DRAFT

FOUNDATION INVESTIGATION AND DESIGN REPORT
MEDIAN BARRIER AND STORM SEWER REPLACEMENT
NORTH OF MAPLEVIEW DRIVE TO NORTH OF ESSA ROAD
BARRIE, ONTARIO

Geocres Number:

Report to

HATCH

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File: 11398

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Appendices

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PART 1: FACTUAL INFORMATION

1.0 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted for the proposed replacement of the median barrier and storm sewer along Highway 400 between approximately 100 m north of Mapleview Drive to approximately 100 m north of Essa Road in Barrie, Ontario. The approximate limits of the work are as follows:

Median Barrier:	Station 26+297 to Station 28+944
Storm Sewer:	Station 26+297 to Station 28+848

The purpose of the investigation was to explore the subsurface conditions along the median within the project limits and, based on the data obtained, to provide borehole logs, a borehole location plan, and a written description of the subsurface conditions at the site.

Thurber carried out the investigation as a sub-consultant to Hatch who are preparing the detailed design for The Ministry of Transportation (MTO) in conjunction with the detailed design of a new Harvie Road / Big Bay Point Road crossing of Highway 400 for the City of Barrie.

2.0 SITE DESCRIPTION

The section of Highway 400 within the study limits presently conveys six lanes of traffic, with three lanes in each direction, separated by a steel box guiderail and approximately 1.0 m wide paved median shoulders in both directions. A depressed grass median is present between approximate Station 26+950 and Station 28+150.

The site is located within the south part of the City of Barrie in an area comprising a mix of vacant land, commercial/retail development and residential subdivisions. In general, highway grades fall from approximate Elev. 298.0 at the south limit to 242.0 at the north limit. The

adjacent lands are gently undulating, and a small watercourse (Whiskey Creek) crosses under Highway 400 at Harvie / Big Bay Point Road.

The study area is located within the western extent of the Peterborough Drumlin Field physiographic region, a rolling till plain located north of the Oak Ridges Moraine. This region generally comprises sandy till drumlins or drumlinoid hills with sand, silt or clay deposits in the intervening lowlands. Locally the surficial materials are expected to comprise glaciofluvial ice-contact sands, with localized glaciolacustrine silt and clay deposits. The underlying bedrock is expected to lie at a depth in excess of 100 m.

3.0 SITE INVESTIGATION AND FIELD TESTING

The site investigation was carried out during the period February 23 to March 6, 2017, and consisted of 17 boreholes (designated Boreholes MS-01 to MS-17) drilled to 5.0 m depth adjacent to the median of the highway. In addition, information from two boreholes drilled at the proposed pier location for the new Harvie / Big Bay Point Road underpass structure (Boreholes UP-03 and UP-04) were used to supplement the data. The approximate locations of the boreholes are shown on the Borehole Locations Drawing provided in Appendix D.

The borehole locations were selected by Hatch and repositioned in the field as necessary in consideration of surface features and underground utilities. All borehole locations were cleared of utilities prior to commencement of drilling.

In general, solid stem augers were used to advance the boreholes, and soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). Hollow stem augers were employed to advance the two deep boreholes at the proposed pier location.

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

Groundwater conditions in the open boreholes were observed throughout the drilling operations. No piezometers were installed within the travelled portion of the highway or on narrow shoulders due to safety reasons. Upon completion, the boreholes were backfilled with bentonite and cuttings to 0.5 m depth, a concrete layer, and then asphalt cold patch at the pavement surface.

4.0 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets in Appendix A. Selected samples were subjected to gradation analysis. The results of this testing program are shown on the Record of Borehole sheets and on the laboratory test result figures attached in Appendix B.

5.0 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference should be made to the Record of Borehole sheets in Appendix A and the "Borehole Locations Drawing" in Appendix D. 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.

In general terms, the subsurface stratigraphy encountered in the boreholes consists of a surficial asphalt layer overlying a varying thickness of granular / embankment fill, underlain by sand deposits.

More detailed descriptions of the individual strata are presented below.

5.1 Pavement Structure

A 175 to 275 mm thick layer of asphalt was encountered in all boreholes drilled in the paved median shoulder of Highway 400. Typically the asphalt was 200 to 225 mm thick.

A granular layer grading from gravelly sand to sand with some gravel, locally sand and gravel, was tentatively identified as pavement base material in Boreholes MS-03 to MS-08, MS-11, MS-17, UP-03 and UP-04. The granular layer was 0.5 to 2.1 m thick.

SPT 'N' values in the granular layer ranged from 20 to 39 blows/0.3 m, indicating a compact to dense condition. Moisture contents ranged from 1 to 10%. The results of grain size distribution analyses carried out on the granular are shown on Figures B1 and B2 in Appendix B and summarized below:

Gravel (%)	19 to 50
Sand (%)	45 to 67
Silt & Clay (%)	5 to 29

5.2 Fill

Existing embankment fill was encountered below the asphalt and pavement structure in all boreholes except Boreholes MS-08 and MS-10. The fill generally consisted of silty sand to sand with trace of silt and gravel. Locally in Boreholes MS-04, MS-16 and MS-17, a 0.7 to 1.6 m thick layer of silty clay fill was encountered within or below the sand fill.

In general, the depth to the base of the fill ranged from 1.2 to 4.3 m. Boreholes MS-15 and MS-17 were terminated in the fill at 5.0 m depth. The fill in Boreholes UP-03 and UP-04 extended to depths of 8.7 and 5.6 m. Fill was not identified below the asphalt layer in Borehole MS-10.

SPT 'N' values recorded in the fill varied widely from 3 to 51 blows/0.3 m, indicating a very loose to very dense condition. Typically the 'N' values ranged from about 15 to 34 blows/0.3 m, indicating compact to dense conditions. The clay zones were firm to very stiff, as evidenced by 'N' values of 6 to 16 blows/0.3 m.

Measured moisture contents ranged from 1 to 19% in the sand fill, and from 20 to 38% in the silty clay fill.

The results of grain size distribution tests carried out on the sand to silty sand fill are shown on Figures B3 to B5 in Appendix B and summarized below:

Gravel (%)	0 to 6	
Sand (%)	61 to 94	
Silt (%)	8 to 28	4 to 18
Clay (%)	2 to 9	

The results of a particle size analysis conducted on sample of the silty clay fill are shown on Figure B6 in Appendix B. The results indicated 31% sand, 43% silt, and 26% clay.

5.3 Sand, Silty Sand and Sandy Silt

A cohesionless deposit primarily consisting of sand, locally grading to silty sand and sandy silt, was encountered below the asphalt layer in Borehole MS-10, and below the fill at depths of 1.2 to 8.7 m in all other boreholes except Boreholes MS-15 and MS-17. The boreholes were terminated in the sand at 5.0 m depth, locally 35.3 and 30.9 m depth in Boreholes UP-03 and UP-04.

SPT ‘N’ values recorded in the sand deposit typically ranged from about 22 to 65 blows/0.3 m penetration, indicating a compact to very dense relative density. Locally in the upper part of Boreholes MS-03, MS-11 to MS-13, UP-03 and UP-04, lower ‘N’ values of 4 to 14 blows/0.3 m were recorded, indicating loose to compact zones. ‘N’ values exceeding 65 blows/0.3 m were obtained at depth in Boreholes MS-05, UP-03 and UP-04.

Measured moisture contents in the sand generally ranged from 1 to 18%, increasing to about 20 to 30% within sandy silt zones in Boreholes MS-01 and MS-05, a thin organic layer in Borehole MS-12, and below depths of about 25 m in deeper Boreholes UP-03 and UP-04.

The results of grain size distribution analyses carried out on samples of the sand and silty sand to sandy silt are shown on Figures B7 to B9 included in Appendix B. The results are also summarized below:

	Sand		Silty Sand to Sandy Silt
Gravel (%)	0 to 17		0 to 8
Sand (%)	76 to 96		24 to 62
Silt (%)	3 to 25	4 to 10	24 to 69
Clay (%)	1 to 6		6 to 19

5.4 Groundwater Levels

Groundwater conditions were observed in the boreholes during and upon completion of drilling. The groundwater levels observed in the open boreholes are summarized in Table 5.1. Water was not observed in the remaining boreholes during drilling.

Table 5.1 - Observed Groundwater Levels

Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
MS-05	Feb 23, 2017	2.0	287.2	Upon completion
MS-16	Mar 05, 2017	2.4	244.5	Upon completion
UP-03	Feb 22, 2017	9.3	281.4	Upon completion
UP-04	Feb 17, 2017	6.4	284.5	Upon completion

The above water level measurements are short-term observations and seasonal fluctuations of the groundwater level are to be expected.

6.0 MISCELLANEOUS

Thurber Engineering positioned the boreholes in the field using a hand-held GPS unit, with consideration of site features. The ground elevations at the borehole locations were interpreted from survey information and contour drawings.

Walker Drilling of Utopia, Ontario supplied and operated the drilling and sampling equipment for the field program.

Full time supervision of the field activities, including obtaining utility clearances, was carried out by Ms. Eckie Siu, Mr. Omar Ali, and Mr. Stephane Loranger of Thurber Engineering. Overall supervision of the field program was performed by Mr. Mohamed Hosney, P.Eng. and Mr. Murray Anderson, P.Eng. of Thurber.

Interpretation of the field data and preparation of the report were performed by Mr. Murray Anderson, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Murray R. Anderson, M.Eng., P.Eng.
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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7.0 GENERAL

This report presents interpretation of the geotechnical data in the factual report and presents geotechnical recommendations regarding replacement of the median storm sewer, storm sewer laterals, and median barrier along Highway 400 within the project limits.

The interpretation and recommendations are intended for the use of the design consultant and MTO, 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 Part 1 of the report, and the implications on equipment selection, construction methodology, and scheduling.

The discussion and recommendations presented in this report are based on the information provided by Hatch and on the factual data obtained in the course of the investigation.

7.1 Median Storm Sewer Replacement

Review of contract drawings from this section of highway (Contract No. 71-150) indicates that the existing median storm sewers typically consist of 300 mm diameter concrete pipe installed at depths of about 1.8 to 2.7 m below median shoulder grade. It is anticipated that the replacement pipes will be of similar size, type and depth.

In general, excavation for replacement of the storm sewers is expected to extend through the existing pavement structure, fill consisting of sand to silty sand, and into the underlying sand deposits. Silty clay fill may be encountered at isolated locations, and the native deposits may

grade to silty sand/sandy silt locally. Groundwater was observed within the anticipated excavation depths at two borehole locations.

All excavation must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of assessing excavation slope requirements in compliance with the OHSA, the fill and native sand deposits are classified as Type 3 soils. Saturated cohesionless soils may be encountered locally, and these should be classified as Type 4 soils if preconstruction dewatering is not carried out.

Roadway protection must be provided in accordance with OPSS 539 and designed for Performance Level 2. Based on available subsurface information, a trench box system should be adequate for the relatively shallow excavation depths anticipated. A shoring system consisting of sheet piling or steel H-piles with timber lagging may be considered if locally deeper excavations are required. Temporary shoring should be designed by a licensed Professional Engineer experienced in design of shoring with consideration of adjacent traffic loads and any sloping retained surfaces.

Based on the water conditions observed in the boreholes, excavation is not expected to extend below the groundwater level, and dewatering measures such as pumping from filtered sumps should be adequate to remove any accumulation of water in trench excavations. Zones of perched water should be anticipated locally (such as encountered in Boreholes MS-05 and MS-16), and the contractor must be prepared to dewater or provide drainage of these areas prior to excavation to maintain trench stability.

The selection of the equipment and method of excavation is the responsibility of the contractor and must be based on his equipment, experience and interpretation of the site conditions. It is anticipated that a hydraulic excavator will be suitable. Provision must be made for the handling of pavement materials and potential obstructions in the fill. The design of the shoring and dewatering system that may be required is also the responsibility of the Contractor and the Contract Documents must alert him to this responsibility.

Sewer pipe installation, trenching, backfilling and compacting should be carried out in accordance with OPSS.PROV 401, OPSS.PROV 410 and OPSD 802.031. Care must be exercised to avoid damaging the pipe when compacting the fill immediately above the crown of the pipe.

