THURBER ENGINEERING LTD.

PRELIMINARY FOUNDATION INVESTIGATION REPORT
HIGHWAY 401 WIDENING, HIGHWAY 16 TO MAITLAND ROAD
HWY 416 SBL - CEDAR GROVE RD OVERPASS, SITE NO. 16X-0307
GWP 4024-20-00 / ASSIGNMENT NO. 4019-E-0010.2

Geocres No.: 31B-104

Report to:

MTO c/o AECOM Canada Ltd.

Latitude: 44.748053°
Longitude: -75.490400°

January 2023
Thurber File No.: 29381

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PART 1. FACTUAL INFORMATION

1 INTRODUCTION

Thurber Engineering Ltd. (Thurber) has been retained by AECOM Canada Ltd. (AECOM) on behalf of the Ministry of Transportation Ontario (MTO) under Assignment No. 4019-E-0010, Work Item No. 2, to carry out Foundation Investigations to support the Preliminary Design and Environmental Assessment for the widening of Highway 401 from Highway 416 to Maitland Road. The overall scope of work comprises replacement or rehabilitation of 14 existing structures, including ten bridges and four structural culverts.

This report addresses the proposed rehabilitation of Bridge Site No. 16X-0307 which supports Highway 416 southbound traffic as it passes over Cedar Grove Road before connecting to Highway 401 westbound (416N-401W). The bridge is located approximately 500 m northeast of the ramp's termination at Highway 401, near the town of Prescott, Ontario.

This section of the report presents the factual findings obtained from a foundation investigation completed at the site, as well as data from existing subsurface information pertinent to the site, obtained from the MTO's Foundation Library and included:

- Report prepared by Jacques, Whitford Limited titled, "*Report on Foundation Investigation for W.P. 374-89-03, Site 16-307, Ramp N-W Over Cedar Grove Road, Highway 401-416 Interchange, District 9, Ottawa"*, dated March, 1992 (Geocres No. 31B-75).

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions influencing design and rehabilitation of the structure was developed during the current investigation.

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 SITE DESCRIPTION

Cedar Grove Road is roughly oriented east-west and the bridge is oriented roughly northeast to southwest. For project purposes, Cedar Grove Road and the 416N-401W ramp bridge are herein described as oriented east-west and north-south, respectively.

The land adjacent to the site typically consists of forested lands and agricultural fields. A Trans-Northern Pipelines Inc. pipeline junction is located immediately southeast of the bridge. The terrain is relatively flat apart from the existing highway embankment and associated drainage ditches. Cedar Grove Road in this area consists of a two-lane local roadway, and the 416N-401W ramp consists of two southbound travelled lanes with paved shoulders. The bridge was constructed under Contract 97-68 and is a single span structure with a length of 35 m and a width of 12.5 m.

The embankment side slopes on the original design drawings (Sheet 159) were to be sloped at approximately 2H:1V except for the southwest embankment which is indicated to be at 1.5H:1V and includes a note indicating rock backfill at abutments. The forward slopes are also indicted to be at 1.5H:1V and incorporate rockfill as well as concrete slope paving.

The side slopes were observed during the current field investigation and were generally grass-covered, with bushes and small trees growing around the abutments. Rockfill material was exposed on the upper portions of the west slope of both the north and south approaches (see Photos 1 and 7 in Appendix D). At the time of the field work, the side slopes appeared to be 2H:1V in all quadrants and did not show any visible signs of distress or other performance issues. Steel beam guiderails are present along the approaches and abut the concrete barrier walls along the bridge.

Based on published geological information in *The Physiography of Southern Ontario* by Chapman and Putnam (1984), the site lies on the border of the physiographic regions known as the Smith's Falls Limestone Plain and the Glengarry Till Plain.

The Smith's Falls Limestone Plain is characterized by typically shallow but including a few localized deep areas of highly variable soils consisting of clays, sands, and gravels. The Glengarry Till Plain is characterized by an undulating surface consisting of morainic ridges and intervening clay flats and swamps, overlying till and similar glaciofluvial deposits containing many cobbles and boulders. Both areas are known to be underlain by limestone and sandstone bedrock.

Photographs showing the existing conditions at the site at the time of the field investigation are included in Appendix D for reference.

3 SITE INVESTIGATIONS AND FIELD TESTING

The original foundation investigation for design of the bridge was carried out in May 1991, prior to its construction. The current investigation was carried out in April/May 2021 to collect additional

subsurface information near the bridge abutments and through the existing embankments. Summaries of the investigations are provided in the following sections.

3.1 Original (1991) Investigation

A total of four boreholes were put down at the site as part of the original investigation. Boreholes 91-1 to 91-4 were put down at the proposed approach embankment and foundation element locations between May 3 and 6, 1991. Boreholes 91-2 and 91-3 were put down near the now-constructed north and south abutments. Boreholes 91-1 and 91-4 were put down beyond the limits of the current study and will not be discussed herein.

Boreholes 91-2 and 91-3 were advanced to depths of 10.7 m and 10.2 m below the existing ground surface at the time of the investigation (prior to construction of the bridge). A standpipe piezometer or monitoring well was installed in each of Boreholes 91-2 and 91-3.

The northing, easting and elevation of the boreholes used in this investigation are shown on the Borehole Location and Soil Strata Drawing No. 1 in Appendix A and in Table 3-1, below. The site is located within MTM Zone 9. Note that the borehole locations were originally surveyed relative to NAD27 horizontal datum and have been converted relative to NAD83 in the drawing, on the Record of Borehole Sheets (where appropriate), and in Table 3-1, below.

Table 3-1: Borehole Summary

Borehole No.	Drilled Location	Northing[1] (Latitude)	Easting[1] (Longitude)	Ground Surface[2] Elevation (m)	Termination Depth (m)
91-2	North Abutment	4 956 966.7 (44.748233)	384 745.4 (-75.490375)	86.3	10.7
92-3	South Abutment	4 956 926.8 (44.747875)	384 742.2 (-75.490422)	86.4	10.2

Notes: 1) Boreholes were surveyed relative to NAD27; coordinates listed above were converted relative to NAD83.
2) Boreholes were put down prior to construction of the existing approach embankment and foundation.

3.2 Current (2021) Investigation

The current site investigation was carried out on April 26 to 27, 2021. Two boreholes were put down at the bridge site: one near the north abutment (Borehole 307-21-1) and one near the south abutment (Borehole 307-21-2).

The locations of the 2021 boreholes were surveyed by Thurber for both location and elevation with a Trimble Catalyst DA1 antenna with centimeter accuracy. The northing, easting and elevation of the boreholes are shown on the Borehole Location and Soil Strata Drawing No. 1 in Appendix A, the individual Record of Borehole sheets in Appendix B.1, and in Table 3-2 below.

Table 3-2: Borehole Summary

Borehole No.	Drilled Location	Northing (Latitude)	Easting (Longitude)	Ground Surface Elevation (m)	Termination Depth (m)
307-21-1	North Abutment	4 956 968.2 (44.748254)	384 746.3 (-75.490366)	94.3	19.0
307-21-2	South Abutment	4 956 917.5 (44.747799)	384 731.6 (-75.490560)	93.8	18.7

The current investigation was carried out using a truck-mounted CME 55 drill rig equipped with hollow-stem augers and rotary diamond drilling equipment.

Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). The boreholes were advanced approximately 3 m into bedrock, with NQ sized coring equipment.

A monitoring well, 19 mm in diameter, was installed in Borehole 307-21-2 and finished with a flushmount cover at the road surface. The installation details are illustrated on the respective Record of Borehole sheets provided in Appendix B.1. Borehole 307-21-1 was backfilled in accordance with MOE requirements (O.Reg 903, as amended).

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

4 LABORATORY TESTING

Geotechnical laboratory testing carried out as part of the current investigation included natural moisture content determination and visual identification of all retained soil samples. Testing for grain size distribution and Atterberg Limits was also carried out on selected samples to MTO and ASTM standards. All rock cores were photographed and their total core recovery (TCR), solid core recovery (SCR) and rock quality designation (RQD) were measured. One Unconfined Compressive Strength (UCS) test was conducted on a recovered core sample from Borehole 307-21-1.

Laboratory testing carried out as part of the 1992 investigation on selected soil samples included grain size distribution, Atterberg limit determination, and a one-dimensional consolidation test.

The results of the geotechnical tests are summarized on the Record of Borehole sheets included in Appendix B and are presented on the figures included in Appendix C.

5 GENERAL DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix B and the Borehole Location and Soil Strata Drawing included in

Appendix A. A general description of the stratigraphy based on the conditions encountered in the boreholes is given in the following sections. However, the factual data presented on the Borehole Records takes precedence over the Soil Strata Drawing and the general description. It must be recognized that the soil and groundwater conditions may vary between and beyond borehole locations. Soil classification for the 2021 boreholes is in accordance with ASTM D2487. Descriptions of cohesive soils and secondary components of all deposits from the 2021 boreholes are described as outlined in the MTO Guideline for Foundation Engineering Services manual (October 2020). Terminology from the historic Geocres information may vary from current.

In general, the subsurface conditions consist of pavement structure and fill over silty clay to clay, which is underlain by a deposit of glacial till consisting of silty sand to sandy clayey silt. The overburden is underlain by interbedded dolostone and sandstone bedrock.

The surficial topsoil and very loose sand deposits in Boreholes 91-2 and 91-3 would have likely been disturbed, altered, or completely removed during the construction of the 416N-401W ramp and bridge structure; these layers are not included in the following descriptions.

5.1 Pavement Structure and Embankment Fill

The 2021 boreholes were advanced through the pavement structure of the 416N-401W ramp. The pavement structure encountered consisted of asphaltic concrete over granular fill. The asphalt ranged in thickness from 200 to 275 mm. A granular embankment fill layer consisting of gravel and sand, trace to some fines to sandy gravel, some silt to silty sand, some gravel was encountered beneath the asphalt in Boreholes 307-21-1 and 307-21-2. The granular embankment fill encountered was 8.9 m and 6.7 m thick with underside elevations of 85.2 m to 86.8 m near the north and south abutments, respectively.

SPTs conducted in the fill gave N-values of 3 blows to greater than 100 blows for 125 mm of penetration, but generally between about 15 and 45 blows per 0.3 m of penetration indicating a compact to dense relative density. It is noted that neither of the 2021 boreholes encountered rock fill. The higher blow counts observed in the boreholes may represent cobbles or a boulder within the fill rather than the relative density of the soil matrix.

The moisture content of the tested embankment fill samples ranged from 1 to 20%. The results of grain size analyses conducted on three samples of the embankment fill are summarized below and are illustrated on Figure C1 in Appendix C.1.

Summary of Grain Size Distribution Testing – Embankment Fill

Soil Particle	Percentage (%)
Gravel	11 – 59
Sand	33 – 70
Silt and Clay	8 – 19

5.2 Silty Sand

A deposit of silty sand was encountered beneath the fill in Borehole 307-21-2. Organics were encountered within the deposit. The layer was approximately 1.2 m thick with a base elevation of 85.6 m.

