Elev. 237.0) in Borehole BH-03 upon completion of drilling. Groundwater was not observed in the remaining boreholes during drilling. The groundwater depths and elevations measured in the piezometers after drilling are summarized in the following table.

Table 4.1 – Ground Water Level Measurements

Borehole No.	Date	Water Level		Comment
		Depth (m)	Elevation (m)	
BH-01	Aug. 9, 2019	1.2	237.7	In piezometer
BH-02	Aug. 9, 2019	0.5	238.3	In piezometer
BH-03	Aug. 9, 2019	2.1	238.8	In piezometer
BH-04	Aug. 9, 2019	1.4	235.0	In piezometer
BH-05	Aug. 9, 2019	3.1	232.0	In piezometer

The recorded levels are short-term observations and seasonal fluctuations are to be expected. The groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

5.0 GEOTECHNICAL RECOMMENDATIONS

This section of the report provides preliminary geotechnical recommendations regarding pavement structure design, subgrade preparation, municipal service installation, and dewatering in support of the proposed Highway 404 North Collector Roads EA Study in Markham, Ontario.

The recommendations are based on the subsurface soil and groundwater conditions encountered during the investigation. The soil conditions may vary between and beyond the borehole locations, and accordingly geotechnical inspection during construction is important to assess any variation of subsurface conditions and to provide additional recommendations if necessitated by such variations.

The interpretation and recommendations are intended for the use of the design consultant and Owner, and shall not be relied upon by any other parties including the construction contractor, or used for any purposes other than development of the project design. Comments on construction methodology and equipment, where presented, are provided only to highlight those aspects that could affect the design of the project. Contractors must make their own assessment of the factual information presented in previous sections of the report, and the implications on equipment selection, construction methodology, and scheduling.

5.1 Pavement Structure Design

The preliminary roadway configuration includes construction of four new roadways within the study area:

- Road “A” extending north of 19th Avenue and connecting to Woodbine Avenue.
- Road “C” extending existing Honda Boulevard northerly to 19th Avenue.
- Road “D” extending easterly from Honda Boulevard to Woodbine Avenue.
- Road “E1” extending Victoria Square Boulevard northerly from Woodbine Avenue to proposed Road “D”

In addition, sections of Woodbine Avenue and 19th Avenue will be reconstructed at the intersections with the new roadways.

Based on the borehole data obtained during the preliminary investigation, development of the roadway infrastructure is expected to be straightforward from a geotechnical perspective. Preliminary recommendations regarding roadway pavement design and subgrade preparation are presented below.

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5.1.1 Design Analysis

Traffic projections were provided by CIMA for Woodbine Avenue, 19th Avenue and Honda Boulevard, and are summarized in Table 5.1. It is understood that 2027 is the horizon year for the partial construction south of 19th Avenue and 2037 is the horizon year for full construction including land north of 19th Avenue. Each road will carry four lanes of traffic.

Table 5.1 – Projected Traffic Volumes

Traffic Projections	Woodbine Avenue	19th Avenue	Honda Boulevard
2017 AADT	7,600	2,100	4,800
2027 AADT	9,900	2,400	7,100
2037 AADT	15,700	8,600	6,900
Truck Traffic %	13	5	5

The traffic data was used to determine the pavement damage caused by the anticipated traffic volumes over the design life of the pavement. Using axle load equivalency factors, different axle loads and axle groups are converted to a standard axle load known as an Equivalent Single Axle Load (ESAL). The Design ESALs calculation was completed in accordance with the MTO *Procedures for Estimating Traffic Loads for Pavement Designs.* Assuming an average truck factor of 2.2, the 20-year design ESALs calculated for the subject roadways are as follows:

Woodbine Avenue	10.3 Million
19th Avenue	1.6 Million
Honda Boulevard	2.1 Million

The pavement design analysis was carried out using the methodology outlined in the 1993 AASHTO "*Guide for the Design of Pavement Structures*", as modified by the Ministry's "*Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions*", and the MTO "*Pavement Design and Rehabilitation Manual*". The AASHTO procedure determines a required Structural Number that characterizes the structural capacity of the pavement layers for a given set of inputs. The following design inputs were used in the AASHTO design analysis.