Prior to placement of the pipe bedding, the base of the trench excavation must be properly dewatered and dry, and free of disturbed or loose soil. In order to confirm uniformity along the

alignment, the exposed subgrade must be inspected and approved prior to placing and compacting the bedding. Any identified disturbed/wet soils should be sub-excavated and replaced with compacted granular materials. It is critical that the pipe be supported on well compacted bedding overlying a competent and uniform subgrade in order to minimize the potential for differential settlement.

Pipe bedding and cover should consist of compacted OPSS Granular A material. The remainder of the trench backfill below the pavement structure should consist of OPSS Granular B Type I material, or alternatively excavated site material consisting of sand with no greater than 25% material passing the 75 µm sieve size may be used.

7.2 Storm Sewer Laterals

It is anticipated that the storm sewer laterals crossing under Highway 400 will be installed at approximately the same depths as the storm sewers with a minimum cover of 1.5 m, and that similar subsurface conditions will be encountered. In view of the need for traffic staging, potential traffic disruption, and impacts on the pavement structure, installation of the laterals is expected to be carried out using trenchless methods.

Trenchless installations should be carried out in general accordance with the requirements of the Non-Standard Special Provision (NSSP) “Pipe Installation by Trenchless Methods”. A copy of this NSSP is attached in Appendix C.

Trenchless installation methods that are typically considered to install pipes under highways include:

- Jack and bore
- Pipe ramming
- Micro-tunnelling (MTBM)
- Hand mining
- Horizontal directional drilling

Selection of an appropriate trenchless method must be the responsibility of the Contractor and will depend upon the relative costs and risks associated with each method. The experience of the Contractor is of primary importance for trenchless installation. Amongst the important issues discussed in the NSSP are maintenance of alignment, handling of oversized obstructions and disposal of cuttings.

Pipe ramming techniques may be considered for this project. During pipe ramming, a sleeve pipe is driven from the access point to the exit point using an air-powered percussion hammer. After the sleeve has been fully or partially driven, the soil inside is removed by augering. This method can accommodate cohesionless soils including zones with water seepage associated with low piezometric head. This technique has a further advantage in that only a small over-cut is created around the pipe, resulting in a lower potential for settlement of the pavement surface above the installation.

Jack-and-bore may also be considered provided the potential risks of face instability and surface settlement are controlled. This method involves simultaneously jacking a casing while removing soil spoil by means of an auger. For the cohesionless soil conditions at this site, it is critical that the casing be advanced closely behind the auger to maintain the hole stability and prevent loss of material. This method is not suitable below groundwater, and dewatering must be implemented in advance of augering.

Depending on the ground conditions and construction methods, either of these trenchless techniques carries a certain degree of risk including the potential of highway settlement due to the relatively shallow soil crown cover. Instrumentation and monitoring for potential settlements on the highway will be required for these trenchless construction methods.

Micro-tunnelling is technically feasible for lateral installation but is unlikely to be cost effective due to the relatively short pipe lengths. Hand-mining is not suitable in view of the small diameters of the laterals. Horizontal directional drilling procedures are not recommended in view of the cohesionless nature of the soils and potential difficulties maintaining the required invert elevations of the sewer pipes.

It should be noted that all trenchless methods will require a new alignment, and the clearance required between the existing and the new pipes for safe installation is typically between 1 to 2 pipe diameters.

Monitoring of the roadway surface should be carried out during the trenchless installation. The settlement monitoring program and condition survey should follow MTO's Guidelines For Foundation Engineering – Tunnelling Specialty For Corridor Encroachment Permit Application.

7.3 Tall Wall Barriers

Tall wall barriers placed in the median should be constructed in accordance with OPSS 740 and OPSD 911.132. Preparation of the granular base under the barrier foundation shall conform to OPSS.PROV 314.

Fill placed under the barrier should consist of compacted sewer trench backfill constructed as outlined previously or similar imported material used to establish grades within the existing grass median to be filled. Granular materials in the shoulder pavement should extend full width of the median under the barrier wall foundations.

7.4 Construction Concerns

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

- Trenchless installations at relatively shallow depth below a highway inherently include some risk of loss of ground into the bore and can potentially result in settlement of the pavement surface. Selection of the trenchless technique employed for installing the sewer must take into account the need to avoid settlement and loss of ground below Highway 400. Confirmatory monitoring of the roadway surface should be carried out during construction, and contingency plans should be prepared to manage any adverse impacts that may arise.

- Trenching along the median for sewer replacement may result in adjacent ground movements depending on the trenching methodology and subsurface conditions. The Contractor must recognize that construction sequencing including the implementation of roadway protection (shoring) and groundwater control will be critical to limiting ground movements to within tolerable limits.

- Groundwater control may be required for installation of the sewers in some locations. Proper construction drainage and potentially sump pumping or additional dewatering measures will be required.

- Although not encountered in the boreholes, cobbles, boulders or other obstructions may be present within the existing highway embankment fill. The Contractor's equipment and methodology must be able to handle and remove such obstructions.

- The Contractor must accurately establish the locations and depths of all buried utilities in the vicinity of the median sewer and lateral alignments.

8.0 CLOSURE

Engineering analysis and preparation of the foundation design report were carried out by Mr. Murray Anderson, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Murray R. Anderson, P.Eng.
Senior Geotechnical Engineer

Dr. P.K. Chatterji, P.Eng.
Review Principal

THURBER

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.

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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.

Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction
1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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

▼ Water Level

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.

UNIFIED SOILS CLASSIFICATION

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MS-01 1 OF 1 METRIC

W.P. _____ LOCATION N 4 911 627.1 E 289 895.1 ORIGINATED BY AHF

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.03.03 - 2017.03.03 CHECKED BY MH

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
297.9	GROUND SURFACE										
0.0	**ASPHALT:** (175mm)										
0.2	**SAND**, some silt, trace gravel Compact to Dense Brown Moist (FILL)		1	GS					○		
			1	SS	20		297		○		
			2	SS	33				○		
295.8							296				
2.1	**SAND**, some silt Dense Brown Moist		3	SS	32				○		
			4	SS	36		295		○		
293.9							294				
4.0	Sandy **SILT**, some clay Compact Brown Wet		5	SS	24				○		0 25 69 6
292.9							293				
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH CONCRETE AND COLD PATCH TO SURFACE.										

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

$15 \overset{20}{\underset{10}{\oplus}} 5$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MS-02 1 OF 1 METRIC

W.P. _____ LOCATION N 4 911 772.0 E 289 864.8 ORIGINATED BY AHF

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.03.03 - 2017.03.03 CHECKED BY MH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
295.5	GROUND SURFACE										
0.0	**ASPHALT:** (200mm)										
0.2	**SAND**, some silt, trace gravel Compact to Loose Brown Moist (FILL)		1	GS			295		○		3 83 14 (SI+CL)
			1	SS	29				○		
			2	SS	11		294		○		
			3	SS	8		293		○		
292.6											
2.9	Silty **SAND**, some clay Compact to Very Dense Brown Moist		4	SS	23		292		○		0 62 24 14
290.5			5	SS	65		291		○		
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

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

$15\frac{20}{10}5$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MS-03 1 OF 1 METRIC

W.P. _____ LOCATION N 4 911 916.5 E 289 839.6 ORIGINATED BY AHF

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.03.03 - 2017.03.03 CHECKED BY MH

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
293.1	GROUND SURFACE						293				
0.0	**ASPHALT:** (200mm)										
0.2	Gravelly **SAND**, trace silt Brown Moist (FILL)		1	GS					○		31 60 9 (SI+CL)
292.4											
0.7	Silty **SAND**, trace gravel Compact Brown Moist (FILL)		1	SS	25		292		○		1 69 28 2
			2	SS	22				○		
291.0							291				
2.1	Silty **SAND**, some clay, trace gravel Compact Brown Moist		3	SS	14				○		8 52 30 10
290.2							290				
2.9	**SAND**, some silt, trace gravel Dense to Very Dense Brown Moist		4	SS	33				○		
			5	SS	52		289		○		
288.1											
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MS-04 1 OF 1 METRIC

W.P. _____ LOCATION N 4 912 213.3 E 289 787.5 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.02.23 - 2017.02.23 CHECKED BY MH

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
289.8	GROUND SURFACE										
0.0	**ASPHALT:** (225mm)										
0.2 / 289.1	**SAND**, some gravel, some silt Brown Moist (FILL)		1	GS					○		
0.7 / 288.3	**SAND**, some silt, trace clay, trace gravel Compact Dark Brown Moist (FILL)		1	SS	15		289		○		
1.5 / 287.4	Silty **CLAY**, some sand, trace gravel Firm Brown (FILL)		2	SS	6		288		○		
2.4	**SAND**, trace to some gravel, trace silt Dense to Very Dense Brown Moist		3	SS	47		287		○		
			4	SS	54		286		○		
284.8			5	SS	56		285		○		
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.6m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MS-05 1 OF 1 METRIC

W.P. _____ LOCATION N 4 912 359.5 E 289 764.0 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.02.23 - 2017.02.23 CHECKED BY MH

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
289.2	GROUND SURFACE										
0.0 / 289.0	**ASPHALT:** (250mm)						289				
0.3 / 288.5	**SAND**, some gravel, trace silt Brown Moist (FILL)		1	GS				○			
0.8 / 287.0	Silty **SAND**, trace gravel Dense Brown Moist (FILL)		1	SS	30		288	○			
			2	SS	33	▽		○			4 61 26 9
2.3 / 285.3	Sandy **SILT**, some clay Compact Grey Wet to Moist		3	SS	29		287	○			0 24 58 18
			4	SS	28		286	○			
4.0 / 284.2	**SAND**, some silt, trace gravel Very Dense Brown Moist		5	SS	93		285	○			3 76 15 6
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE OPEN TO 3.7m AND WATER LEVEL AT 2.0m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MS-06 1 OF 1 METRIC

W.P. _____ LOCATION N 4 912 504.3 E 289 735.0 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.02.23 - 2017.02.23 CHECKED BY MH

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
288.4	GROUND SURFACE										
0.0	**ASPHALT:** (200mm)										
0.2	**SAND**, some gravel, trace silt Compact Brown Moist (FILL)		1	GS			288				
			1	SS	20						
286.9							287				
1.5	**SAND**, some silt, trace gravel Dense Brown Moist (FILL)		2	SS	32						
285.9			3	SS	48		286				
2.5	**SAND**, trace to some gravel, trace silt Dense to Very Dense Brown Moist		4	SS	58		285				
283.4			5	SS	42		284				
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MS-07 1 OF 1 METRIC

W.P. _____ LOCATION N 4 912 650.0 E 289 695.4 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.02.23 - 2017.02.23 CHECKED BY MH

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 (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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
286.6	GROUND SURFACE										
0.0 / 286.4	**ASPHALT:** (250mm)										
0.3	**SAND**, some gravel, some silt Compact Brown Moist (FILL)		1	GS					○		
			1	SS	28		286		○		19 64 13 4
285.1											
1.6	Gravelly **SAND**, some silt, some clay Compact Brown (FILL)		2	SS	29		285		○		21 50 18 11
284.4											
2.3	Silty **SAND**, trace clay, trace gravel Loose Brown Moist (FILL)		3	SS	5		284		○		
283.6											
3.0	Silty **SAND**, some clay, trace gravel Compact Brown Moist		4	SS	23				○		6 47 28 19
283.2							283				
3.5	**SAND**, trace silt, trace gravel Very Dense Brown Moist										
			5	SS	59		282		○		
281.6											
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.3m, THEN ASPHALT TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MS-08 1 OF 1 METRIC

W.P. _____ LOCATION N 4 912 785.7 E 289 632.1 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.03.06 - 2017.03.06 CHECKED BY MH