One SPT carried out in this layer gave an N-value of 21 blows per 0.3 m of penetration, indicating a compact relative density. The sample of the silty sand had a moisture content of 16%.

5.3 Silty Clay to Clay

A native, cohesive deposit ranging in composition from silty clay to clay was encountered below the fill in Borehole 307-21-1, below the silty sand in Borehole 307-21-2, and within 200 mm of the existing ground surface in Boreholes 91-2 and 91-3 at the time of drilling. The silty clay deposit has a thickness of 3.4 m and 6.0 m, with a base elevation of 80.1 to 81.8 m.

The upper portion of the clay has generally been weathered to a grey-brown crust. SPTs conducted in the weathered crust gave N-values ranging from 9 to 17 blows for 0.3 m of penetration. Two field vane tests carried out within the lower portion of the weathered crust in Borehole 91-3 gave undrained shear strengths of approximately 230 kPa to greater than 240 kPa. These in-situ test results indicate a hard consistency. Remolded field vane testing indicates that the weathered crust has a high sensitivity. Recorded moisture contents of the weathered crust ranged from 26 to 31%.

Unweathered grey clay was encountered beneath the weathered crust in all boreholes drilled during the investigations. SPTs conducted in the grey clay gave N-values ranging from 7 to 13 blows for 0.3 m of penetration. Field vane testing carried out in 1991 in the grey clay gave undrained shear strength values ranging from 130 kPa to greater than 240 kPa, indicating a very stiff to hard consistency. Remolded field vane testing indicates that the clay is of medium to high sensitivity. Recorded moisture contents of the grey clay ranged from 22 to 33%.

The results of two grain size analysis tests conducted on the weathered crust and one grain size analysis on the grey clay are summarized below and are illustrated on Figure C2 in Appendix C.1 and Figure 1 in Appendix C.2, respectively.

Summary of Grain Size Distribution Testing – Silty Clay to Clay

Soil Particle	Percentage (%)
Gravel	0
Sand	0 – 3
Silt	38 – 41
Clay	56 – 62

The results of the Atterberg Limits testing carried out on two samples of the weathered crust and one sample of the grey clay are summarized below and are illustrated on Figure C3 in Appendix C.1 and Figure 2 in Appendix C.2, respectively. The laboratory results indicate that the material is generally a clay of intermediate plasticity (CI) to high plasticity (CH).

Summary of Atterberg Limit Testing – Silty Clay to Clay

Parameter	Value
Liquid Limit	47 – 51
Plastic Limit	20 – 22
Plasticity Index	25 – 30

One laboratory oedometer (one-dimensional consolidation) test was carried out on a relatively undisturbed clay sample obtained during the 1991 investigation with a thin-walled tube sampler. The results of that testing are presented on Figure 3 in Appendix C.2 and indicate a material with and over-consolidation ratio (OCR) in excess of 13 .

5.4 Till: Sandy Clayey Silt to Sandy Silt to Silty Sand

A glacial till deposit of sandy clayey silt to sandy silt to silty sand with varying amounts of gravel was present beneath the silty clay to clay deposit in all boreholes. Occasional to frequent cobbles and boulders were noted in the till in all boreholes. The thickness of the glacial till deposit ranged from 2.2 to 3.2 m and the underside of this layer ranged from elevation 77.9 to 78.6 m.

SPTs conducted in this layer gave N-values ranging from 15 to 69 blows for 0.3 m of penetration indicating a compact to very dense relative density.

The moisture content of this unit ranged from 7 to 18%. The results of grain size distribution testing carried out on three samples of the till are summarized below and are illustrated on Figure C4 in Appendix C.1 and Figure 4 in Appendix C.2.

Summary of Grain Size Distribution Testing – Glacial Till

Soil Particle	Percentage (%)	
Gravel	7 – 13	
Sand	22 – 41	
Silt	50 - 65	42 – 48
Clay		8 – 17

The results of Atterberg Limits testing carried out on the fines of two samples of this material are summarized below and are illustrated on Figure C5 in Appendix C.1 and Figure 5 in Appendix C.2. The laboratory results indicate that the fines are non-plastic (ML) to low plasticity (CL-ML).

Summary of Atterberg Limit Testing – Glacial Till Fines

Parameter	Value
Liquid Limit	17
Plastic Limit	13 – 14
Plasticity Index	3 – 4

5.5 Bedrock

Bedrock was proven by coring in all boreholes. The bedrock encountered consisted of fresh to slightly weathered, fine to coarse grained, very strong, interbedded dolostone and sandstone encountered at elevations ranging from 77.9 to 78.6 m. The 1991 investigation described the bedrock as dolomitic limestone. Quartz vugs were present in Borehole 307-21-2. Photographs of the bedrock core from the current investigation are provided in Appendix C. The following table summarizes the rock core quality:

Summary of Rock Core Quality

Parameter	Range	Average
Total Core Recovery (TCR), %	97 – 100	99
Solid Core Recovery (SCR), %	65 – 98	86
Rock Quality Designation (RQD), %	53 – 97	80
Fracture Index	0 to >10	-

Based on the average RQD value, the bedrock is classified as good quality. It is noted that vertical fractures were observed in the core recovered from Borehole 307-21-1. Unconfined compressive strength (UCS) testing was carried out on one sample of the bedrock from Borehole 307-21-1. The result of 162 MPa indicates a very strong rock, and is included in Appendix C. A summary of the bedrock surface information is provided in Table 5-1, below:

Table 5-1: Summary of Bedrock Depth/Elevation

Borehole No.	Depth to Bedrock Surface (mbgs)	Bedrock Surface Elevation (m)
307-21-1	15.7	78.6
307-21-2	15.9	77.9
91-2	7.9[1]	78.4
91-3	8.4[1]	78.0

Note: 1) The 1991 boreholes were put down prior to construction of the existing approach embankments and foundations and the ground surface at the time of the investigation was lower than the current ground elevation.

5.6 Groundwater

The groundwater levels measured in the monitoring well and standpipe piezometers installed during the current and the 1991 field investigations are presented in Table 5-2.

These observations are considered short term and it should be noted that the groundwater level may vary with season and fluctuations of the groundwater level are to be expected. In particular, the groundwater may be at a higher elevation after periods of significant and/or prolonged precipitation.

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Table 5-2: Summary of Groundwater Levels

Borehole No.	Bottom of Screen Elevation (m)	Screened Unit	Depth (mbgs)	Groundwater Elevation (m)	Date of Measurement
307-21-2	78.7	Silty Clay/ Glacial Till	7.8	86.0	2021/07/01
			2.0[1]	91.8[1]	2022/12/19
91-2	81.6	Silty Clay	0.5	85.8	1991/06/25
	78.4	Glacial Till	0.5	85.8	1991/06/25
91-3	78.2	Silty Clay/ Glacial Till	0.5	85.9	1991/06/25

Note: 1) Measured groundwater level may be a result of ice blockage due to frozen surficial inflow and is not considered to be representative of typical conditions at the site. Consideration may be given to carrying out additional groundwater level measurements during subsequent stages of design.

6 MISCELLANEOUS

It is noted that the conditions reported on the 1991 borehole records may not reflect current conditions due to construction or other activities in the area subsequent to those investigations.

The 2021 borehole location was selected by Thurber relative to existing site features. The as-drilled location and ground surface elevation of the borehole was surveyed by Thurber following completion of the field program. The elevation survey of the boreholes was carried out with reference to geodetic elevation benchmarks provided by the MTO.

Eastern Ontario Diamond Drilling of Hawkesbury, Ontario supplied and operated the drilling equipment and carried out the drilling, soil sampling, in-situ testing, piezometer installation and borehole decommissioning. The field investigation was supervised on a full-time basis by Jamil Pirani, EIT, of Thurber.

Routine geotechnical laboratory testing was completed by Thurber's laboratory in Ottawa, Ontario. Unconfined compressive strength testing of the bedrock was carried out by Stantec's laboratory in Ottawa.

Overall project management and direction of the field investigation was provided by Matt Kennedy, P.Eng. Interpretation of the factual data and preparation of this report was carried out by Sarah Harrold, EIT and Matt Kennedy, P.Eng. The report was reviewed by Paul Carnaffan, P.Eng. and Fred Griffiths, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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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.

2. COMPLETE REPORT

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.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

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.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

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.

7. INDEPENDENT JUDGEMENTS OF CLIENT

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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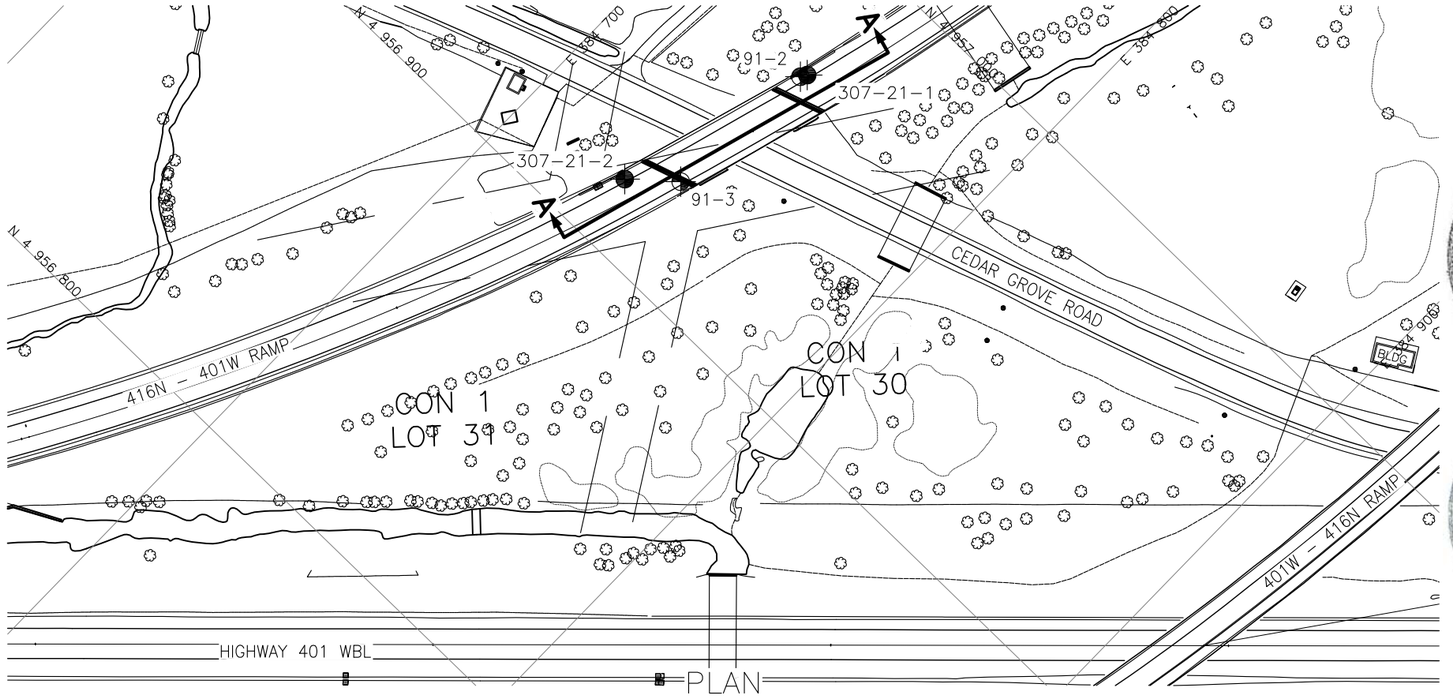
Appendix A.