- Design period = 20 years
- Initial serviceability, (Pi) = 4.5
- Terminal serviceability (Pt) = 2.5
- Reliability level (R) = 90 percent
- Overall standard deviation (So) = 0.44
- Mean soil resilient modulus (MR) = 30 MPa (Compact Sandy Silt Till)

Based on the design input parameters and calculated ESALs, a design SN (SN_{Des}) value of 143 mm is required for Woodbine Avenue and 111 to 115 mm for the other roads. The recommended pavement design thickness, based on the structural requirements, traffic projections, and subgrade conditions, is presented below.

5.1.2 Recommended Pavement Design

Based on the analysis presented above and assuming adequate drainage of the pavement materials, the pavement structure recommended for Woodbine Avenue is as follows:

HL1	50 mm
HDBC (2 lifts)	140 mm
OPSS Granular A Base	150 mm
OPSS Granular B Type I Subbase	500 mm

The minimum pavement structure specified by the City of Markham's Design Criteria for Collector and Industrial Roads is considered adequate for 19th Avenue and the internal roads:

HL3	50 mm
HL8 (2 lifts)	100 mm
OPSS Granular A Base	150 mm
50 mm Crusher Run Limestone (CRLS) Subbase	450 mm

All Hot Mix Asphalt (HMA) materials should meet the requirements of OPSS.MUNI 310, OPSS.MUNI 1150 and City of Markham/York Region Specifications as applicable, and be compacted to at least 91 percent of the MRD for HDBC and 92 percent of MRD for the other mixes. The recommended asphalt cement grade is PG 64-28 for Woodbine Avenue and 58-28 for the remaining roads, in conformance with OPSS.MUNI.1101. Aggregates for the asphalt mixes should be in accordance with OPSS.MUNI.1003. Recycled Asphalt Pavement (RAP) material should not be used in HL1 and HDBC asphalt mixes.

The new granular base and subbase material should meet the requirements of OPSS.MUNI 1010 or City of Markham/York Region specifications and be compacted to at least 100 percent of the SPMDD. All granular material should be compacted in accordance with the requirements of OPSS.MUNI 501.

Smooth transitions are required in all areas where the new pavement meets the existing asphalt surface at the intersections. All longitudinal and transverse joints should meet the requirements of OPSS.MUNI 310. All longitudinal joints should be staggered between the asphalt lifts, accomplished by offsetting the paving edge and the upper asphalt course by a minimum of 150 mm. At all transverse tie-ins to existing pavements, the top lift of asphalt should extend a minimum of 5 m in length beyond the transverse joint in the upper binder lift. A tack coat shall be utilized between all asphalt lifts, all vertical faces, and at all tie-ins to existing pavement. Tie-ins between new and existing granular material should be carried out over a distance of at least 10 m to minimize the potential for differential frost action along the road.

5.1.3 Pavement Subgrade Preparation

Pavement subgrade preparation should include removal of the pavement structure (on existing roads) and surficial vegetation, topsoil, organic or compressible material. Grading to the new top of subgrade should match or exceed the thickness of the existing pavement to maintain lateral drainage at the top of subgrade. The exposed subgrade should be compacted and proof-rolled with a heavy roller and examined to identify areas of unstable subgrade. Any soft/wet areas identified shall be subexcavated and replaced with approved material within 2% of Optimum Moisture Content (OMC), and compacted to at least 98% of Standard Proctor Maximum Dry Density (SPMDD).

Bulk fill used to raise the road grade should be constructed as engineered fill, consisting of approved inorganic material, placed in maximum 200 mm thick lifts, within 2% of OMC, and compacted to at least 98% of SPMDD. Standard side slopes of 2H:1V or flatter should be suitable for embankment construction. Exposed embankment surfaces should be provided with a vegetation cover or otherwise protected against erosion in accordance with OPSS.MUNI 804.