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 ● QUICK TRIAXIAL + FIELD VANE × 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
283.3	GROUND SURFACE										
0.0 / 283.0	**ASPHALT:** (275mm)						283				
0.3	**SAND** and **GRAVEL** to gravelly **SAND**, trace silt Dense Brown Moist (FILL)		1	GS							50 45 5 (SI+CL)
			1	SS	33		282				25 67 8 (SI+CL)
281.6											
1.7	**SAND**, trace to some gravel, occasional black sand seams Dense Brown Moist		2	SS	32						
			3	SS	36		281				
			4	SS	31		280				17 78 5 (SI+CL)
			5	SS	48		279				
278.2											
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.6m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MS-09 1 OF 1 METRIC

W.P. _____ LOCATION N 4 912 928.2 E 289 571.7 ORIGINATED BY AHF

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.03.03 - 2017.03.03 CHECKED BY MH

SOIL PROFILE			SAMPLES			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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
278.2	GROUND SURFACE										
0.0	**ASPHALT:** (200mm)										
0.2	**SAND**, some silt, trace gravel Compact Brown Moist (FILL)		1	GS			278		○		
277.0			1	SS	29				○		
1.2	**SAND**, trace to some silt Compact Brown Moist		2	SS	22		277		○		
			3	SS	26		276		○		
			4	SS	27		275		○		0 94 6 (SI+CL)
273.2			5	SS	48		274		○		
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

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

$15 \overset{20}{\oplus} 5$ (%) STRAIN AT FAILURE
10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MS-10 1 OF 1 METRIC

W.P. _____ LOCATION N 4 913 061.7 E 289 491.5 ORIGINATED BY AHF

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.03.03 - 2017.03.03 CHECKED BY MH

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 (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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
273.3	GROUND SURFACE										
0.0	**ASPHALT:** (200mm)										
0.2	**SAND**, trace to some silt, trace gravel Compact Brown Moist		1	GS			273		○		2 88 10 (SI+CL)
			1	SS	25				○		2 94 4 (SI+CL)
							272				
			2	SS	25				○		
							271				
			3	SS	26				○		
			4	SS	30		270		○		
							269				
268.3			5	SS	24				○		
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MS-11 1 OF 1 METRIC

W.P. _____ LOCATION N 4 913 162.8 E 289 408.4 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.03.06 - 2017.03.06 CHECKED BY MH

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 ● QUICK TRIAXIAL + FIELD VANE × 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
269.6	GROUND SURFACE										
0.0	**ASPHALT:** (200mm)										
0.2	Gravelly **SAND**, some silt Brown Moist		1	GS					○		27 62 11 (SI+CL)
268.9	(FILL)						269				
0.7	**SAND**, some silt, trace gravel Loose Brown Moist		1	SS	9				○		5 73 19 3
268.1	(FILL)										
1.5	**SAND**, trace to some silt Loose to Compact Brown Moist		2	SS	6		268		○		
			3	SS	9		267		○		
			4	SS	12				○		
	Dense						266				
264.6			5	SS	38		265		○		0 88 10 2
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MS-12 1 OF 1 METRIC

W.P. _____ LOCATION N 4 913 289.6 E 289 306.9 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.03.05 - 2017.03.05 CHECKED BY MH

SOIL PROFILE			SAMPLES			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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
264.6	GROUND SURFACE										
0.0 / 264.3	**ASPHALT:** (250mm)										
0.3	**SAND**, trace to some silt, trace gravel Compact Brown Moist (FILL)		1	GS			264		○		6 76 15 3
			1	SS	15				○		
			2	SS	19		263		○		
			3	SS	22		262		○		3 86 8 3
261.5											
3.1 / 261.2	**SAND**, some silt with organics Loose		4	SS	8				○		
3.4	Dark Brown Moist Silty **SAND**, trace gravel Compact Grey Wet						261				
259.6			5	SS	11		260		○		
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MS-13 1 OF 1 METRIC

W.P. _____ LOCATION N 4 913 404.4 E 289 214.8 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.03.05 - 2017.03.05 CHECKED BY MH

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
260.2	GROUND SURFACE										
0.0	**ASPHALT:** (190mm)										
0.2	**SAND**, trace silt Brown Moist (FILL)		1	GS			260		○		0 86 9 5
259.4											
0.8	**SAND**, some silt, trace gravel Compact Brown Moist (FILL)		1	SS	19				○		4 72 17 7
							259				
			2	SS	21				○		
258.1											
2.1	**SAND**, trace to some silt, trace gravel Loose Brown Moist		3	SS	4		258		○		
			4	SS	4		257		○		
255.9											
4.3	Silty **SAND**, trace clay, trace gravel Compact Brown Moist		5	SS	24		256		○		2 62 28 8
255.2											
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MS-14 1 OF 1 METRIC

W.P. _____ LOCATION N 4 913 526.8 E 289 110.3 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.03.05 - 2017.03.05 CHECKED BY MH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
255.2	GROUND SURFACE										
0.0	**ASPHALT:** (200mm)										
0.2	**SAND**, trace gravel, trace silt Dense to Compact Brown Moist (FILL)		1	GS			255		○		
			1	SS	33				○		
							254				
			2	SS	21				○		
							253				
			3	SS	18				○		
							252				
			4	SS	18				○		
251.1											
4.1	**SAND**, trace gravel, trace silt Dense Brown Moist						251				
			5	SS	37				○		4 90 6 (SI+CL)
250.2											
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

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

$15\frac{20}{10}5$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MS-15 1 OF 1 METRIC

W.P. _____ LOCATION N 4 913 637.0 E 289 022.2 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.03.05 - 2017.03.05 CHECKED BY MH

SOIL PROFILE			SAMPLES			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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
251.0	GROUND SURFACE										
0.0	**ASPHALT:** (225mm)										
0.2	**SAND**, trace to some silt, trace gravel Compact Brown Moist (FILL)		1	GS					○		
			1	SS	26		250		○		2 94 4 (SI+CL)
			2	SS	20				○		
			3	SS	16		249		○		
			4	SS	17		248		○		4 78 18 (SI+CL)
			5	SS	13		247		○		
246.0							246				
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MS-16 1 OF 1 METRIC

W.P. _____ LOCATION N 4 913 744.4 E 288 930.4 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.03.05 - 2017.03.05 CHECKED BY MH

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
246.9	GROUND SURFACE										
0.0	**ASPHALT:** (200mm)										
0.2	**SAND**, trace to some silt, trace gravel Brown Moist (FILL)		1	GS					○		2 89 9 (SI+CL)
	Compact Wet		1	SS	26		246		○		
			2	SS	17		245		○		
			3	SS	24	▽			○		
243.3			4	SS	7		244		○		
3.6	Silty **CLAY**, sandy, trace gravel Firm Grey Moist (FILL)						243				
242.6											
4.3	Silty **SAND** Dense Grey Moist		5	SS	41		242		○		
241.9											
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE OPEN TO 3.7m AND WATER LEVEL AT 2.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.5m, CUTTINGS TO 0.6m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

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

$15 \oplus^{20}_{10} 5$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MS-17 1 OF 1 METRIC

W.P. _____ LOCATION N 4 913 869.6 E 288 827.4 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.03.05 - 2017.03.05 CHECKED BY MH

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
241.9	GROUND SURFACE										
0.0	**ASPHALT:** (175mm)										
0.2	Gravelly **SAND**, trace silt Dense Brown Moist (FILL)		1	GS					○		29 64 7 (SI+CL)
			1	SS	34		241		○		
240.0			2	SS	39				○		
1.9	Silty **CLAY**, sandy Stiff to Very Stiff Dark Grey Moist (FILL)		3	SS	16		240		○		0 31 43 26
238.4			4	SS	10		239		○		
3.5	**SAND**, some silt, trace gravel Compact Brown Moist (FILL)						238				
236.9	Trace rootlets Dark Brown		5	SS	25		237		○		
5.0	END OF BOREHOLE AT 5.0m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No UP-03 1 OF 4 METRIC

W.P. _____ LOCATION Harvie / Big Bay Point Road N 4 912 083.6 E 289 809.4 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.02.21 - 2017.02.22 CHECKED BY MH

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
290.7	GROUND SURFACE										
0.0	**ASPHALT:** (225mm)										
0.2	**SAND**, some gravel, trace silt Compact Brown Moist (FILL)		1	GS					○		
			1	SS	29		290		○		
289.2											
1.5	Silty **SAND**, trace clay Dense to Very Dense Brown Moist (FILL)		2	SS	31		289		○		
			3	SS	51		288		○		
			4	SS	44				○		0 71 25 4
			5	SS	34		287		○ ○		
			6	SS	31		286		○		
	Occasional wood fibres Very Loose		7	SS	3		285		○		0 69 24 7
282.0							284				
8.7	**SAND**, trace silt, trace gravel Loose to Compact Brown Moist		8	SS	7	▽	283		○		5 87 8 (SI+CL)
							282				
							281				

Continued Next Page

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

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No UP-03 2 OF 4 METRIC

W.P. _____ LOCATION Harvie / Big Bay Point Road N 4 912 083.6 E 289 809.4 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.02.21 - 2017.02.22 CHECKED BY MH

SOIL PROFILE			SAMPLES			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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	SAND, trace silt, trace gravel Compact Brown Moist						280				
			9	SS	13				○		
							279				
	Occasional black sand seams Compact to Dense		10	SS	32				○		
							278				
			11	SS	31		277		○		
							276				
			12	SS	27				○		
							275				
			13	SS	21		274		○		
							273				
			14	SS	44		272		○		
	Some silt to silty Very Dense						271				
	Continued Next Page										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No UP-03 3 OF 4 METRIC

W.P. _____ LOCATION Harvie / Big Bay Point Road N 4 912 083.6 E 289 809.4 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.02.21 - 2017.02.22 CHECKED BY MH

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 (20 40 60 80 100) ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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
	Continued From Previous Page									
	SAND, some silt to silty Very Dense Brown Moist		15	SS	61		270	○	○	0 73 25 2
			16	SS	53		269	○	○	
							268			
							267			
			17	SS	72		266	○	○	
							265			
							264			
			18	SS	86		263	○	○	
							262			
							261			

Continued Next Page

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No UP-03 4 OF 4 METRIC

W.P. _____ LOCATION Harvie / Big Bay Point Road N 4 912 083.6 E 289 809.4 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.02.21 - 2017.02.22 CHECKED BY MH

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										
	SAND, some silt to silty Very Dense Brown Wet										
			19	SS	95		260				
							259				
			20	SS	102						
							258				
			21	SS	100/ 0.250		257				
255.4			22	SS	102/ 0.250		256				
35.3	END OF BOREHOLE AT 35.3m. WATER LEVEL AT 9.3m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No UP-04 1 OF 4 METRIC

W.P. _____ LOCATION Harvie / Big Bay Point Road N 4 912 054.1 E 289 814.8 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.02.13 - 2017.02.17 CHECKED BY MH

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
290.9	GROUND SURFACE										
0.0	**ASPHALT:** (200mm)										
0.2	**SAND**, some gravel to gravelly Brown Moist		1	GS					○		
290.1	(FILL)						290				
0.8	Silty **SAND**, trace gravel Compact to Dense Brown Moist (FILL)		1	SS	22				○		
			2	SS	22		289		○		
			3	SS	49				○		
			4	SS	42		288		○		
			5	SS	40		287		○		
285.3							286				
5.6	**SAND**, trace silt, trace gravel Loose Brown Moist		6	SS	9	▽	285		○		
	Very Dense		7	SS	60		284				
			8	SS	88		283		○		
							282				
							281		○		

Continued Next Page

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

20
15 ⊕ 5 (%) STRAIN AT FAILURE
10

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No UP-04 2 OF 4 METRIC

W.P. _____ LOCATION Harvie / Big Bay Point Road N 4 912 054.1 E 289 814.8 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.02.13 - 2017.02.17 CHECKED BY MH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 20 40 60 80 100 (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × 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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	SAND, trace silt, trace gravel Very Dense Brown Moist						280		○		
			9	SS	76						
							279		○		
			10	SS	87						
							278				
			11	SS	76		277		○		
							276				
			12	SS	80				○		
							275				
			13	SS	64		274		○		
							273				
			14	SS	84				○		
							272				
							271				