Borehole Location Plan and Stratigraphic Drawings

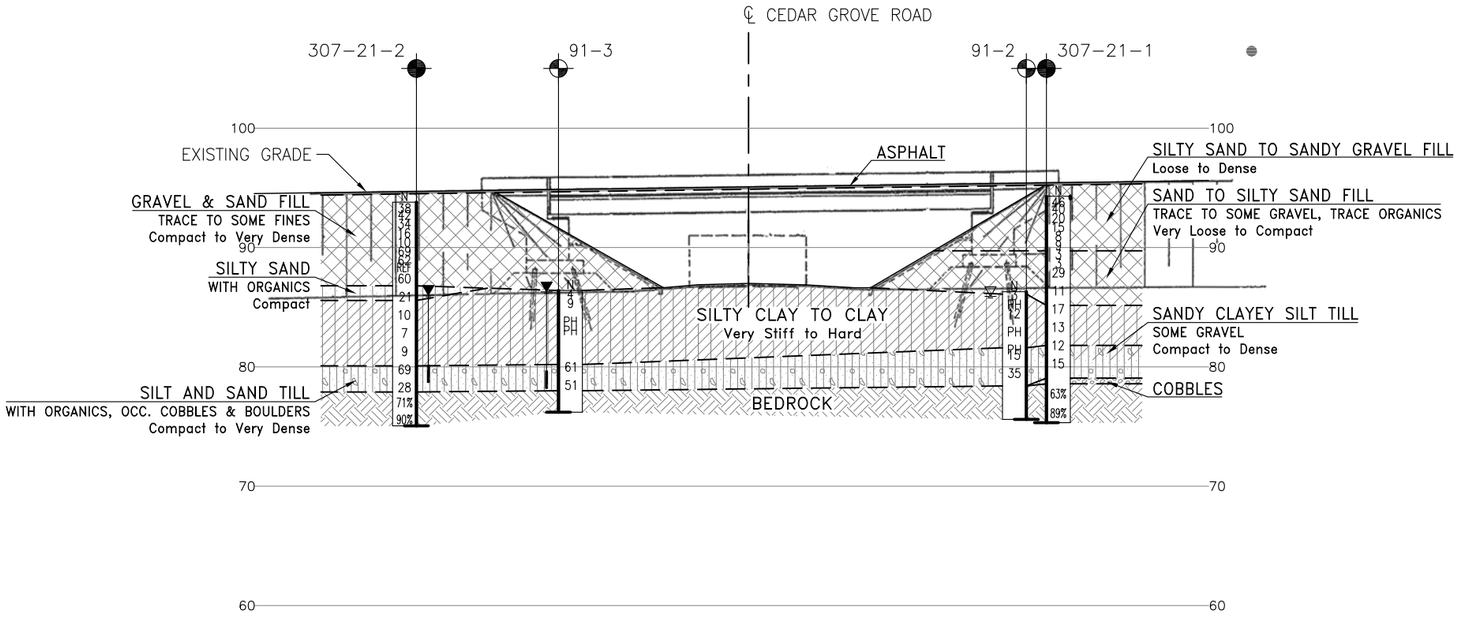
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

30 0 30 60m

SCALE 1:1500



SECTION A–A

10 0 10 20m H 1:500

4 0 4 8m V 1:200

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

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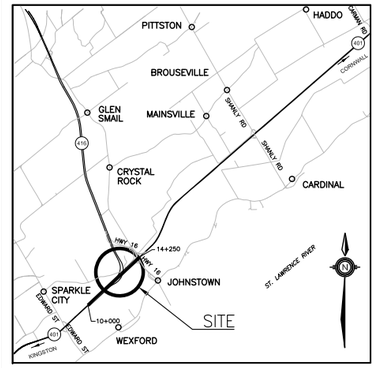
CONT No
GWP No 4024-20-00

SHEET

HIGHWAY 401
416N – 401W RAMP
BRIDGE OVER CEDAR GROVE RD
BOREHOLE LOCATIONS AND SOIL STRATA

Ontario

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⊕	Borehole (Current Investigation)
⊕	Borehole (Previous Investigation)
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
307-21-1	94.3	4 956 968.2	384 746.3
307-21-2	93.8	4 956 917.5	384 731.6
91-2	86.3	4 956 966.7	384 745.4
91-3	86.4	4 956 926.8	384 742.2

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 9.

GEOCRES No. 31B-104

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	MJK	CHK –	CODE	LOAD	DATE JAN 2023
DRAWN	MFA	CHK MK	SITE 16–307	STRUCT	DWG 1

FILENAME: H:\Drafting\29000\29381\TED-29381-BHPP(16-307).dwg
PLOTDATE: 1/23/2023 11:50 PM

THURBER

Appendix B.

Record of Borehole Sheets

THURBER

Appendix B.1

Current (2021) Investigation

THURBER

SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in sizes from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services)

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	> 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	< 2 mm in thickness

RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

N-VALUE:

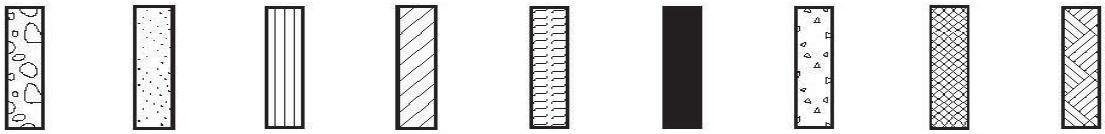
Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, the number of blows are reported over the sampler penetration in millimetres (e.g. 50/75).

DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an “A” size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.

THURBER

STRATA PLOT:
Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders
Cobbles
Gravel

Sand

Silt

Clay

Organics

Asphalt

Concrete

Fill

Bedrock

TEXTURING CLASSIFICATION OF SOILS

Classification	Particle Size
Boulders	Greater than 200 mm
Cobbles	75 – 200 mm
Gravel	4.75 – 75 mm
Sand	0.075 – 4.75 mm
Silt	0.002 – 0.075 mm
Clay	Less than 0.002 mm

TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	12 or less
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

SAMPLE TYPES

SS	Split spoon samples
ST	Shelby tube or thin wall tube
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ etc.	Rock core sample obtained with the use of standard size diamond coring equipment

TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

Descriptive Term	SPT "N" Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50

THURBER

MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	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	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, 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.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note - W_L= Liquid Limit

THURBER

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock materials.
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 structures are preserved.

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 0.1 m in length or larger, as a percentage of total core length
Unconfined Compressive Strength: (UCS)	Axial stress required to break the specimen.
Fracture Index: (FI)	Frequency of natural fractures per 0.3 m of core run.

DISCONTINUITY SPACING

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

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)
Extremely Strong	Greater than 250
Very Strong	100 – 250
Strong	50 – 100
Medium Strong	25 – 50
Weak	5 – 25
Very Weak	1 – 5
Extremely Weak	0.25 – 1

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 307-21-1 1 OF 2 METRIC

GWP# 4024-20-00 LOCATION Lat: 44.748254°, Long: -75.490366° N 4 956 968.2 E 384 746.3 ORIGINATED BY JP

HWY 401 BOREHOLE TYPE CME 55 Truckmount, HSA/NQ Coring COMPILED BY SH

DATUM Geodetic DATE 2021.04.26 - 2021.04.27 CHECKED BY MJK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
94.3											
0.0	**ASPHALT (200 mm)**										
0.2	SILTY SAND, some gravel to SANDY GRAVEL, some silt Brown Loose to dense **FILL**		1	SS	46		94				
			2	SS	40						
							93				
			3	SS	20						59 33 8 (SI+CL)
							92				
			4	SS	15						
							91				
			5	SS	8						
			6	SS	9		90				
89.7											
4.6	SAND, some silt to SILTY SAND, trace to some gravel No to trace organics Brown to brown with black Very loose to compact **FILL**		7	SS	3						11 70 19 (SI+CL)
			8	SS	3		89				
			9	SS	29		88				
							87				
			10	SS	11						
							86				
85.2											
9.1	**SILTY CLAY** to **CLAY** Grey-brown Hard **WEATHERED CRUST**		11	SS	17		85				

DOUBLE LINE 29381 BOREHOLE LOGS REHAB SITES.GPJ 2012TEMPLATE(MTO).GDT 12-23-22

Continued Next Page

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

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 307-21-1 2 OF 2 METRIC

GWP# 4024-20-00 LOCATION Lat: 44.748254°, Long: -75.490366° N 4 956 968.2 E 384 746.3 ORIGINATED BY JP

HWY 401 BOREHOLE TYPE CME 55 Truckmount, HSA/NQ Coring COMPILED BY SH

DATUM Geodetic DATE 2021.04.26 - 2021.04.27 CHECKED BY MJK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
83.6	**SILTY CLAY** to **CLAY** Grey-brown Hard **WEATHERED CRUST**						84				
10.7	**SILTY CLAY** to **CLAY** Grey Very stiff		12	SS	13		83				0 0 38 62
81.8			13	SS	12		82				
12.5	**SANDY CLAYEY SILT**, some gravel Grey Compact **GLACIAL TILL**						81				13 22 48 17
80.6											
13.7	**SILTY SAND**, trace gravel Grey Compact **GLACIAL TILL**		14	SS	15		80				9 41 42 8
78.6	- frequent cobbles below 15.2 m depth						79				
15.7	Interbedded **DOLOSTONE and SANDSTONE** Fresh to slightly weathered Grey Fine to coarse grained Very strong Slightly weathered and vertical fracture from 16.3 to 16.8 m		1	RUN			78			FI 1 1 4 2 4	RUN #1 TCR=100% SCR=65% RQD=63% UCS = 162 MPa
	Fractured from 17.1 to 17.5 m		2	RUN			77			>10 0 0 2 1	RUN #2 TCR=100% SCR=92% RQD=89%
75.3							76			0	
19.0	End of Borehole										