The top of the compacted subgrade should be graded smooth with a minimum crossfall of 3% towards side ditches or subdrains. Continuity of drainage should be maintained at transitions from existing pavement to new pavement.

5.2 Municipal Service Installation

Excavations for open cut installation of utilities will extend into compact to very dense sandy silt till. Use of a hydraulic excavator should be suitable for trench excavation within these materials. Provision should be made for handling and removal of pavement materials, possible obstructions in any fill, very dense soil, and cobbles or boulders in the till.

All temporary excavations must be carried out in accordance with the current Occupational Health and Safety Act (OHSA) of Ontario and local regulations. In general, the sandy silt till soils

are classified as Type 2. Groundwater is not expected to pose construction issues during excavation of relatively shallow trenches.

In general, groundwater was measured at depths of 0.5 to 3.1 m in the standpipe wells. Considering the borehole observations and the consistency of the soils on site, dewatering of shallow excavations should generally be feasible using sumps and pumps.

Prior to placement of pipe bedding, the base of the trench should be maintained in a dry condition, free of loose or disturbed material. The utility pipes must be placed on a uniformly competent subgrade. Pipe bedding materials, compaction and cover should follow OPSD 802.030 to 802.034, and/or City of Markham specifications.

In areas where a less competent subgrade is encountered, it may be necessary to increase the sewer bedding thickness. Any excessively soft, loose or compressible materials at the pipe subgrade should be subexcavated and replaced with OPSS Granular A material compacted to at least 95 percent of SPMDD.

Trench backfill materials should be placed and compacted as per OPSS.MUNI 401 or City of Markham specifications. Where utility trenches are located beneath the roadway, OPSS Granular A or B material, or unshrinkable fill should be employed as backfill.

Where the utility trench is located outside of the roadway, the portion of the trench above the pipe cover can be backfilled with excavated till provided it is unfrozen and free of organics, debris and other deleterious materials. The placement moisture content should be within about 2 percent of the OMC for efficient compaction, and the till must be adequately broken down and compacted in the trench.

5.3 Detailed Geotechnical Investigation

The information presented in this report is provided for preliminary design and planning purposes only. Detailed geotechnical investigation will be required to confirm the subsurface conditions and recommendations. This work should include additional boreholes along the existing and proposed roadway alignments, investigation at culvert or structure locations (if any), further assessment of dewatering requirements and the need for a PTTW or EASR registration during construction, and chemical testing to confirm the requirements for reuse or disposal of excavated material.

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STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

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All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

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The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

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5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

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The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