Continued Next Page

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No UP-04 3 OF 4 METRIC

W.P. _____ LOCATION Harvie / Big Bay Point Road N 4 912 054.1 E 289 814.8 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.02.13 - 2017.02.17 CHECKED BY MH

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, ● QUICK TRIAXIAL, + FIELD VANE, × 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
	Continued From Previous Page										
	SAND, trace silt Very Dense Brown Moist		15	SS	77				○		
			16	SS	97		270		○		
							269				
							268				
							267				
	Loose (hydraulic disturbance)		17	SS	9		266		○		0 96 3 1
							265				
							264				
			18	SS	112		263		○		
							262				
			19	SS	103		261		○		

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 UP-04 4 OF 4 METRIC

W.P. _____ LOCATION Harvie / Big Bay Point Road N 4 912 054.1 E 289 814.8 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.02.13 - 2017.02.17 CHECKED BY MH

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 (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	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										
	SAND, trace silt Very Dense Brown Moist										
260.0			20	SS	114		260		○		0 94 4 2
30.9	END OF BOREHOLE AT 30.9m. WATER LEVEL AT 6.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.6m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

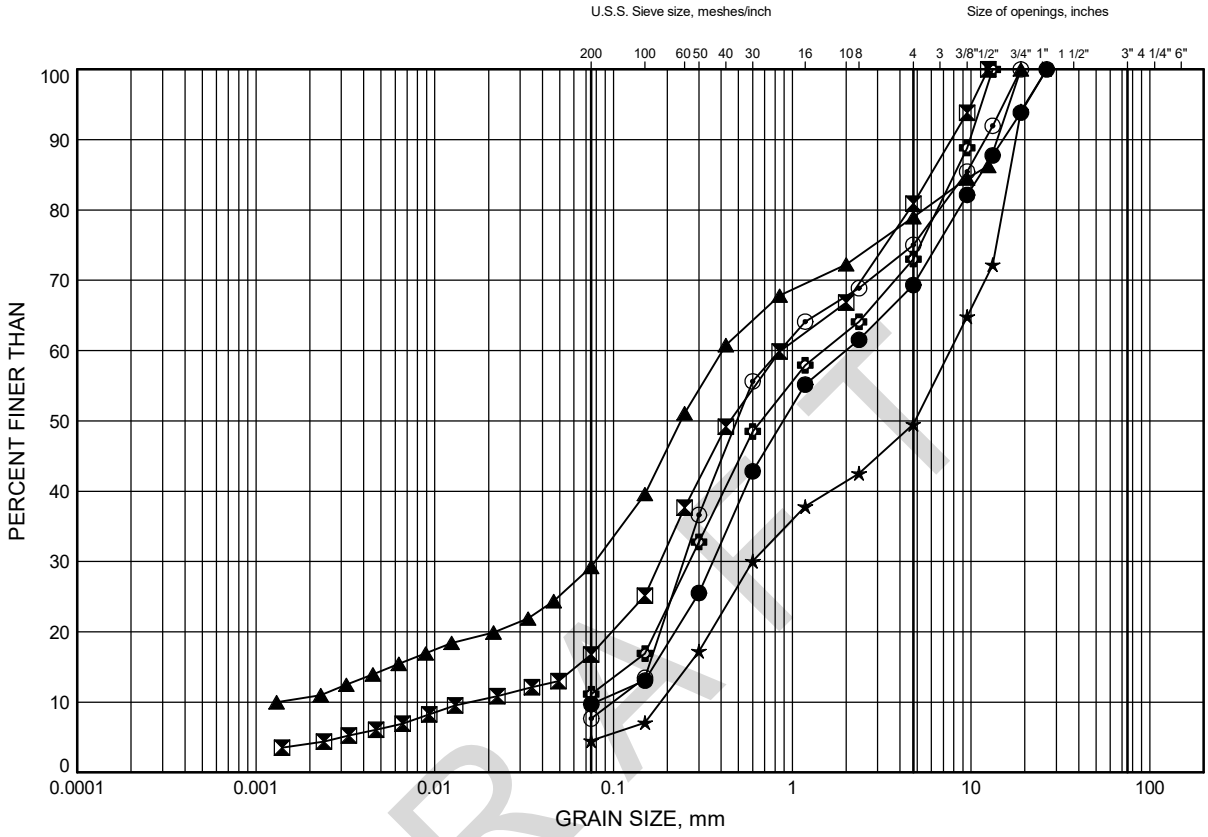
Appendix B

Laboratory Test Results

GRAIN SIZE DISTRIBUTION

FIGURE B1

Gravelly Sand Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MS-03	0.46	292.63
⊠	MS-07	1.07	285.58
▲	MS-07	1.75	284.89
★	MS-08	0.45	282.82
⊙	MS-08	0.99	282.28
✿	MS-11	0.41	269.19

Date April 2017

W.P.

THURBER

Prep'd MFA

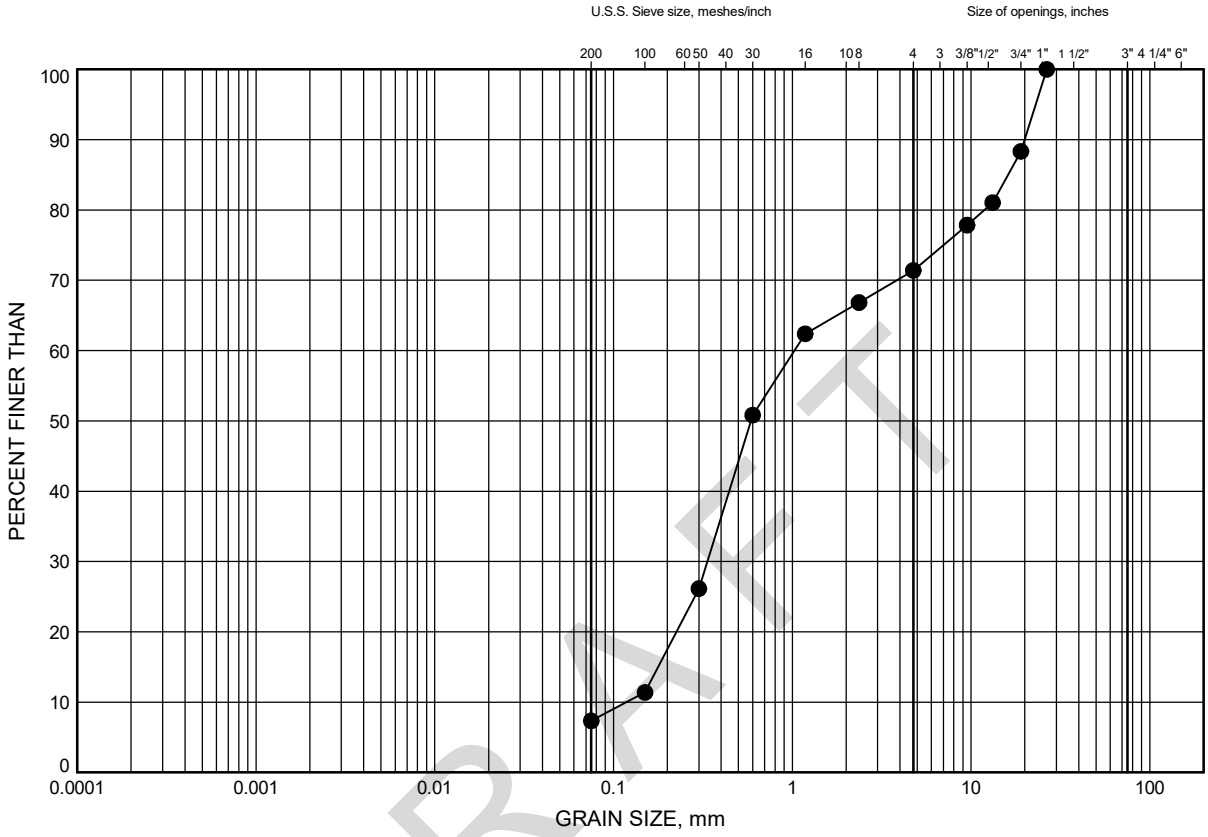
Chkd. MRA

GRAIN SIZE DISTRIBUTION - THURBER MTO-11398.GPJ 4/10/17

GRAIN SIZE DISTRIBUTION

FIGURE B2

Gravelly Sand Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MS-17	0.39	241.51

Date April 2017

W.P.

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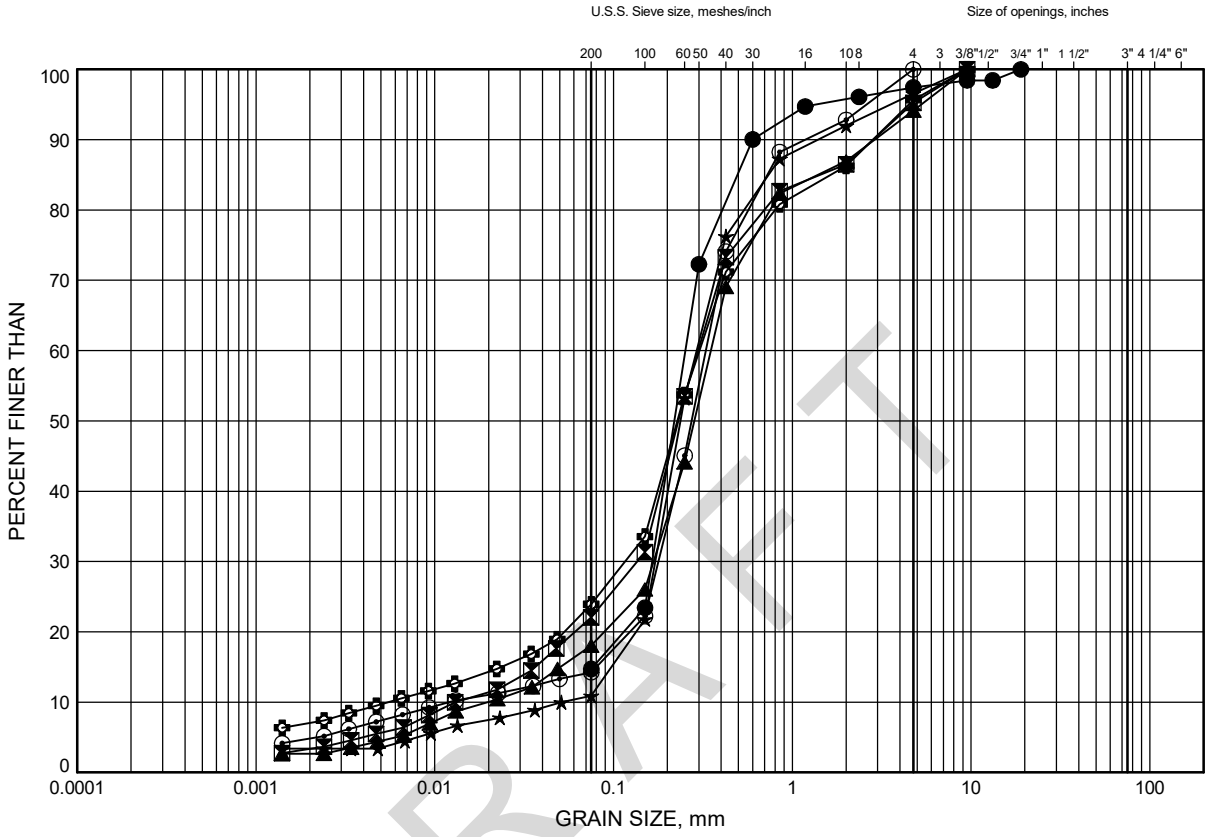
Chkd. MRA

GRAIN SIZE DISTRIBUTION - THURBER MTO-11398.GPJ 4/10/17

GRAIN SIZE DISTRIBUTION

FIGURE B3

Sand Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MS-02	0.46	295.05
⊠	MS-11	0.99	268.61
▲	MS-12	0.43	264.17
★	MS-12	2.51	262.09
⊙	MS-13	0.41	259.79
✿	MS-13	0.99	259.21

Date April 2017

W.P.