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

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

DOUBLE LINE 29381 BOREHOLE LOGS REHAB SITES.GPJ 2012TEMPLATE(MTO).GDT 12-23-22

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 307-21-2 1 OF 2 METRIC

GWP# 4024-20-00 LOCATION Lat: 44.747799°, Long: -75.49056° N 4 956 917.5 E 384 731.6 ORIGINATED BY JP

HWY 401 BOREHOLE TYPE CME 55 Truckmount, HSA/NQ Coring COMPILED BY SH

DATUM Geodetic DATE 2021.04.27 - 2021.04.27 CHECKED BY MJK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
93.8											
0.0 / 93.5	**ASPHALT (275 mm)**										
0.3	GRAVEL and SAND, trace to some fines Grey-brown to brown Compact to very dense **FILL**		1	SS	38		93				
			2	SS	42						
			3	SS	34		92				
			4	SS	16		91				
			5	SS	10						45 46 9 (SI+CL)
			6	SS	69		90				
			7	SS	62		89				
			8	SS	REF						
			9	SS	60		88				
86.8							87				
7.0	**SILTY SAND** with organics Brown Compact		10	SS	21	▼	86				
85.6											
8.2	**SILTY CLAY** Grey-brown Very stiff **WEATHERED CRUST**						85				
			11	SS	10						0 3 41 56
							84				

Continued Next Page

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

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

DOUBLE LINE 29381 BOREHOLE LOGS REHAB SITES.GPJ 2012TEMPLATE(MTO).GDT 12-23-22

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 307-21-2 2 OF 2 METRIC

GWP# 4024-20-00 LOCATION Lat: 44.747799°, Long: -75.49056° N 4 956 917.5 E 384 731.6 ORIGINATED BY JP

HWY 401 BOREHOLE TYPE CME 55 Truckmount, HSA/NQ Coring COMPILED BY SH

DATUM Geodetic DATE 2021.04.27 - 2021.04.27 CHECKED BY MJK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
83.1	**SILTY CLAY** Grey-brown Very stiff **WEATHERED CRUST**						83		○		
10.7	**SILTY CLAY** Grey Very stiff		12	SS	7		82				
			13	SS	9		81		○		
80.1							80				
13.7	**SILTY SAND** Grey Compact to very dense Occasional cobbles/boulders **GLACIAL TILL**		14	SS	69		79		○		
			15	SS	28		78		○		
77.9										FI	
15.9	**DOLOSTONE** with quartz vugs Fresh Grey Fine Grained		1	RUN			77			3 1 4 3 1 1	RUN #1 TCR=97% SCR=91% RQD=71%
			2	RUN			76			1 0 1	RUN #2 TCR=98% SCR=98% RQD=90%
75.1										1	
18.7	End of Borehole Flushmount 19 mm diameter PVC monitoring well installed. Well Readings: Date: Depth (m): Elev. (m): 2021/07/01 7.8 86.0 2022/12/19 2.0 91.8										

+ ³, × ³: Numbers refer to Sensitivity

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

DOUBLE LINE 29381 BOREHOLE LOGS REHAB SITES.GPJ 2012TEMPLATE(MTO).GDT 12-23-22

THURBER

Appendix B.2

Previous (1991/1992) Investigation

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 91-2 METRIC

W P 374-89-03 LOCATION Co-ords: N: 4 956 966.7 E: 384 745.4 ORIGINATED BY Y.L.
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, N-Casing, Rock Coring COMPILED BY C.K.K.
DATUM Geodetic DATE May 3, 1991 CHECKED BY G.J.K.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
86.3	Ground Surface						
	Topsoil						
0.2	Sand, trace silt		1	SS	3	Seal	86
0.4	Silty Clay Very Stiff to Hard					June 25, 1991	
			2	TW	PH	Native Material	85
			3	SS	12		
	Brown / Grey						84
						Seal	
			4	TW	PH	Sand Backfill	83
						Piezometer	
81.6							82
4.7	Het. Mixture of Sandy Silt, some clay and gravel, occ. boulders (Glacial Till) Compact to Dense Grey		5	TW	PH	Seal	
			6	SS	15	Native Material	81
						Seal	
						Sand Backfill	80
			7	SS	35		
78.4						Piezometer	79
7.9	Bedrock Dolomitic Limestone Fair to Excellent		8	NQ RC	REC 100%	Native Material	78
							77
			9	NQ RC	REC 100%		
75.6							76
10.7	End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPo
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
40 80 120 160 200

PLASTIC LIMIT Wp | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

0 1 40 59

RQD = 53%

RQD = 97%

OFFICE REPORT ON SOIL EXPLORATION

$+^3$, $\times^5$: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 91-3 METRIC

W P 374-89-03 LOCATION Co-ords: N: 4 956 926.8 E: 384 742.2 ORIGINATED BY Y.L.

DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, N-Casing, Rock Coring COMPILED BY C.K.K.

DATUM Geodetic DATE May 3, 1991 CHECKED BY G.J.K.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
86.4	Ground Surface										
86.2	Topsoil					Seal	86				
0.2	Silty Clay Very Stiff to Hard		1	SS	4						
						June 25, 1991					
			2	SS	9		85				
	Brown					Native Material					
	Grey		3	TW	PH		84				
			4	TW	PH		83			18.8	
						Seal					
						Sand Backfill	82				
							81				
80.2											
6.2	Het. Mixture of Sandy Silt, some clay and gravel, occ. boulders (Glacial Till) Very Dense Grey		5	SS	61	Monitoring Well	80		OH		7 35 (58)
							79				
78.0			6	SS	51						
8.4	Bedrock Dolomitic Limestone Good to Excellent		7	NQ RC	REC 98%	Seal	78				RQD = 86%
			8	NQ RC	REC 100%		77				RQD = 93%
76.2											
10.2	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20 10 ◇ 5 (%) STRAIN AT FAILURE

THURBER

Appendix C.

Laboratory Testing

THURBER

Appendix C.1

Particle Size Analysis Figures (2021)

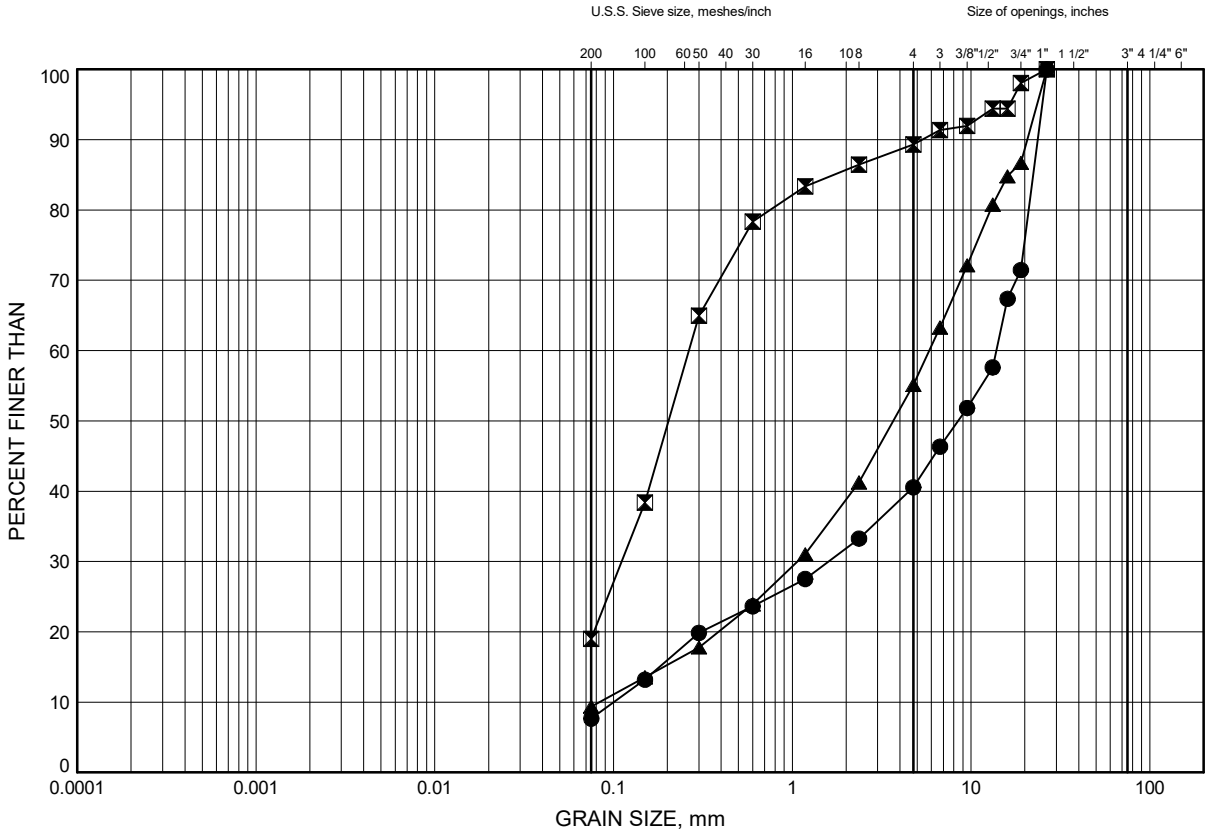
Atterberg Limit Test Results (2021)

Hwy 416 Cedar Grove Road Overpass SBL (Site No. 16X-0307)

GRAIN SIZE DISTRIBUTION

FIGURE C1

EMBANKMENT FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	307-21-1	1.8	92.5
⊠	307-21-1	4.9	89.5
▲	307-21-2	3.6	90.2