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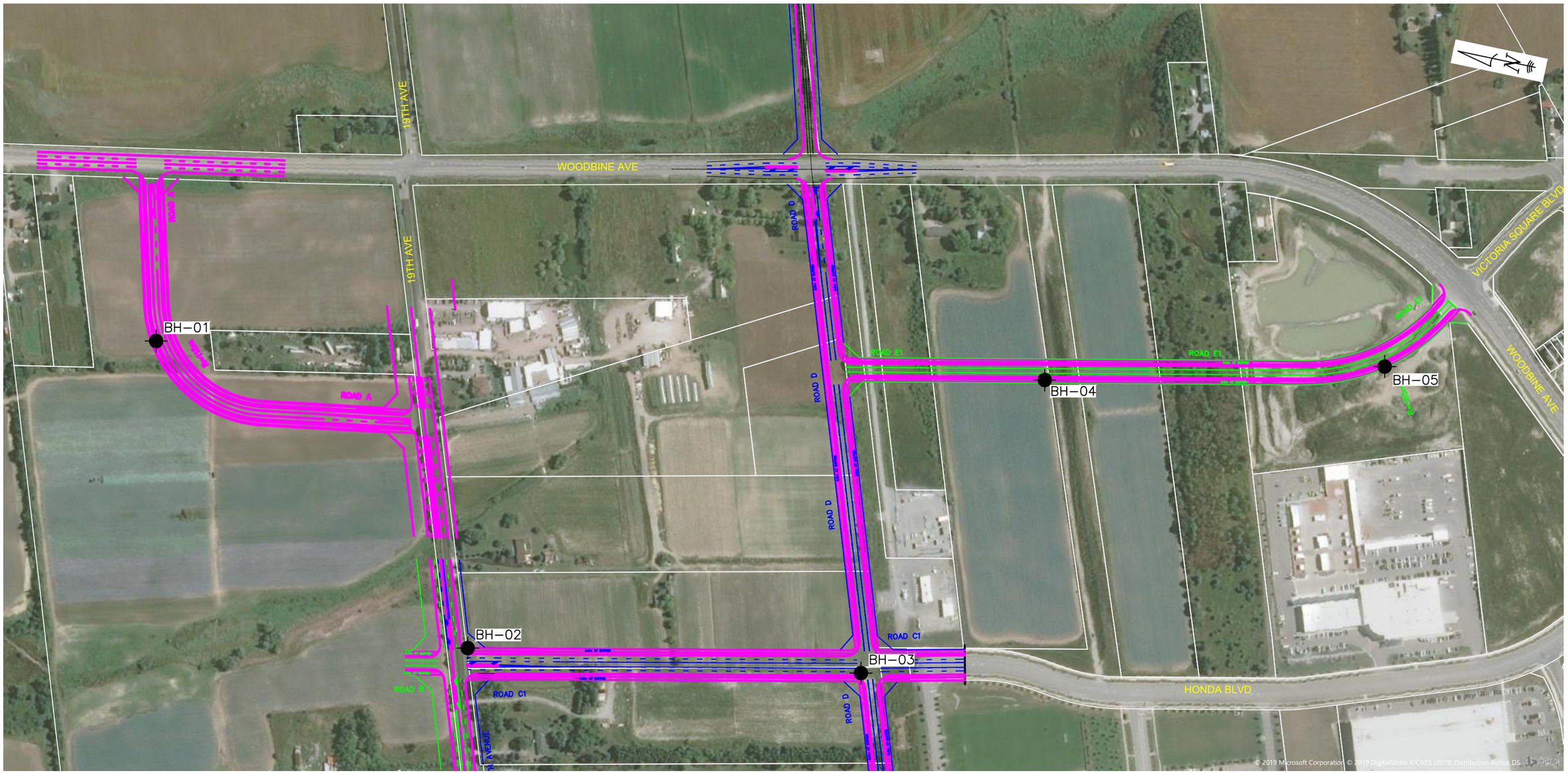
APPENDIX A

BOREHOLE LOCATION PLAN



PLAN

80 0 80 160m

SCALE 1:4000

LEGEND

BOREHOLE LOCATION

BASE PLAN PROVIDED BY

CIMA Canada Inc.

HIGHWAY 404 NORTH COLLECTOR ROADS
CITY OF MARKHAM

BOREHOLE LOCATION PLAN

JOB# 18189

THURBER ENGINEERING LTD.

ENGINEER :	DRAWN :	APPROVED :
GRL	BH	MRA
DATE :	SCALE :	DRAWING No.
SEPTEMBER	1:4000	1

FILENAME: H:\Drafting\18000\18189\TED-18189-BHPL.dwg
PLOTDATE: Sep 9, 2019 - 8:53 AM

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APPENDIX B

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

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.