THURBER

Prep'd MFA

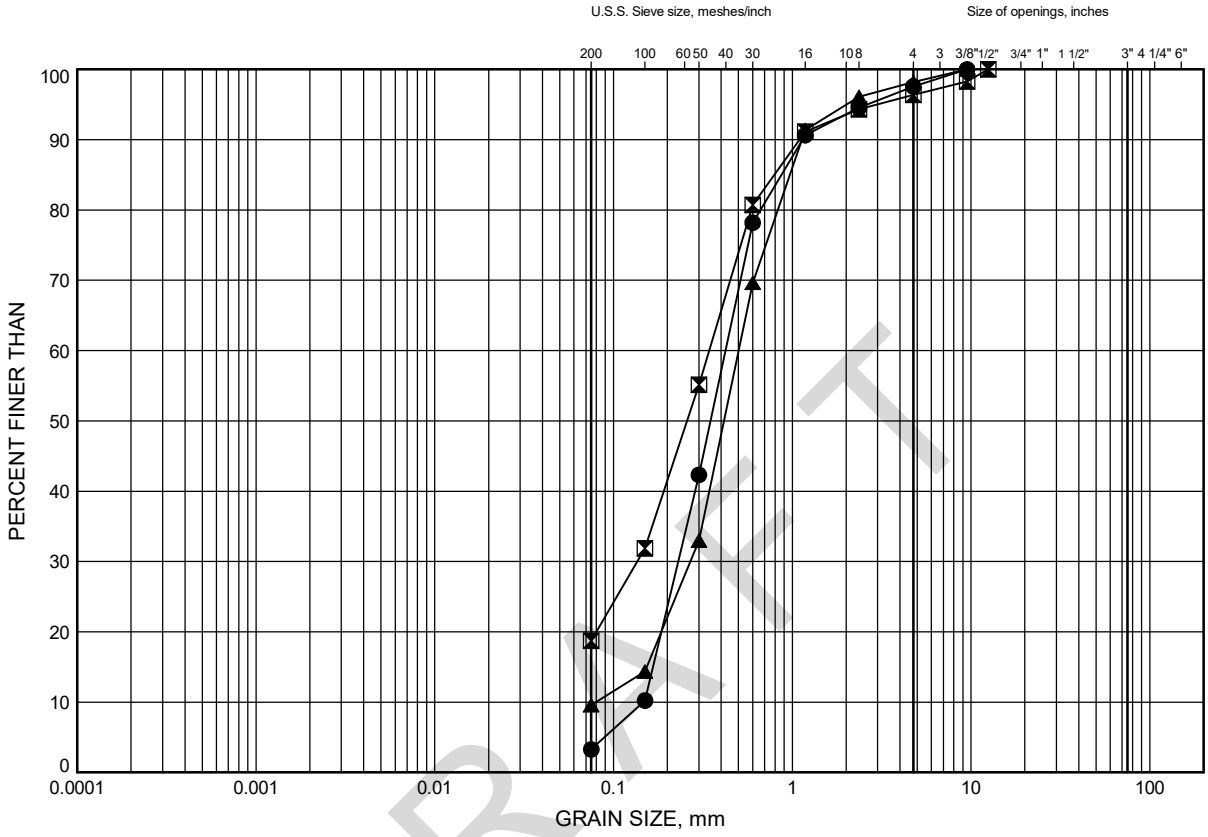
Chkd. MRA

GRAIN SIZE DISTRIBUTION - THURBER MTO-11398.GPJ 4/10/17

GRAIN SIZE DISTRIBUTION

FIGURE B4

Sand Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MS-15	0.99	250.01
⊠	MS-15	3.28	247.72
▲	MS-16	0.41	246.49

Date April 2017

W.P.

THURBER

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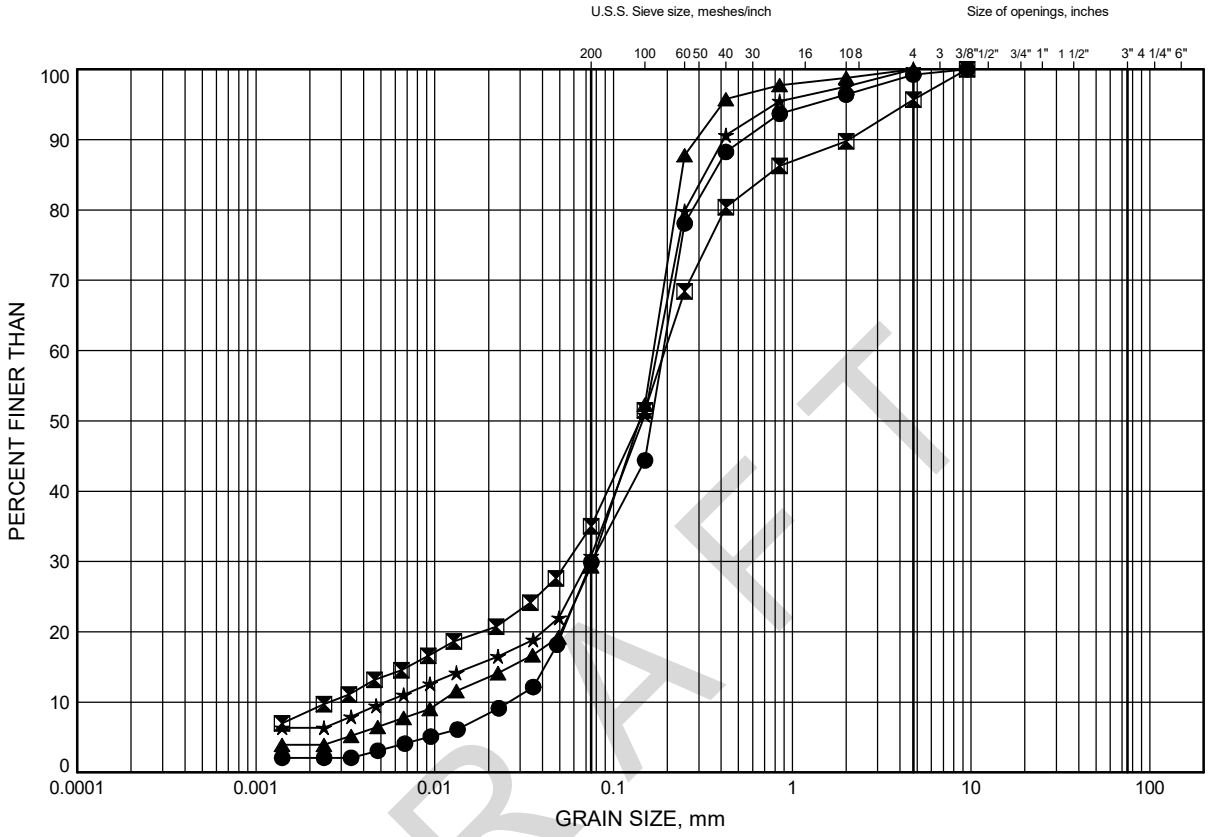
GRAIN SIZE DISTRIBUTION - THURBER MTO-11398.GPJ 4/10/17

Harvie / Big Bay Point Road

GRAIN SIZE DISTRIBUTION

FIGURE B5

Silty Sand Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MS-03	0.99	292.09
⊠	MS-05	1.75	287.49
▲	UP-03	3.28	287.38
★	UP-03	7.85	282.81

Date April 2017

W.P.

THURBER

Prep'd MFA

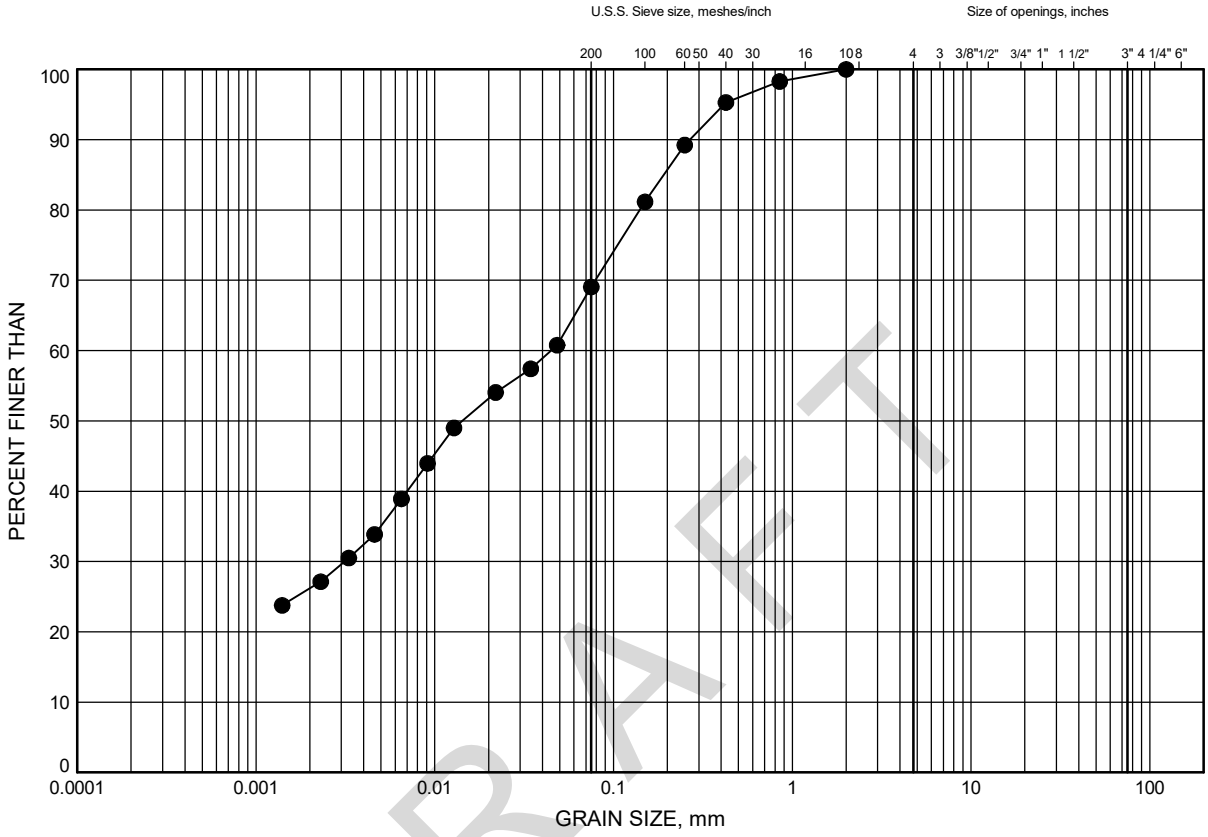
Chkd. MRA

GRAIN SIZE DISTRIBUTION - THURBER MTO-11398.GPJ 4/10/17

GRAIN SIZE DISTRIBUTION

FIGURE B6

Sandy Silty Clay Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MS-17	2.51	239.39

Date April 2017

W.P.