Date November 2021

WP# 4024-20-00

THURBER

Prep'd SH

Chkd. MJK

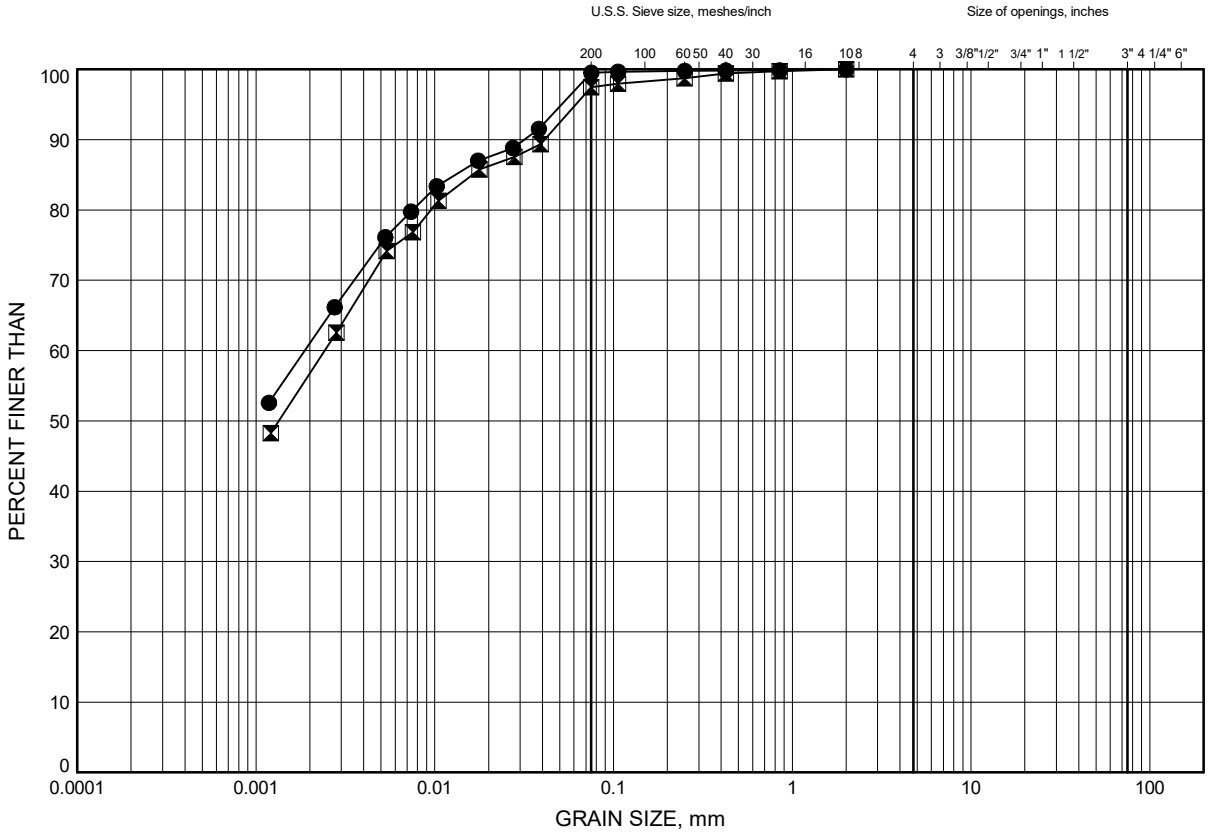
GRAIN SIZE DISTRIBUTION - THURBER 29381 BOREHOLE LOGS.GPJ 3/6/21

Hwy 416 Cedar Grove Road Overpass SBL (Site No. 16X-0307)

GRAIN SIZE DISTRIBUTION

FIGURE C2

SILTY CLAY TO CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	307-21-1	11.0	83.4
⊠	307-21-2	9.4	84.3

Date November 2021

WP# 4024-20-00

THURBER

Prep'd SH

Chkd. MJK

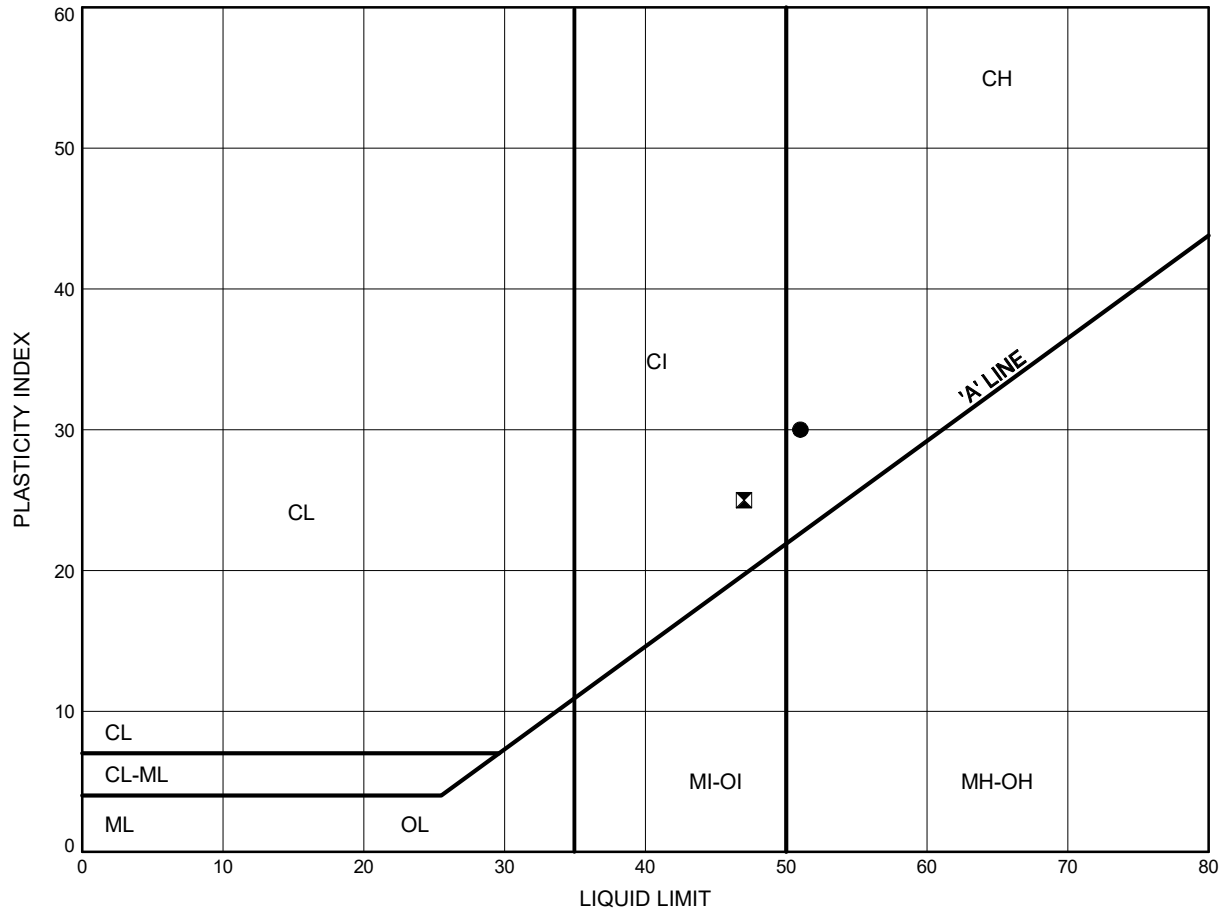
GRAIN SIZE DISTRIBUTION - THURBER 29381 BOREHOLE LOGS.GPJ 3/6/21

Hwy 416 Cedar Grove Road Overpass SBL (Site No. 16X-0307)

ATTERBERG LIMITS TEST RESULTS

FIGURE C3

SILTY CLAY TO CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	307-21-1	11.0	83.4
⧓	307-21-2	9.4	84.3

Date November 2021

WP# 4024-20-00

THURBER

Prep'd SH

Chkd. MJK

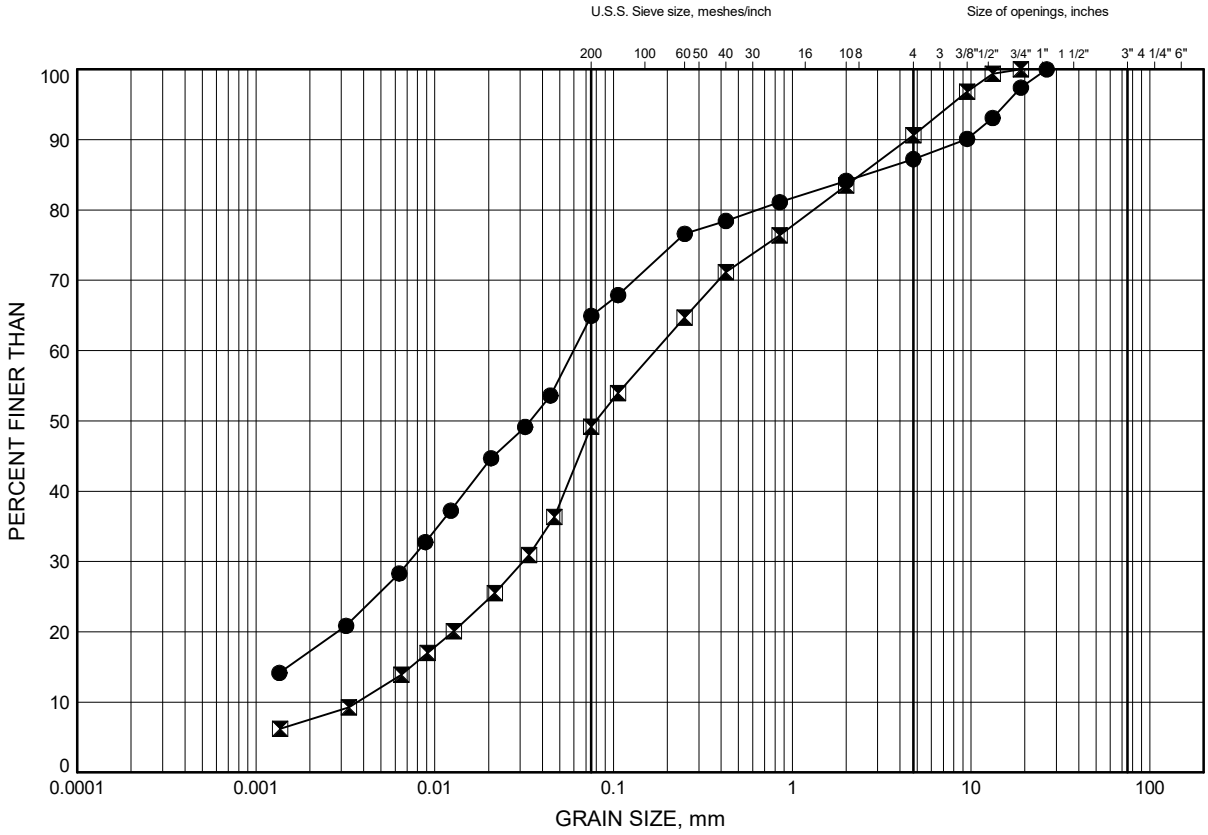
THURBALT 29381 BOREHOLE LOGS.GPJ 3/6/21

Hwy 416 Cedar Grove Road Overpass SBL (Site No. 16X-0307)

GRAIN SIZE DISTRIBUTION

FIGURE C4

GLACIAL TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	307-21-1	12.6	81.7
⧓	307-21-1	14.0	80.3