RECORD OF BOREHOLE BH-01

PROJECT : Highway 404 North Collector Roads EA Study
LOCATION : Markham, ON
STARTED : July 11, 2019
COMPLETED : July 12, 2019
N 4 864 716.0 E 630 125.8

Project No. 18189
SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	COMMENTS
		GROUND SURFACE		238.86				
		TOPSOIL (300mm)		0.00				
		Sandy **SILT**, some clay to clayey, trace gravel, dense to very dense, brown, moist: (TILL)		238.56 0.30	1	SS	7	
1	Solid Stem Augers				2	SS	30	
2					3	SS	51	Grain Size Analysis: Gr 2%/ Sa 29%/ Si 59%/ Cl 10%
					4	SS	56	
3		becoming grey			5	SS	59	
4								
5					6	SS	50/ 0.125	
		END OF BOREHOLE AT 5.18m. BOREHOLE OPEN TO 3.7m UPON COMPLETION. Monitoring Well installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.		233.68 5.18				
6								
7								
8								
9								

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH: Cu, KPa
nat V - ✚ Q - ✖
rem V - ● Cpen ▲
40 80 120 160

WATER CONTENT, PERCENT
wp w wl
10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Bentonite
Filter Sand
Slotted Screen

WATER LEVEL READINGS:

DATE	DEPTH(m)	ELEV.(m)
Aug 09/19	1.15	237.71

GROUNDWATER ELEVATIONS

▽ WATER LEVEL UPON COMPLETION ▼ WATER LEVEL IN WELL/PIEZOMETER

LOGGED : GF
CHECKED : GRL

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THURBER2S TEL-18189.GPJ 3/12/20

RECORD OF BOREHOLE BH-02

PROJECT : Highway 404 North Collector Roads EA Study
LOCATION : Markham, ON
STARTED : July 11, 2019
COMPLETED : July 11, 2019
N 4 864 343.2 E 629 886.8

Project No. 18189
SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	COMMENTS	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		238.77						
	Solid Stem Augers	**TOPSOIL** (350mm)		0.00						
		Sandy **SILT**, some clay to clayey, trace gravel, compact to dense, brown, moist: (TILL)		238.41 0.36	1	SS	9			
1					2	SS	21	Grain Size Analysis: Gr 5%/ Sa 39%/ Si 46%/ Cl 10%		Bentonite
2					3	SS	38			
3					4	SS	36			Filter Sand
					5	SS	39			Slotted Screen
4										
5					6	SS	30			
		END OF BOREHOLE AT 5.18m. BOREHOLE OPEN TO 4.6m UPON COMPLETION. Monitoring Well installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.		233.59 5.18						
6										
7										
8										
9										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH: Cu, KPa
nat V - ✚ Q - ✖
rem V - ● Cpen ▲
40 80 120 160

WATER CONTENT, PERCENT
wp w wl
10 20 30 40

WATER LEVEL READINGS:

DATE	DEPTH(m)	ELEV.(m)
Aug 09/19	0.48	238.29

GROUNDWATER ELEVATIONS

▽ WATER LEVEL UPON COMPLETION ▼ WATER LEVEL IN WELL/PIEZOMETER

LOGGED : GF
CHECKED : GRL

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THURBER2S TEL-18189.GPJ 3/12/20

RECORD OF BOREHOLE BH-03

PROJECT : Highway 404 North Collector Roads EA Study
LOCATION : Markham, ON
STARTED : July 11, 2019
COMPLETED : July 11, 2019
N 4 863 948.3 E 629 944.3

Project No. 18189
SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	COMMENTS: DYNAMIC CONE PENETRATION RESISTANCE PLOT	SHEAR STRENGTH: Cu, KPa (nat V - ✚, rem V - ●, Q - ✖, Cpen ▲) / WATER CONTENT, PERCENT (wp, w, wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		240.86							
		TOPSOIL (250mm)		0.00							
		Sandy **SILT**, some clay to clayey, trace gravel, compact to very dense, brown, moist: (TILL)		0.25	1	SS	16				
1					2	SS	18				Bentonite
2	Solid Stem Augers				3	SS	25				
					4	SS	59				Filter Sand
3					5	SS	84	Grain Size Analysis: Gr 7%/ Sa 34%/ Si 43%/ Cl 16%			
		becoming grey									Slotted Screen
4											
					6	SS	73				
5				235.68							
		END OF BOREHOLE AT 5.18m. BOREHOLE OPEN TO 4.4m AND WATER LEVEL AT 3.9m UPON COMPLETION. Monitoring Well installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.		5.18							
6		WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) Aug 09/19 2.10 238.76									
7											
8											
9											