THURBER

Prep'd MFA

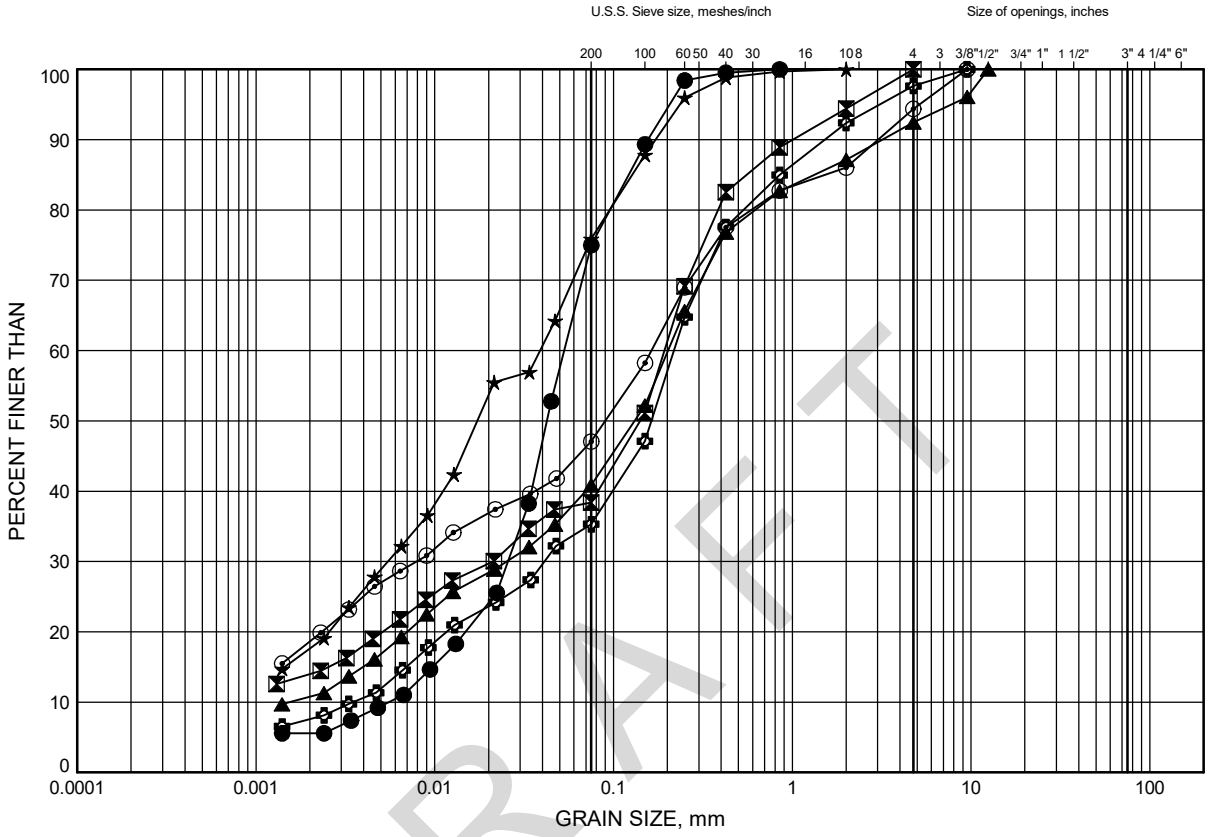
Chkd. MRA

GRAIN SIZE DISTRIBUTION - THURBER MTO-11398.GPJ 4/10/17

GRAIN SIZE DISTRIBUTION

FIGURE B7

Sandy Silt to Silty Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MS-01	4.88	293.02
⊠	MS-02	3.28	292.23
▲	MS-03	2.51	290.57
★	MS-05	2.59	286.65
⊙	MS-07	3.28	283.37
✿	MS-13	4.80	255.40

Date April 2017

W.P.

THURBER

Prep'd MFA

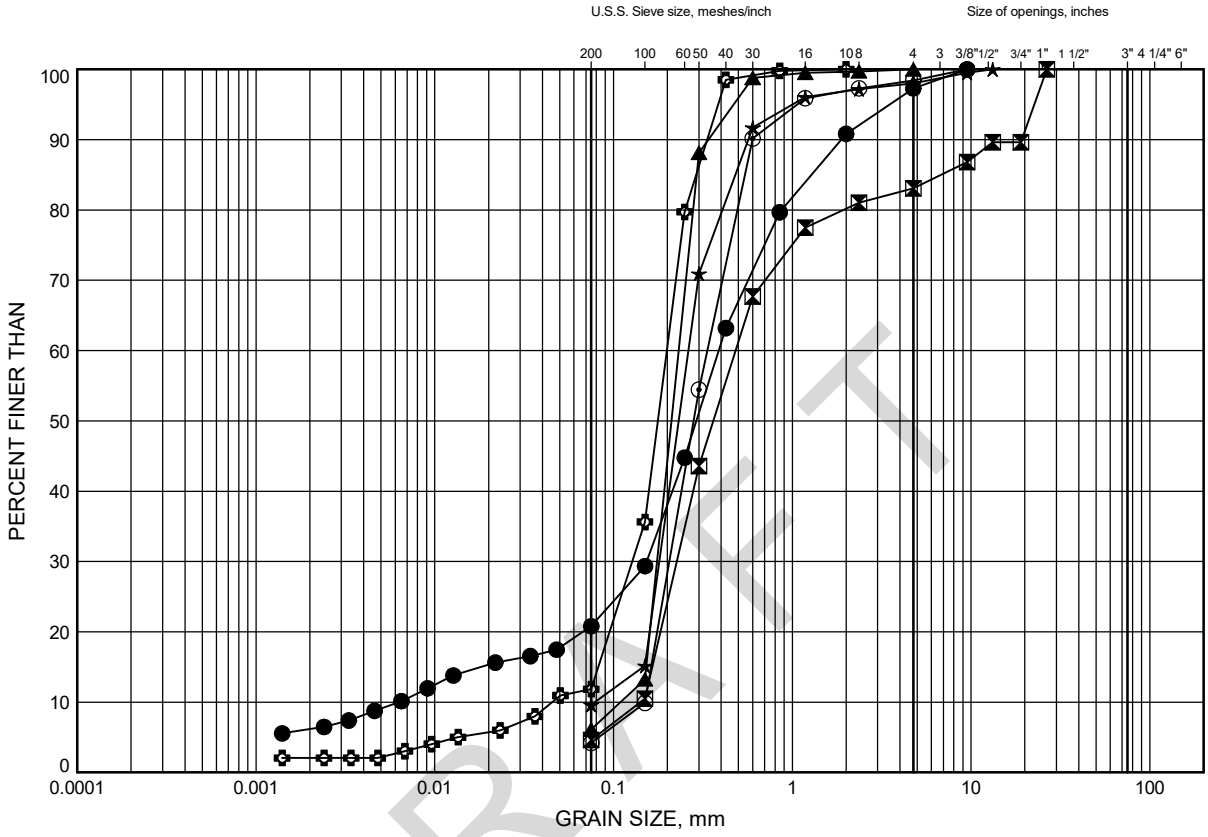
Chkd. MRA

GRAIN SIZE DISTRIBUTION - THURBER MTO-11398.GPJ 4/10/17

GRAIN SIZE DISTRIBUTION

FIGURE B8

Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MS-05	4.80	284.44
⊠	MS-08	3.28	279.99
▲	MS-09	3.28	274.96
★	MS-10	0.46	272.84
⊙	MS-10	0.99	272.31
✿	MS-11	4.88	264.72

Date April 2017

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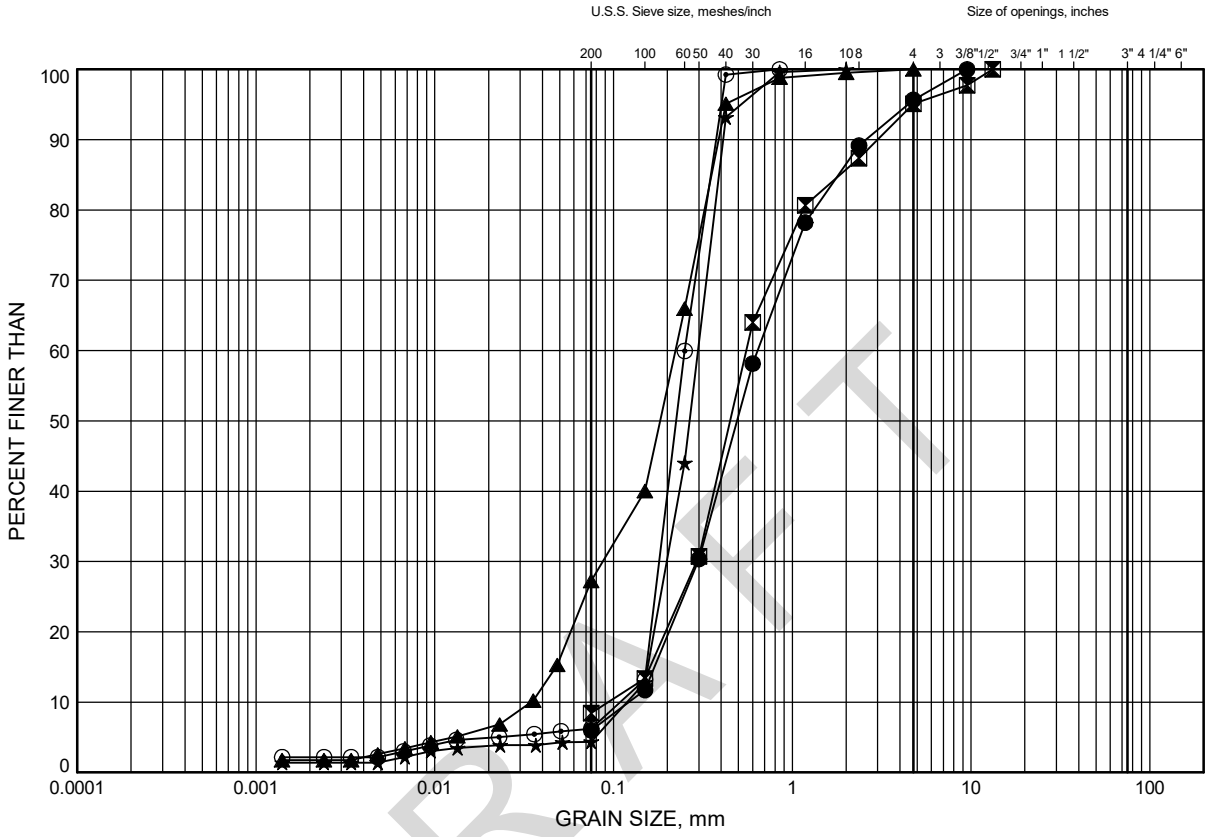
GRAIN SIZE DISTRIBUTION - THURBER MTO-11398.GPJ 4/10/17

Harvie / Big Bay Point Road

GRAIN SIZE DISTRIBUTION

FIGURE B9

Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MS-14	4.80	250.40
⊠	UP-03	9.37	281.28
▲	UP-03	20.04	270.61
★	UP-04	24.69	266.17
⊙	UP-04	30.71	260.15

Date April 2017

W.P.

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Prep'd MFA

Chkd. MRA

GRAIN SIZE DISTRIBUTION - THURBER MTO-11398.GPJ 4/10/17

Appendix C

List of Standard Specifications and Special Provisions

1) The following Standard Specifications and Special Provisions are referenced in this report:

OPSS.PROV 314

OPSS.PROV 401

OPSS.PROV 410

OPSS 539

OPSS 740

OPSS 902

OPSD 802.031

OPSD 911.132

PIPE INSTALLATION BY TRENCHLESS METHOD – Item No.

Non Standard Special Provision January 2012

1. SCOPE

This specification covers the general requirements for the installation of pipes by trenchless methods.

The Contractor shall determine the most appropriate method of installation. Specifications for Jack and Bore, Pipe Ramming, Directional Drilling, and Tunnelling are provided herein, and shall be applied to the installation method considered feasible by the Contractor.

OPSS 415 (Construction Specification for Pipeline and Utility Installation by Tunnelling), OPSS 416 (Construction Specification for Pipeline and Utility Installation by Jacking and Boring) and OPSS 450 (Construction Specification for Pipeline and Utility Installation in Soil by Horizontal Directional Drilling) shall not be used to do the work for the above tender item.

2. REFERENCES

This specification refers to the following standards, specifications, or publications:

Foundation Investigation and Design Report, Shamrock Lake Centre Culvert Replacement, Highway 11, Thunder Bay District, Ontario, GWP No. 6910-12-00, WP No.6910-12-00, Site No. 48C-338/C, by Thurber Engineering Ltd., Reference No. 13639.