Date November 2021

WP# 4024-20-00

THURBER

Prep'd SH

Chkd. MJK

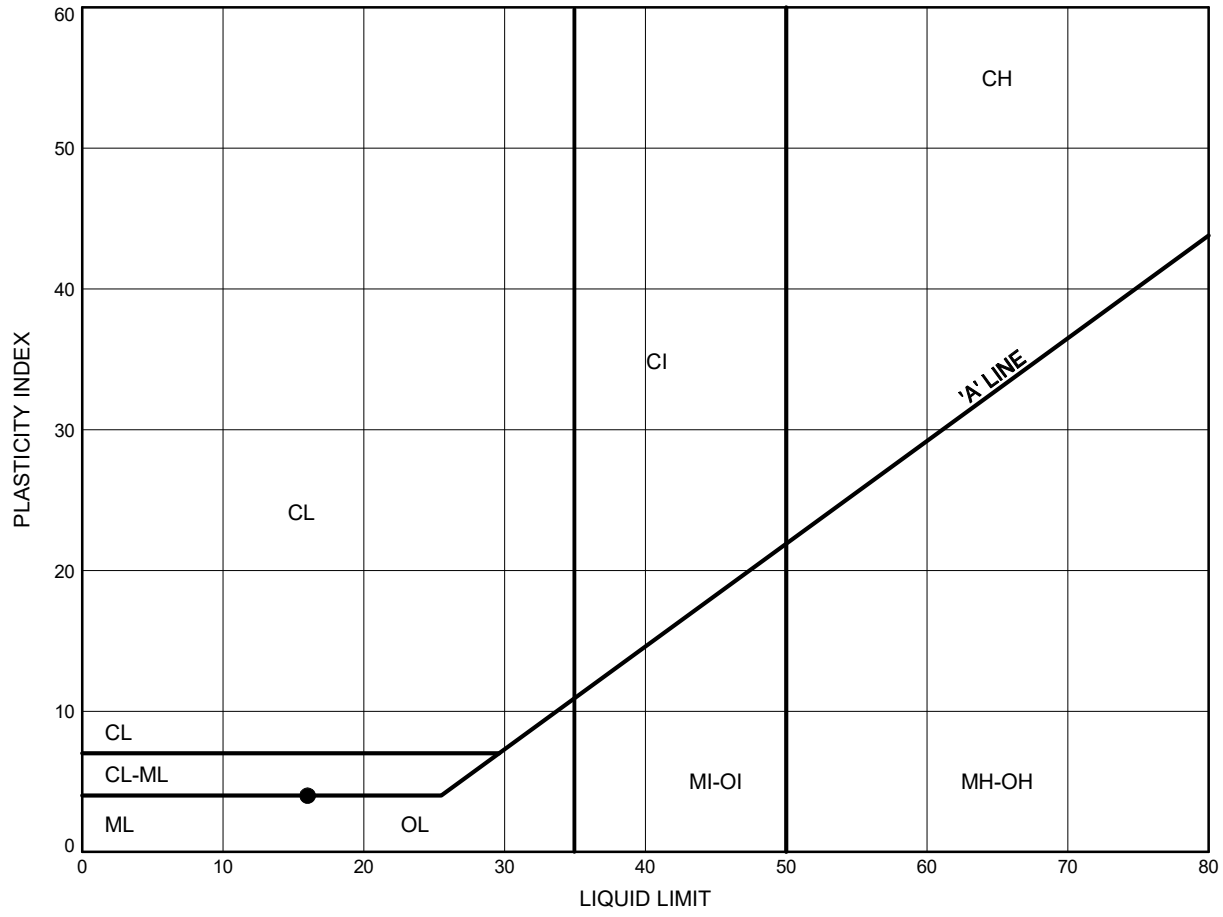
GRAIN SIZE DISTRIBUTION - THURBER 29381 BOREHOLE LOGS.GPJ 3/6/21

Hwy 416 Cedar Grove Road Overpass SBL (Site No. 16X-0307)

ATTERBERG LIMITS TEST RESULTS

FIGURE C5

GLACIAL TILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	307-21-1	12.6	81.7

Date November 2021

WP# 4024-20-00

THURBER

Prep'd SH

Chkd. MJK

THURBALT 29381 BOREHOLE LOGS.GPJ 3/6/21

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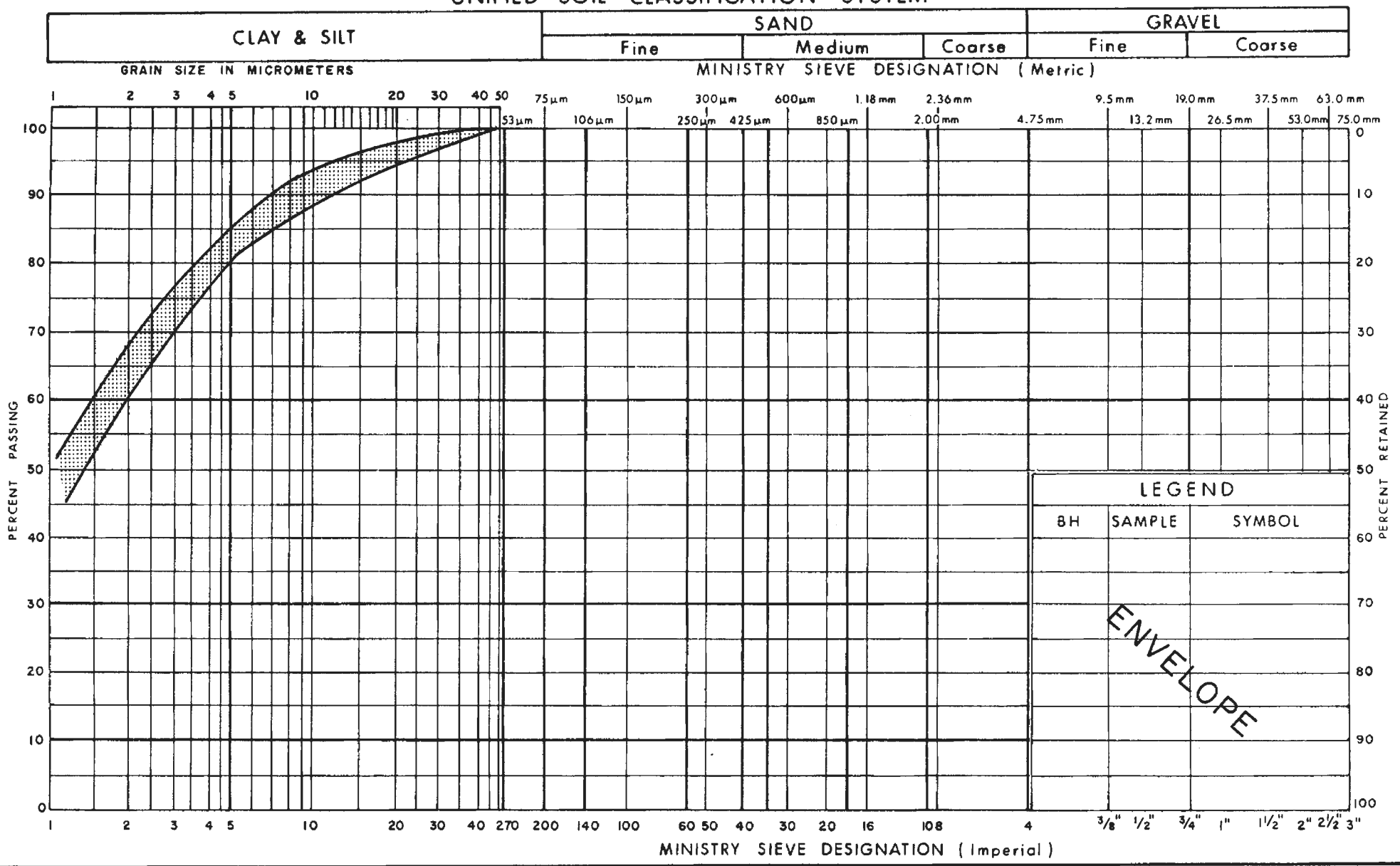
Appendix C.2

Particle Size Analysis Figures (1991)

Atterberg Limit Test Results (1991)

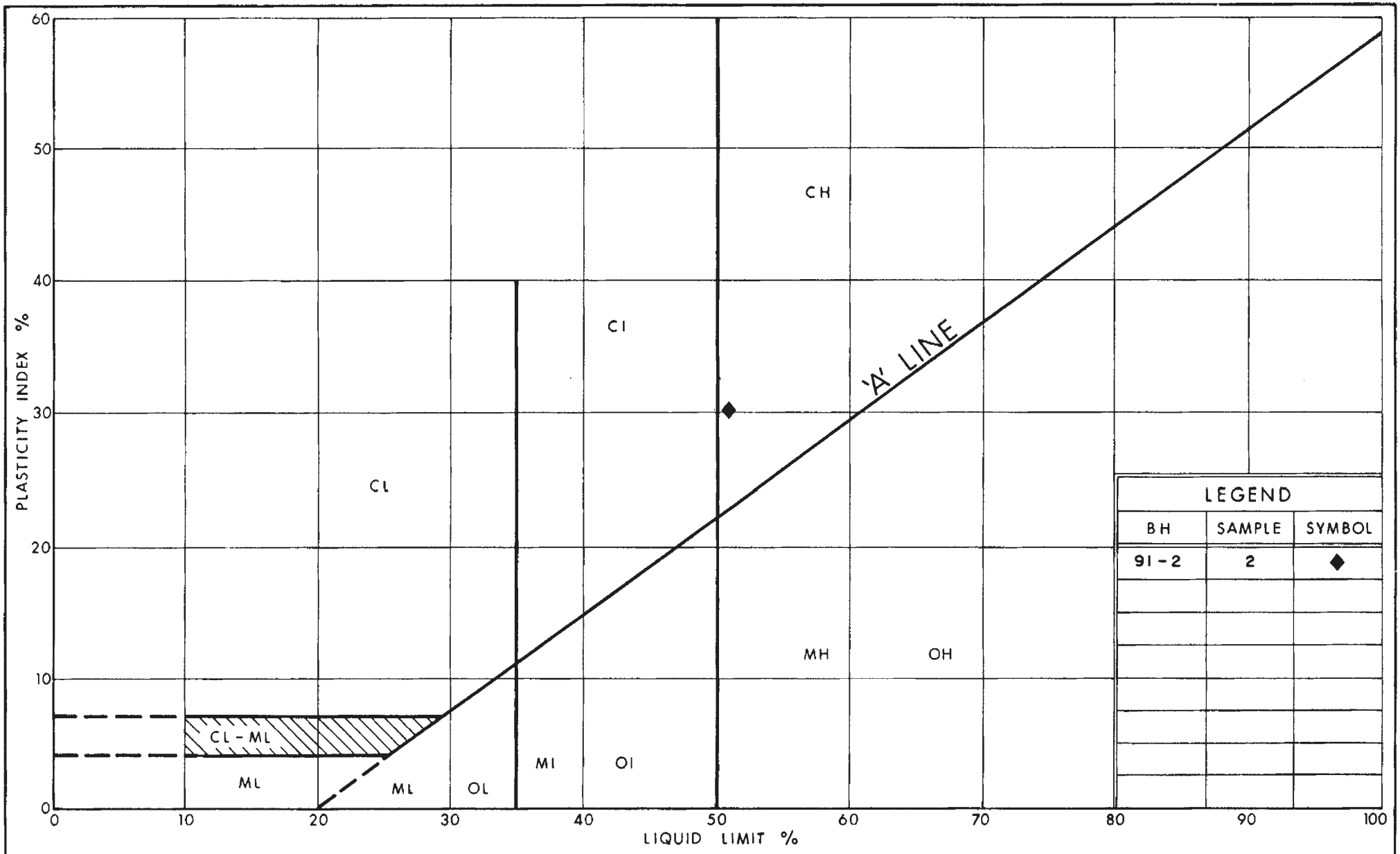
UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION
SILTY CLAY