GROUNDWATER ELEVATIONS

▽ WATER LEVEL UPON COMPLETION ▼ WATER LEVEL IN WELL/PIEZOMETER

LOGGED : GF
CHECKED : GRL

THURBER

THURBER2S TEL-18189.GPJ 3/12/20

RECORD OF BOREHOLE BH-04

PROJECT : Highway 404 North Collector Roads EA Study
LOCATION : Markham, ON
STARTED : July 12, 2019
COMPLETED : July 12, 2019
N 4 863 827.5 E 630 272.9

Project No. 18189
SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	COMMENTS	SHEAR STRENGTH: Cu, KPa (nat V - ✤, rem V - ●, Q - ✖, Cpen ▲) 40 80 120 160 / WATER CONTENT, PERCENT wp w wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		236.35				DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100			
		TOPSOIL (200mm)		0.00							
		Sandy **SILT**, some clay to clayey, trace gravel, dense to very dense, brown, moist: (TILL)		0.20	1	SS	17				
1	Solid Stem Augers				2	SS	45				Bentonite
2					3	SS	78				
3					4	SS	37	Grain Size Analysis: Gr 6%/ Sa 36%/ Si 41%/ Cl 17%			Filter Sand
					5	SS	75/ 0.125				
4											Slotted Screen
		becoming grey			6	SS	79				
5				231.17							
		END OF BOREHOLE AT 5.18m. BOREHOLE OPEN TO 5.18m UPON COMPLETION. Monitoring Well installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.		5.18							
6		WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) Aug 09/19 1.38 234.97									
7											
8											
9											

GROUNDWATER ELEVATIONS

▽ WATER LEVEL UPON COMPLETION ▼ WATER LEVEL IN WELL/PIEZOMETER

LOGGED : GF
CHECKED : GRL

THURBER

THURBER2S TEL-18189.GPJ 3/12/20

RECORD OF BOREHOLE BH-05

PROJECT : Highway 404 North Collector Roads EA Study
LOCATION : Markham, ON
STARTED : July 12, 2019
COMPLETED : July 12, 2019
N 4 863 493.5 E 630 357.3

Project No. 18189
SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	COMMENTS: DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	SHEAR STRENGTH: Cu, KPa (nat V - ✚, rem V - ●, Q - ✖, Cpen ▲) (40 80 120 160) / WATER CONTENT, PERCENT (wp, w, wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		235.07							
0	Solid Stem Augers	Sandy **SILT**, some clay to clayey, trace gravel, compact to very dense, brown, moist: (TILL)			1	SS	36				
1					2	SS	20				Bentonite
2					3	SS	39	Grain Size Analysis: Gr 2%/ Sa 37%/ Si 47%/ Cl 14%			
3		becoming grey			4	SS	42				Filter Sand
					5	SS	40				Slotted Screen
4											
5				229.89	6	SS	86				
		END OF BOREHOLE AT 5.18m. BOREHOLE OPEN TO 4.4m UPON COMPLETION. Monitoring Well installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.		5.18							
6		WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) Aug 09/19 3.12 231.95									
7											
8											
9											