Ontario Provincial Standard Specifications, General

OPSS 180	Management and Disposal of Excess Material

Ontario Provincial Standard Specifications, Construction

OPSS 504	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 507	Site Restoration Following Installation of Pipelines, Utilities and Associated Structures in Open Cut
OPSS 514	Trenching, Backfilling, and Compaction
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 538	Support Systems
OPSS 539	Protection Schemes

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1802	Smooth Walled Steel Pipe

MTO Specifications

OPSS 1820	Material Specification for Circular Concrete Pipe
OPSS 1840	Material Specification for Non-Pressure Polyethylene Plastic Pipe Products

American Society for Testing and Materials (ASTM) International Standards

ASTM A252-93	Welding and Seamless Steel Pipe Piles
ASTM D2657-03	Standard Practice for Heat Fusion Joining of Polyelofin Pipe and Fittings
ASTM D3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
ASTM F894	Polyethylene Large Diameter Profile Wall Sewer and Drain Pipe

Canadian Standards Association Standards:

CSA B182.6	Profile Polyethylene Sewer Pipe and Fittings.
CAN/CSA A5-93	Portland Cement
CSA W59	Welded Steel Construction (Metal Arc Welding)

3. DEFINITIONS

For the purpose of this specification, the following definitions apply:

Backreamer: a cutting head suitably designed for the subsurface conditions that is attached to the end of a drill string to enlarge the pilot bore during a pullback operation.

Bore Path: a drilled path according to the grade and alignment tolerances specified in the Contract Documents.

Design Engineer: means the Engineer retained by the Contractor who produces the original design and working drawings. The design engineer shall be licensed to practice in the Province of Ontario.

Design Checking Engineer: means the Engineer retained by the Contractor who checks the original design and working drawings. The design checking engineer shall be licensed to practice in the Province of Ontario.

Digger Shield/Hand Mining: a method of forming a horizontal bore in the subsurface by essentially simultaneously jacking ahead while tunnelling advances using hand–mining (man-entry operation or "Jack and Mine) or a "digger" type shield with a hydraulic excavator arm to remove materials from inside the liner pipe.

Drilling Fluids: a mixture of water and additives, such as bentonite, polymers, surfactants, and soda ash, designed to block the pore space on a bore wall, reduce friction in the bore, and to suspend and carry cuttings to the surface.

Drilling Fluid Fracture or Frac Out: a condition where the drilling fluid's pressure in the bore is sufficient to overcome the in situ confining stress, thereby fracturing the soil and/or rock materials and allowing the drilling fluids to migrate to the surface at an unplanned location.

Engineer: a Professional Engineer licensed by the Professional Engineers of Ontario to practice in the Province of Ontario.

Excavation: includes all materials encountered regardless of type and extent. Excavation shall include removal of natural soil, large boulders, cobbles, wood and fill regardless of means necessary to break consolidated materials for removal.

Environmentally Sensitive Area (ESA): areas adjacent to construction that are off limits to the Contractor as specified elsewhere in the Contract.

Fill: man-made mixture of previously placed/handled materials such as sand, clay, silt, gravel, broken rock, sometimes containing organic and/or deleterious materials, placed in an excavation or other area to raise the surface elevation.

Grouting: injection of grout into voids.

Guidance System: an electronic system capable of locating the position, depth and orientation of the drill head during the directional drilling process.

Directional Drilling (DD): directional boring or guided boring.

HDPE: high density polyethylene.

Inadvertent Returns: the flow of unexpected fluids, saturated materials (or running soil) towards the drilling rig that typically originated from an artesian aquifer encountered during the drilling process.

Jack and Bore: a method of forming a horizontal bore in the subsurface by essentially simultaneously jacking ahead and rotating a cutter head, followed by removal of material from inside the bore.

Loss of Circulation: the discontinuation of the flow of drilling fluid in the bore back to the entry or exit point or other planned recovery points.

Pilot Bore: the initial bore to set directional controlled horizontal and vertical alignment between the connecting points.

Pipe Jacking: a method for installing steel casing or concrete pipe in the subsurface utilizing hydraulically operated jacks of adequate number and capacity to ensure smooth and uniform advancement without overstressing the liner/pipe.

Pipe Ramming: a method for installing steel casings utilizing the energy from a percussion hammer to advance a steel casing with a cutting shoe attached at the front end of the casing.

Primary Liner (Support): system installed prior to or concurrent with excavation, to maintain stability of an excavation and to support earth or rock and any structure utilities or other facilities in or on the supported earth or rock mass, until the excavation is completed.

Product: pipe culverts, pipe sewers, watermain pipe and sanitary pipe.

Pullback: that part of the DD method in which the drill string is pulled back through the bore path to the entry point.

Quality Verification Engineer (QVE): an Engineer who has a minimum of five (5) years experience in the field of pipe installation using trenchless methods or alternatively has demonstrated expertise by providing satisfactory quality verification services for the work at a minimum of two (2) projects of similar scope to the contract. The Quality Verification Engineer

shall be retained by the Contractor to certify that the work is in general conformance with the contract documents and to issue Certificate(s) of Conformance.

Reaming: a process for pulling a tool attached to the end of the drill string through the bore path to enlarge the bore and mix the cuttings with the drilling fluid. This typically includes multiple passes.

Rock: natural beds or massive fragments, or the hard, stable, cemented part of the earth's crust, igneous, metamorphic, or sedimentary in origin, which may or may not be weathered and includes boulders having a size equivalent to 0.3 m in diameter or greater.

Secondary Liner: concrete pipe, HDPE pipe or un-reinforced cast-in-place concrete, installed subsequent to tunnel excavation.

Shaft: vertically sided excavation used as entry and/or exit points from which the trenchless method is initiated or directed for the installation of product.

Strike Alert: a system that is intended to alert and protect the operator in the case of inadvertent drilling into an electrical utility cable. The strike alert system consists of a sensor and an alarm connected to the drill rig and a grounding stake. The alarm may be audio or visual or both.

Slurry: a mixture of soil and/or rock cuttings, and drilling fluid.

Soil: all materials except those defined as rock, and excludes stone masonry, concrete, and other manufactured materials; includes rock fragments having an equivalent size less than 0.3 m in diameter.

Tunnelling: an underground method of constructing a passage open at both ends that involves installing a pipe.

4. DESIGN AND SUBMISSION REQUIREMENTS

4.01 General

The Contractor's documentation, submission requirements and installation methods shall specifically consider and address the subsurface conditions at each pipe crossing as identified in the Foundation Investigation Report.

4.02 Working Drawings

Three copies of stamped working drawings for portal or shaft construction, primary liner, excavation, secondary lining, dewatering and groundwater control and grouting shall be submitted to the Contract Administrator (CA) at least one (1) week prior to the commencement of the work for information purposes. All submissions shall bear the seal and signature of the Design Engineer and Design Checking Engineer. The Contractor shall have a copy of the stamped working drawings at the site during construction.

As a minimum, working drawings/details pertaining to the tunnel design and construction shall include the following (as appropriate):

a) Plans, Elevations and Details:

- A work plan outlining the materials, procedures, methods and schedule to be used to execute the work;
- A list of personnel, including backup personnel, and their qualifications and experience;
- A safety plan including the company safety manual and emergency procedures;
- The work area layout;
- An erosion and sediment control plan that includes a contingency plan in the event the erosion and sediment control measures fail;
- A drilling fluid management plan, if applicable, that addresses control of frac-out pressures, any potential environmental impacts and includes a contingency plan detailing emergency procedures in the event that the fluid management plan fails;
- Lighting, ventilation and fire safety details as may be required by applicable occupational health and safety regulations; and
- Excavated materials disposal plan.

b) Design Criteria:

- Primary liner design details, if applicable; and
- Design assumption and material data when materials other than those specified are proposed for use.
- Drill path design, details of alignment and alignment control, maximum curvature and reaming stages;

c) Materials:

- Certification from the manufacturer that the product furnished on the contract meets the specifications cited in the manufacturer's product specification and that the materials supplied are suitable for the application; and
- Material mixture for filling voids and installation procedures.

d) Upstream/Downstream Portal Installation Procedure:

- The access shaft or entry/exit pit details designed and stamped/signed by the Design Engineer, as applicable; and
- Face support and other temporary support details, if applicable.

e) Primary Liner/Secondary Liner Installation and Grouting Procedure:

- Excavation and pipe jacking procedures, including methodology to handle obstructions and preventing soil cave-in; and
- Details of tunnelling equipment/methods to be used for the works.

f) Excavation and Dewatering:

- Ground control/dewatering details, as applicable, describing the proposed method for control, handling, treatment, and disposal of water.

g) Monitoring Method

- The methods to be employed to monitor and maintain the alignment of the installation;

4.03 Site Survey

Prior to commencing the work, the Contractor shall, at each pipe location, layout the alignment and install settlement monitoring points.

4.04 Certificate of Conformance

The Contractor shall submit details of the sequence and method of construction to the Quality Verification Engineer for review, prepared and stamped by the Design Engineer. The Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by the Quality Verification Engineer a minimum of one week prior to commencement of work under this item. The Certificate shall state that the construction procedures are in conformance with the requirements and specifications of the contract documents.

The Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by the Quality Verification Engineer upon completion of each of the following operations and prior to commencement of each subsequent operation for each pipe installation:

Site Surveying (as noted in Section 4.02)
Excavation for pits including dewatering of excavation
Jacking/Ramming/Directional Drilling of Casing/Liner
Excavation and Dewatering
Installation of the Product
Grouting Operations

Each Certificate of Conformance shall state that the work has been carried out in general conformance with the contract documents, specifications and/or stamped working drawings.

In addition, upon completion of the installation of the pipe at each location, the Contractor shall submit to the Contract Administrator a **final** Certificate of Conformance sealed and signed by the Quality Verification Engineer. The Certificate shall state that the pipe has been installed in general conformance with the Contractor's Submission and Design Requirements, stamped working drawings and contract documents.

The Design Engineer will not be permitted to carry out the work of the Quality Verification Engineer.

5. MATERIALS

5.01 Product

The product shall be concrete pipe or high density polyethylene pipe as specified.

5.02 Concrete

Concrete shall be according to OPSS 1350. The concrete strength shall be as specified in the Contractor's design submission.

5.03 Concrete Reinforcement

Steel reinforcing for concrete work shall be according to OPSS 1440.

5.04 Timber

Timber shall be sound, straight, and free from cracks, shakes and large or loose knots.

5.05 Grout

The Contractor shall submit the proposed grout mix design for grouts to be used for lubricating jacking pipe and for filling of voids and annular spaces. Purging grout shall consist of a mixture of one part Portland cement conforming to the requirements of CAN/CSA A5-93 and two parts mortar sand conforming to OPSS 1004 wetted with only sufficient water to make the mixture plastic.

5.06 Jack and Bore Materials

5.06.01 Pipe Materials

Steel pipe shall conform with ASTM A252-95 welded joints suitable for jacking operations. The Contractor shall select pipe class for pipe jacking.

Concrete pipe as per OPSS 1820.

Fittings shall be suitable for and compatible with the class and type of pipe with which they will be used.

5.07 Pipe Ramming Materials

5.07.01 Pipe Materials

Steel pipe shall conform with ASTM A 252-93 welded joints.
New steel casing when specified shall be smooth wall carbon steel pipe according to ASTM A252-93 Grade 2.

Used steel casing can be used provided that the steel casing can resist the applicable static and dynamic loadings.

Pipe wall thickness shall be determined by the Contractor based on static and dynamic loads from traffic loading and anticipated ramming forces for selected pipe and driven pipe lengths. The wall thickness shall be increased as required to ensure the casing is not damaged during handling and installation. A minimum wall thickness of 50 mm and minimum yield strength of 240 MPa is required.

Pipe segments shall be determined by the Contractor.

Steel pipe joints shall be pressure fit type or welded.

All steel casing pipe shall be square cut.

Steel casing pipe shall have roundness such that the difference between the major and minor outside diameters shall not exceed 1% of the specified nominal outside diameter or 6 mm, whichever is less.

Steel casing pipe shall have a minimum allowable straightness of 1.5 mm maximum per metre of length.

5.07.02 Mill Certificates

For permanent casing, the Contractor shall submit to the Contract Administrator at the time of delivery one copy of the mill certificate, indicating that the steel meets the requirements for the appropriate standards for casings.

Where mill test certificates originate from a mill outside Canada or the United States of America the Contractor shall have the information on the mill certificate verified by testing by a Canadian laboratory.