FIG No 1
W P 374-89-03

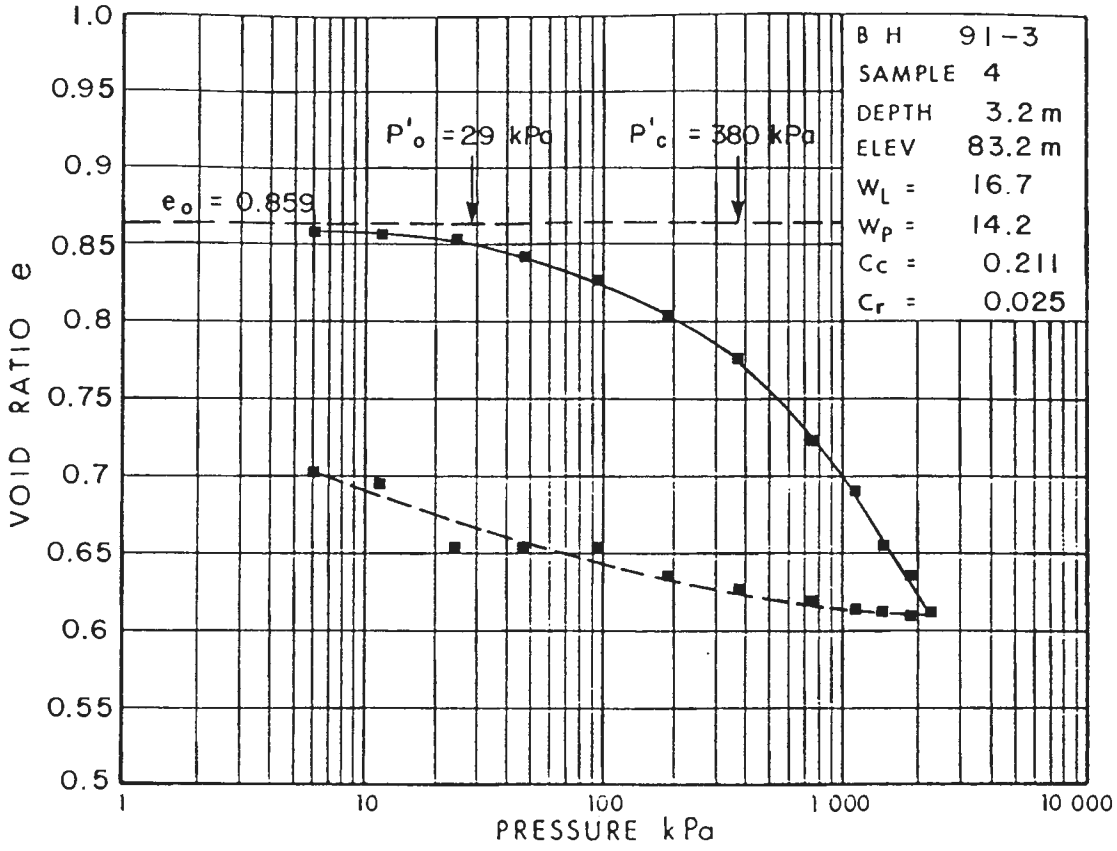


Ministry of Transportation
Ontario

PLASTICITY CHART
SILTY CLAY

FIG No 2
W P 374 - 89 - 03

VOID RATIO - PRESSURE CURVES



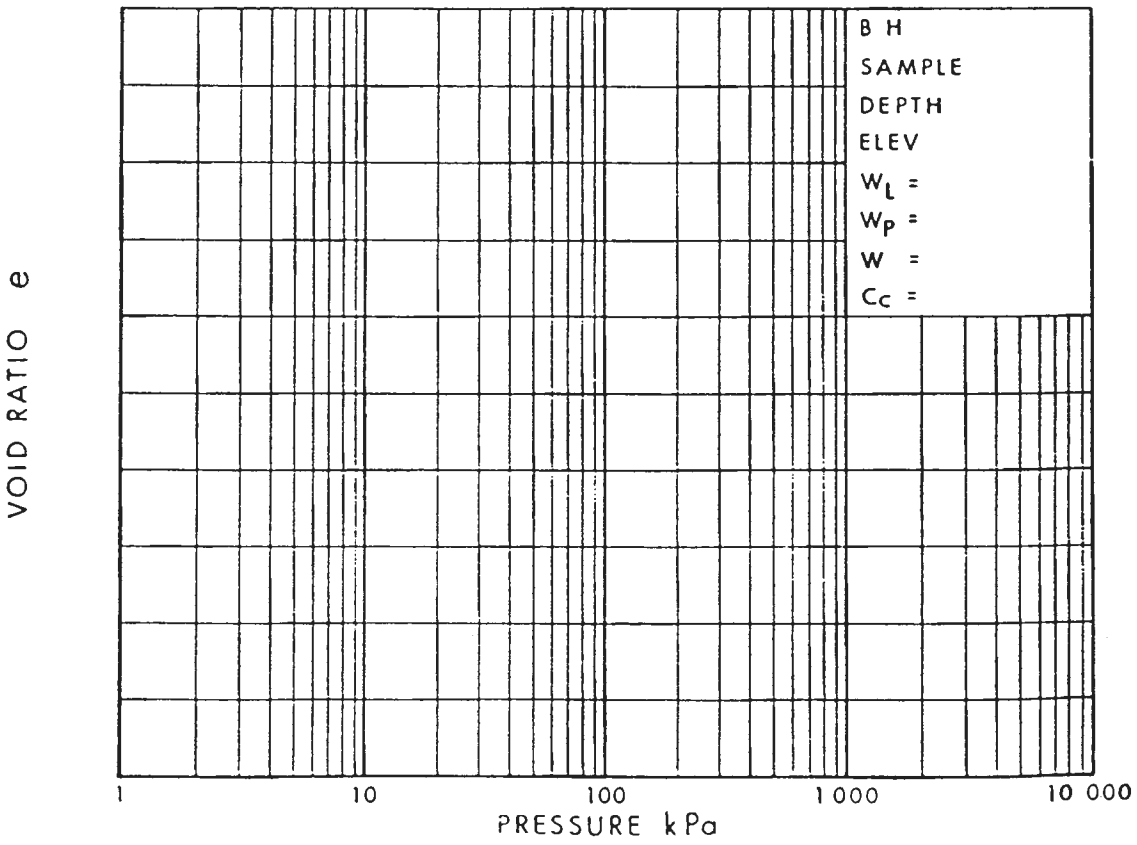
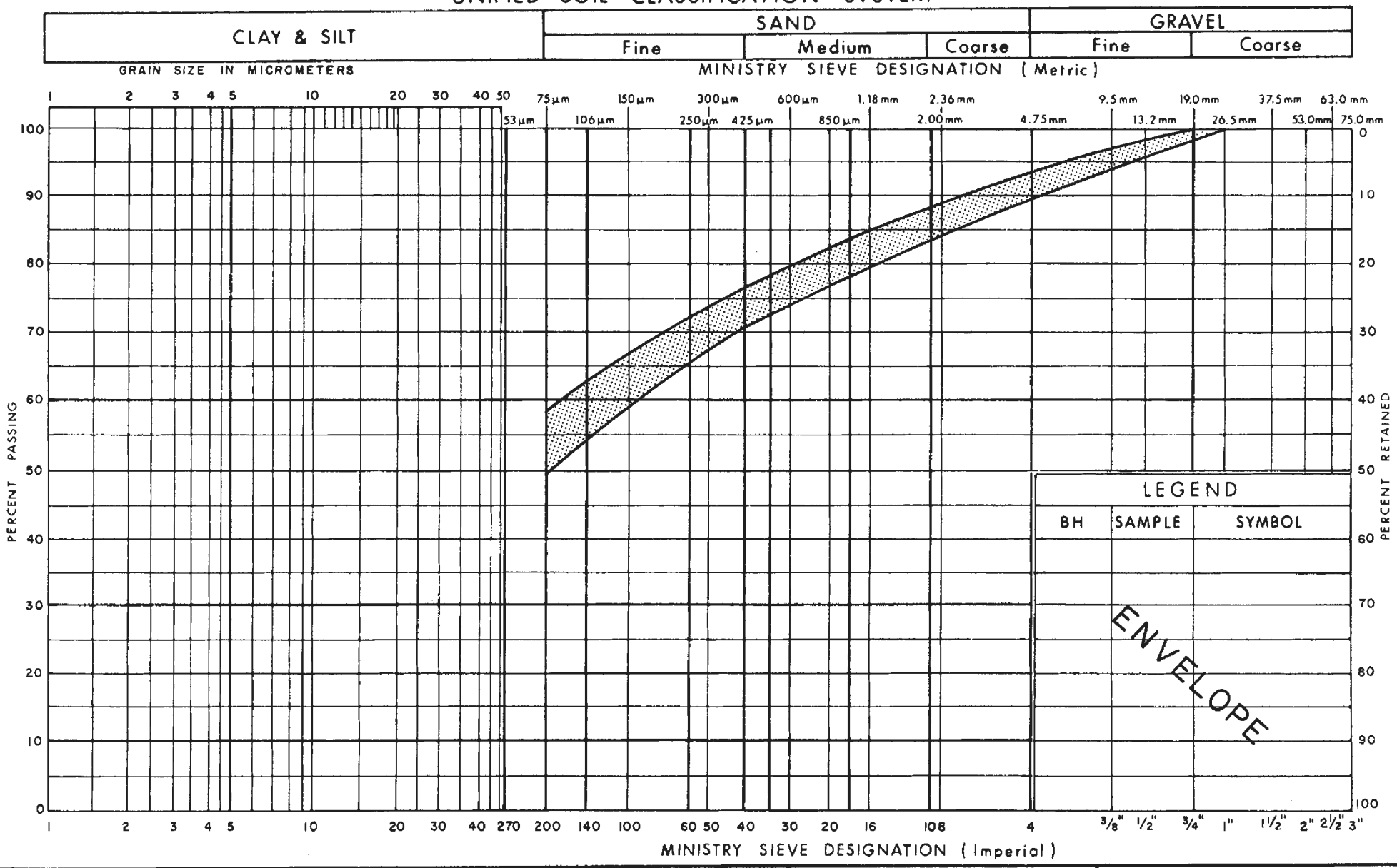