GROUNDWATER ELEVATIONS

▽ WATER LEVEL UPON COMPLETION ▼ WATER LEVEL IN WELL/PIEZOMETER

LOGGED : GF
CHECKED : GRL

THURBER

THURBER2S TEL-18189.GPJ 3/12/20

THURBER

APPENDIX C

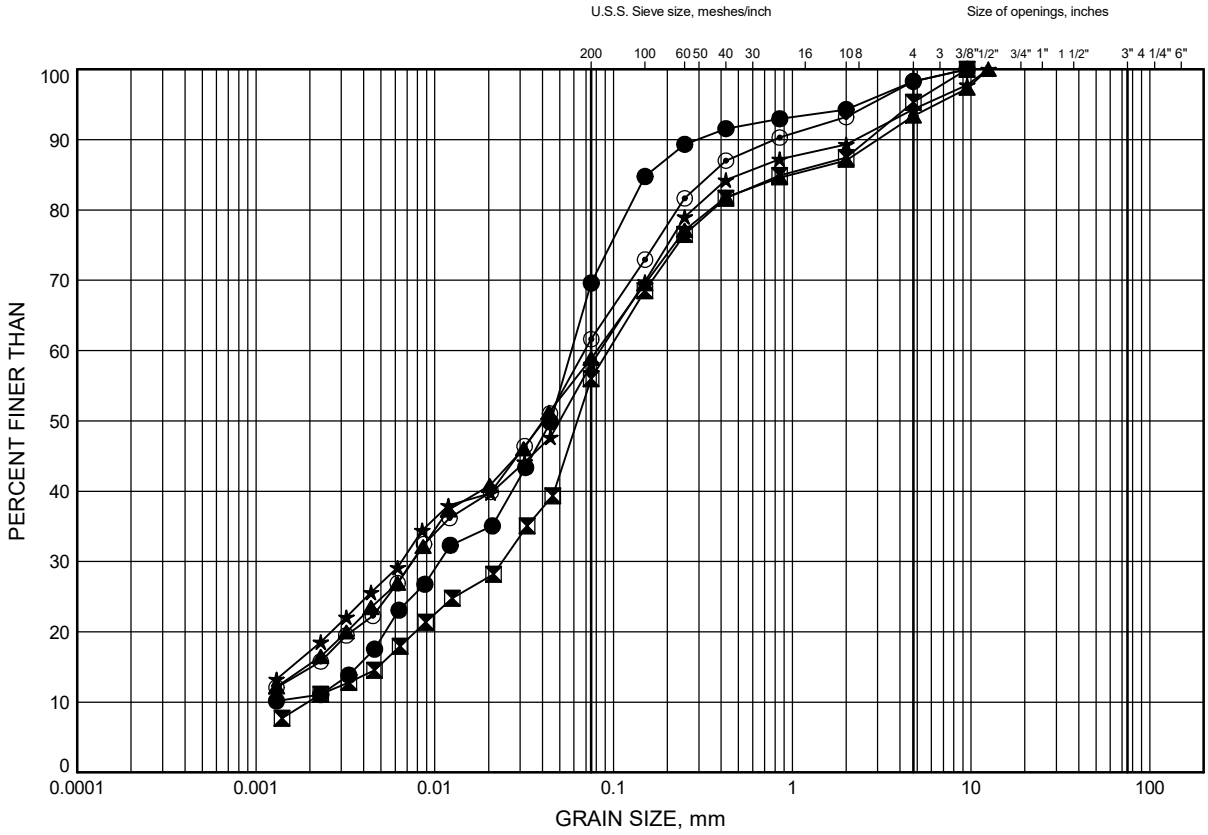
GEOTECHNICAL LABORATORY TEST RESULTS

Highway 404 North Collector Roads EA Study

GRAIN SIZE DISTRIBUTION

FIGURE C1

Sandy SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-01	1.83	237.03
⊠	BH-02	1.07	237.70
▲	BH-03	3.35	237.51
★	BH-04	2.59	233.76
⊙	BH-05	1.83	233.24