Fig 3

WP 374-89-03

UNIFIED SOIL CLASSIFICATION SYSTEM



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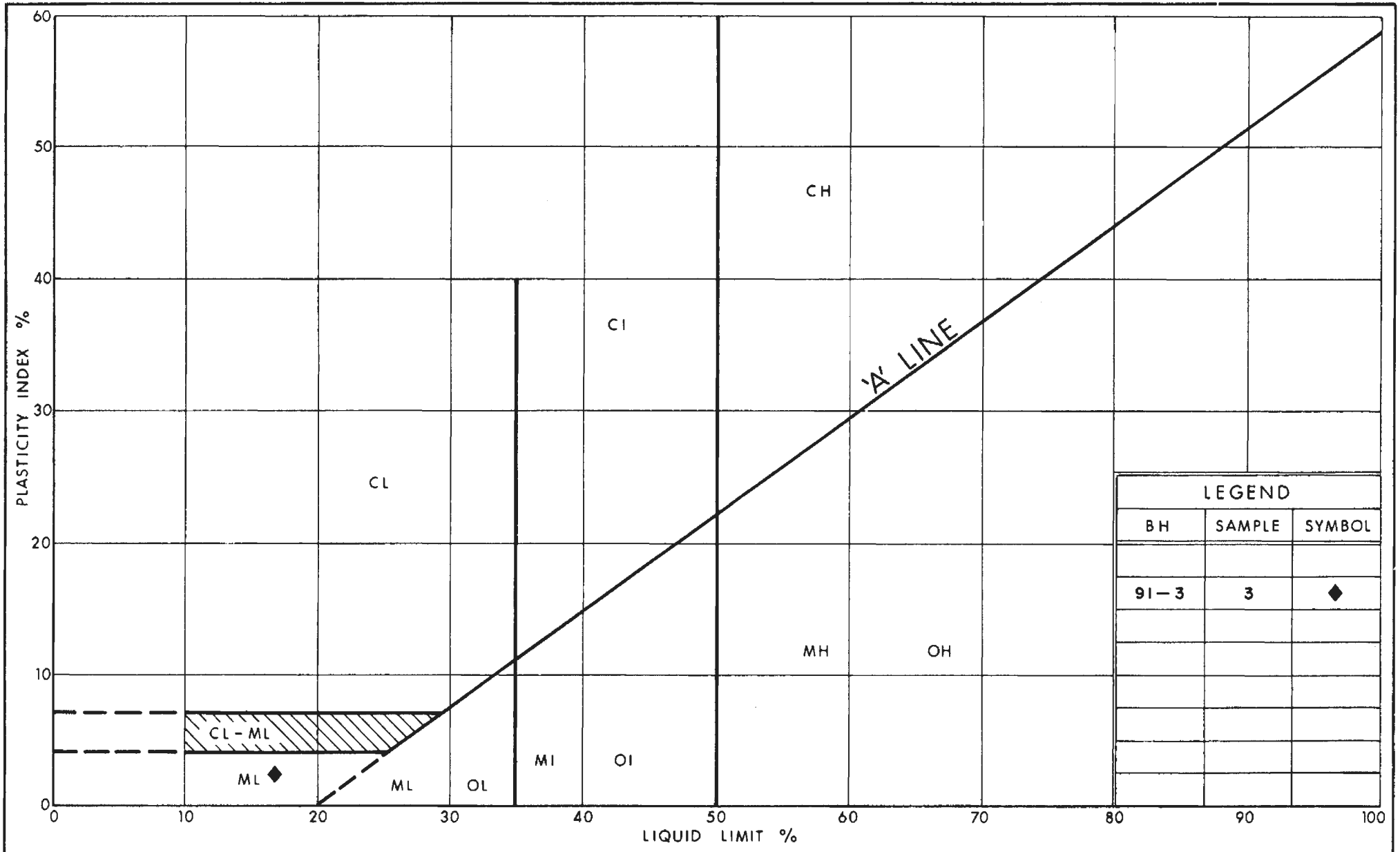
GRAIN SIZE DISTRIBUTION

HET MIXTURE OF SANDY SILT,
SOME CLAY & GRAVEL, OCCASIONAL BOULDERS (Glacial Till)

FIG No 4

W P 374-89-03



Ministry of Transportation
Ontario

PLASTICITY CHART

HET MIXTURE OF SANDY SILT, SOME CLAY & GRAVEL, OCCASIONAL BOULDERS (Glacial Till)

FIG No 5

W P 374 - 89 - 03

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Appendix C.3

UCS Test Results

Stantec Consulting Ltd
2781 Lancaster Rd, Suite 100 A&B
Ottawa, ON K1B 1A7
Tel: (613) 738-6075
Fax: (613) 722-2799

May 25, 2021
File: 122410864

Attention: **Thurber Engineering, File #29381**

Reference: **ASTM D7012, Method C, Unconfined Compressive Strength of Intact Rock Core Highway 401/416 Interchange**

The following table summarizes unconfined compressive strength results for five intact rock cores.

Location	Sample Depth	Compressive Strength (MPa)	Description of Break
259-21-1 Run-2	8'6"-9'1"	205.3	Well-formed cone at both ends
306-21-2 Run-1	77'2"-77'9"	219.8	Well-formed cone at both ends
307-21-1 Run-1	55'-55'7"	162.4	Well-formed cone at both ends
308-21-1 Run-2	72'6"-73'3"	216.9	Vertical cracking throughout, no well-formed cones.
250-21-21 Run-2	24'8"-25'3"	181.6	Well-formed cone at both ends

Sincerely,

Stantec Consulting Ltd

Brian Prevost

Brian Prevost
Laboratory Supervisor
Tel: 613-738-6075
brian.prevost@stantec.com

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Appendix C.4

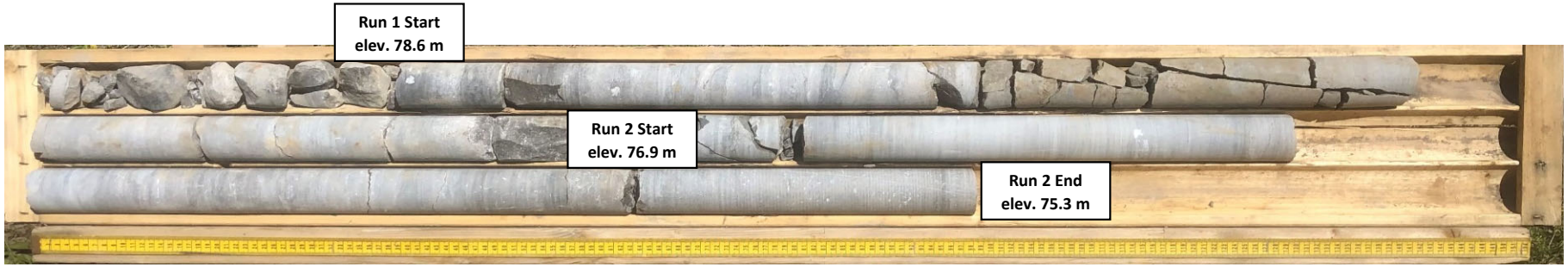
Bedrock Core Photographs

Borehole 307-21-1

Run 1 to 2 (of 2)

Elevation 78.8 m to 75.4 m

Dry



THURBER ENGINEERING LTD.

Highway 401/416 Interchange
Hwy 416 Cedar Grove Road Overpass SBL
(Site No. 16X-0307)
Assignment No. 4019-E-0010.2, GWP 4024-20-00

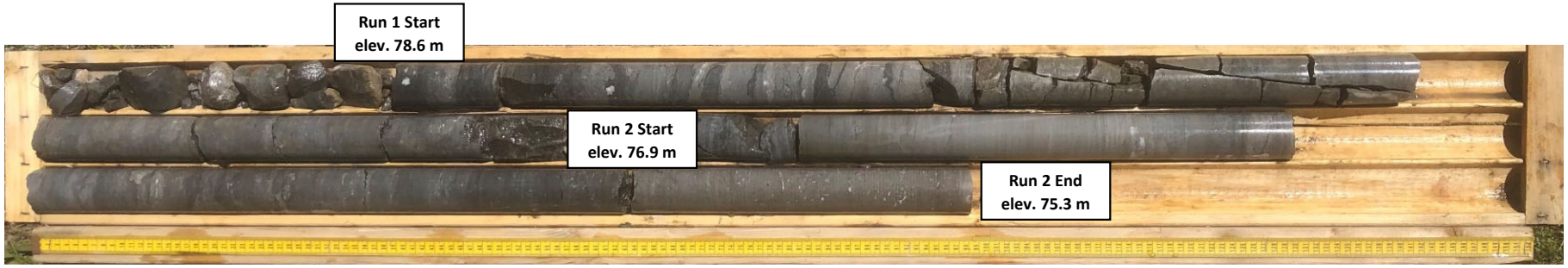
BH 307-21-1
Project No.: 29381

Borehole 307-21-1

Run 1 to 2 (of 2)

Elevation 78.8 m to 75.4 m

Wet



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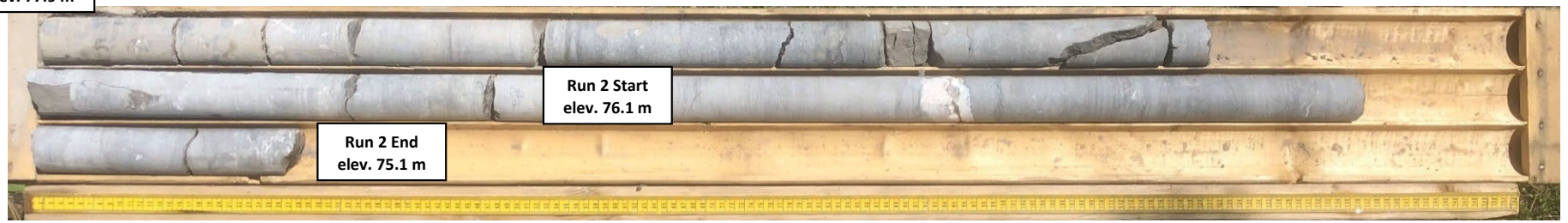
Hwy 416 Cedar Grove Road Overpass SBL
(Site No. 16X-0307)
Assignment No. 4019-E-0010.2, GWP 4024-20-00

BH 307-21-1
Project No.: 29381

Borehole 307-21-2

Run 1 to 2 (of 2)

Elevation 77.9 m to 75.0 m



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Assignment No. 4019-E-0010.2, GWP 4024-20-00

BH 307-21-2
Project No.: 29381

Borehole 307-21-2

Run 1 to 2 (of 2)

Elevation 77.9 m to 75.0 m

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Highway 401/416 Interchange
Hwy 416 Cedar Grove Road Overpass SBL
(Site No. 16X-0307)
Assignment No. 4019-E-0010.2, GWP 4024-20-00

BH 307-21-2
Project No.: 29381

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Appendix D.

Site Photographs

Photo 1. Looking north at the west side of the north embankment (2021/03/29)

Photo 2. West side of north abutment (2021/03/29)

Photo 3. North deck and abutment (2021/03/29)

Photo 4. Asphalt paved surface of 416N-401W ramp bridge (2021/03/29)

Photo 5. Looking south at south abutment (2021/03/29)

Photo 6. South deck and abutment looking east (2021/03/29)

Photo 7. Looking south at the west side of the south embankment (2021/03/29)

Photo 8. Looking north 416N-401W ramp bridge (2021/03/29)