Date September 2019

Project 18189

THURBER

Prep'd BH

Chkd. GRL

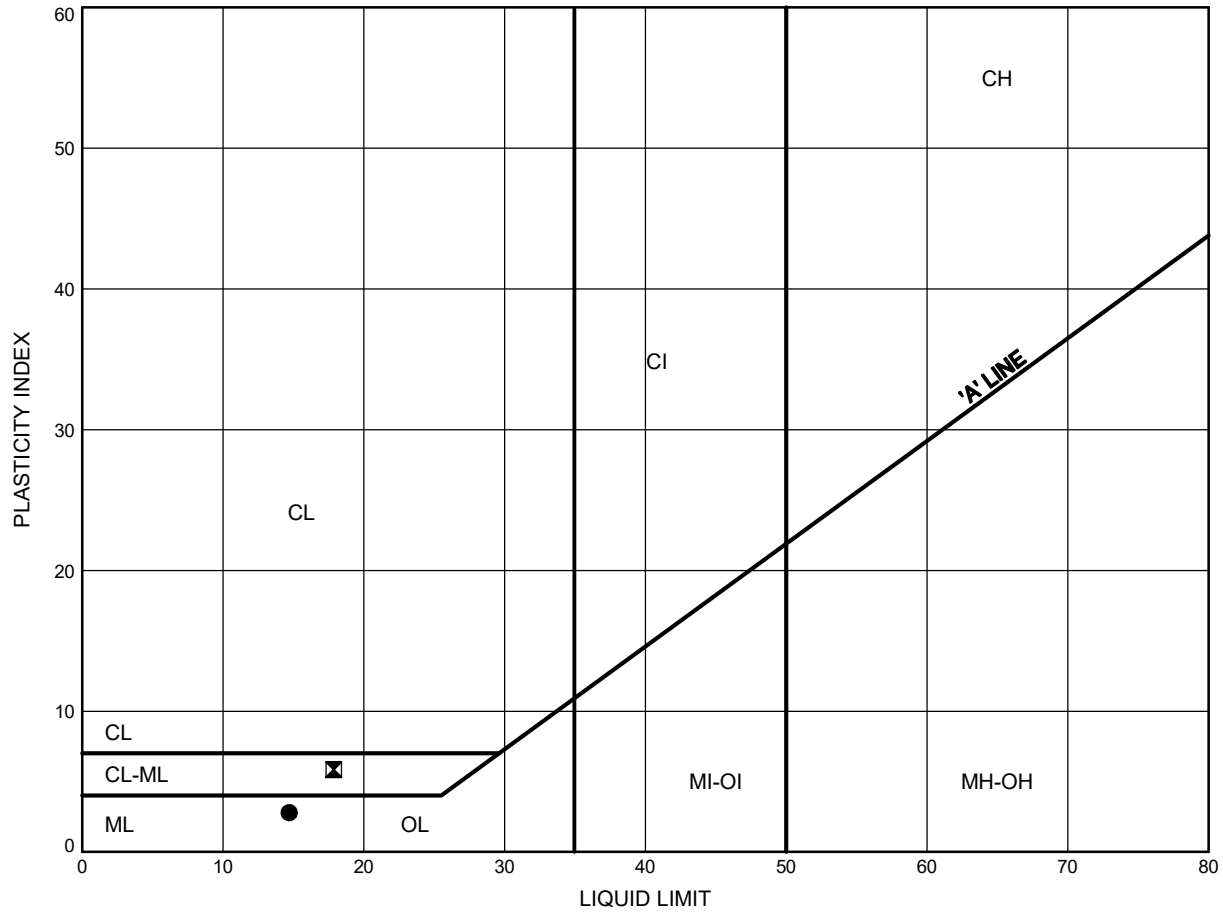
GRAIN SIZE DISTRIBUTION - THURBER TEL-18189.GPJ 9/9/19

Highway 404 North Collector Roads EA Study

ATTERBERG LIMITS TEST RESULTS

FIGURE C2

Sandy SILT TILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-02	1.07	237.70
⊠	BH-05	1.83	233.24

Date September 2019

Project 18189

THURBER

Prep'd BH

Chkd. GRL

THURBALT TEL-18189.GPJ 9/9/19