The laboratory shall be accredited by a Canadian National Accreditation Body to comply with the requirements of ISO/IEC Guide 25 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test certificates shall be stamped with the name of the Canadian testing laboratory and appropriate wording stating that the material conforms to the specified material requirements. The stamp shall include the appropriate material specification number, the date and the signature of an authorized officer of the Canadian testing laboratory.

5.08 Directional Drilling Materials

5.08.01 Drilling Fluids

The drilling fluids shall be mixed according to the manufacturer's recommendations and be appropriate for the anticipated subsurface conditions.

5.08.02 Pipe Materials

High Density Polyethylene (HDPE) pipe as per OPSS 1840 shall be used in accordance with ASTM D3350.

The requirements for fittings shall be suitable for and compatible with the class and type of pipe with which they will be used and in according to CAN/CSA-B182.6 or ASTM F894.

The Contractor shall determine the required dimensional ratio (DR) of the HDPE pipe to support all subsurface conditions and hydrostatic pressures, and to withstand the grouting pressure and installation forces. The Contractor shall identify these forces in his submission requirements.

The Contractor's submission shall demonstrate, in conjunction with the manufacturer's specifications, that the heat resistance of the pipe material is sufficient to tolerate without damage the heat of hydration generated by grout curing.

Fittings shall be suitable for and compatible with the class and type of pipe with which they will be used.

Jointing of HDPE piping shall be completed by thermal butt fusion in accordance with manufacturer's recommended procedures and as outlined in the latest revision of ASTM D2657. All manufacturer's recommendations and procedures shall be followed during the jointing process.

Jointing of HDPE piping to other piping materials or appurtenances shall be completed using flanged connections.

5.09 Tunnelling Materials

5.09.01 Primary Liner

Tunnelling methods will require installation of a primary liner to provide support and stability to the excavation.

5.09.02 Secondary Liner

Concrete or High Density Polyethylene Pipe shall be used according to the following requirements.

5.09.02.01 Concrete Pipe

Concrete pipe as per OPSS 1820 shall be used. The Contractor shall select the pipe class to withstand grouting pressure and installation forces. The Contractor shall identify these forces in his submission requirements.

Fittings shall be suitable for and compatible with the class and type of pipe with which they will be used.

5.09.02.02 High Density Polyethylene (HDPE)

High Density Polyethylene (HDPE) pipe as per OPSS 1840 shall be used in accordance with ASTM D3350.

The requirements for fittings shall be according to CAN/CSA-B182.6 or ASTM F894.

The Contractor shall determine the required dimensional ratio (DR) to withstand the grouting pressure and installation forces. The Contractor shall identify these forces in his submission requirements.

Fittings shall be suitable for and compatible with the class and type of pipe with which they will be used.

Jointing of HDPE piping shall be completed by thermal butt fusion in accordance with manufacturer's recommended procedures and as outlined in the latest revision of ASTM D2657. All manufacturer's recommendations and procedures shall be followed during the jointing process.

Jointing of HDPE piping to other piping materials shall be completed using flanged connections.

6. EQUIPMENT

6.01 Jack & Bore Equipment

Jack & bore equipment shall be determined by the Contractor and shall be identified in the submission requirements specified herein.

Specific details of the manner in which rock or boulders will be broken and removed from the face and the face will be protected to prevent soil loss into the liner shall be submitted to the Contract Administrator for information purposes prior to proceeding with the works.

6.02 Pipe Ramming Equipment

Pipe ramming equipment shall be determined by the Contractor and shall be identified in the submission requirements specified herein.

The pipe ramming hammer(s) shall be capable of driving the pipe casing from the drive pit through the existing subsurface conditions at the site.

Specific details of the manner in which rock or boulders will be broken and removed from the face and the face will be protected to prevent soil loss into the pipe shall be submitted to the Contract Administrator for information purposes prior to proceeding with the works.

6.03 Directional Drilling Equipment

6.03.01 General

The directional drilling equipment shall consist of a directional drilling rig and a drilling fluid mixing and delivery system of sufficient capacity to successfully complete the product installation without exceeding the maximum tensile strength of the product being installed.

6.03.02 Drilling Rig

The directional drilling rig shall:

- consist of a leak free hydraulically powered boring system to rotate, push, and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill head;
- contain a guidance system to accurately guide boring operations;
- be anchored to the ground to withstand the rotating, pushing, and pulling forces required to complete the product installation; and
- be grounded during all operations unless otherwise specified by the drilling rig manufacturer.

6.03.03 Drill Head

The drill head shall be steerable by changing its rotation, be equipped with the necessary cutting surfaces and drilling fluid jets, and be of the type for the anticipated subsurface conditions,

6.03.04 Guidance System

The guidance system shall be setup, installed, and operated by trained and experienced personnel. The operator shall be aware of any magnetic or electromagnetic anomalies and shall consider such influences in the operation of the guidance system when a magnetic or electromagnetic system is used.

6.03.05 Drilling Fluid Mixing System

The drilling fluid mixing system shall be of sufficient size to thoroughly and uniformly mix the required drilling fluid.

6.03.06 Drilling Fluid Delivery System

The delivery system shall have a means of measuring and controlling fluid pressures and be of sufficient flow capacity to ensure that all slurry volumes are adequate for the length and diameter of the final bore and the anticipated subsurface conditions. Connections between the delivery pump and drill pipe shall be leak-free.

6.04 Tunnelling Equipment

Tunnelling equipment shall be determined by the Contractor and shall be identified in the submission requirements specified herein.

Specific details of the manner in which rock or boulders will be broken and removed from the tunnel face shall be submitted to the Contract Administrator information purposes. Use of explosives or rock fracturing chemicals shall only be considered subject to a field demonstration satisfactory to the Ministry prior to its use.

7. CONSTRUCTION

7.01 General

The Contractor shall notify the Contract Administrator at least 48 hours in advance of starting work. The proposed method of pipe installation shall be subject to the limitations presented in the following subsections.

7.01.01 Layout, Alignment and Depth Control

The location of the installation shall be established from the lines, elevations and tolerances specified in the Contract Documents. The pipe installation shall be to the horizontal and vertical alignments specified in the Contract Drawings. Deviations from location, alignment, grades and/or invert levels shall be corrected by the Contractor at no cost to the Ministry.

All reference points necessary to construct the pipe installation and appurtenances shall be laid out.

The Contractor shall calibrate tracking and locating equipment at the beginning of each work day, and shall monitor and record the alignment and depth readings provided by the tracking system at every 5 m in normal conditions and every 2 m where precise alignment control is necessary;

The Contract Administrator shall be provided with the assistance and access necessary to check the layout of the pipe installation and associated appurtenances.

All excavations shall be carried out in accordance with the Occupational Health and Safety Act (OHSA) of Ontario.

For directional drilling, the contractor shall ensure that during pilot hole drilling the maximum degree of deviation or "dog-leg" shall be 2.5 degrees per 9m drill pipe length. Any deviation exceeding 2.5 degrees will necessitate a pull-back and straightening of the alignment at the Contractor's sole expense. The pilot hole exit location shall be within 0.5m of the target location.

7.01.02 Shafts

Shafts shall be specified in the Contractor's submission. The boundaries and protection of these shall be as required to contain all disturbances to areas outside of the ESA limits.

Shafts shall be maintained in a drained condition.

A minimum 2.4 m high secure fence shall be installed around the perimeter of the construction shaft area with gates and truck entrances. The fence shall be removed on completion of the work.

7.01.03 Protection Systems

The construction of all protection systems shall be according to OPSS 539. Where the stability, safety, or function of an existing roadway, watercourse, other works, proposed works or ESA's may be impaired due to the method of operation, protection shall be provided. Protection systems include primary liner and portal excavation support systems. Protection may include sheathing, shoring, and piles where necessary to prevent damage to such works or proposed works

7.01.04 Settlement or Heave

Any disturbance to the ground surface (settlement or heave) as a result of the pipe installation shall be immediately corrected by the Contract, at no additional cost to the Ministry.

7.01.05 Stability of Excavation

The construction methods, plant, procedures, and precautions employed shall ensure that excavations are stable, free from disturbance, and maintained in a drained condition.

The construction methods, plant, and materials employed shall prevent the migration of soil and/or rock material into the excavation from adjacent ground.

7.01.06 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 504.

Existing underground facilities shall be exposed to verify its horizontal and vertical locations when the outlet pipe path comes within 1.0 m horizontally or vertically of the existing facility. Existing facilities shall be exposed by non-destructive methods.

7.01.07 Transporting, Unloading, Storing and Handling Materials

Manufacturer's handling and storage recommendations shall be followed.

7.01.08 Trenching, Backfilling and Compacting

Trenching, backfilling, and compacting for entry and exit points or other locations along the pipe path shall be according to OPSS 514.

7.01.09 Dewatering

The work of this Section includes control, handling, treatment, and disposal of groundwater. The Contractor shall review the foundation investigation report for reference to soil and groundwater conditions on the project site and plan a dewatering scheme accordingly.

The Contractor shall control groundwater inflows to excavations to maintain stability of surrounding ground, to prevent erosion of soil, to prevent softening of ground exposed in the excavation, and to avoid interfering with execution of the work.

The Contractor shall maintain excavations free of standing water at all times during excavation, including while concrete is curing.

Should water enter the excavation in amounts that could adversely affect the performance of the work or could cause loss of ground, the Contractor shall take immediate steps to control the inflow.

The Contractor is alerted that seepage zones of perched water within the fill materials should be expected, particularly where granular materials are excavated.

Dewatering shall be according to OPSS 517.

7.01.10 Removal of Boulders

The Contractor is alerted that cobbles and boulders should be anticipated in the soil deposits at the site. Accordingly, the Contractor shall address the removal of cobbles and boulders in the proposed method of construction. The Contractor shall immediately inform the Contract Administrator of any obstruction encountered.

7.01.11 Record Keeping

Verification record requirements of the alignment and depth of the installation shall be as specified in the Contract Documents. A copy of the verification records shall be given to the Contract Administrator at the completion of the installation.

7.01.12 Testing

Testing of the product installation shall consist of verifying the specified grade between the two ends of the pipe and passing of water from the median end of the pipe to the outlet end to confirm gravity flow conditions.

7.01.13 Management and Disposal of Excess Material

Management and disposal of excess material shall be according to OPSS 180. Satisfactory re-usable excavated material required for backfill shall be separated from unsuitable excavated material.

7.01.14 Site Restoration

Site restoration shall be according to OPSS 507.

7.01.15 Supervision

A qualified individual, who is experienced in the pipe installation by trenchless methods shall supervise the work at all times.

7.02 Jack and Bore Installation

7.02.01 Method of Installation Procedure

The installation procedure to be used shall be subject to the following limitations:

- Hydraulically operated jacks of adequate number and capacity shall be provided to ensure smooth and uniform advancement without over-stressing of the pipe.
- A suitably padded jacking head or collar shall be provided to transfer and distribute jacking pressure uniformly over the entire end bearing area of the pipe.
- The jacking pipe shall be fully supported in the jacking pit at the specified line and grade.
- Selection of the excavation method and jacking equipment shall take into consideration the conditions at each pipe crossing.

7.02.02 Pipe Installation

Concrete pipe joints shall be water tight and according to OPSS 1820 and must withstand jacking forces, determined by the Contractor.

During the jacking of the liner the space between the liner and the wall of the excavation shall be kept filled with bentonite slurry. Upon completion of jacking, the space between the liner and the wall of the excavation shall be filled with grout.

The annular space between the liner and the product shall be fully grouted with a water tight, expandable and stable grout.

7.03 Pipe Ramming Installation

For pipe ramming installation the following requirements apply:

Only smooth walled steel pipe shall be used. But welding of pipe joints shall conform to CAS W59.

Ramming equipment of adequate capacity shall be provided to ensure smooth and uniform advancement without overstressing of the pipe. Delays shall be avoided between ramming operations.

A ramming head shall be provided to transfer and distribute jacking pressure uniformly over the entire end bearing area of the pipe.

Two or more lubricated guide rails or sills shall be provided of sufficient length to fully support the pipe at the specified line and grade in the ramming pit. Pipe shall be installed to the line and grade specified.

Following installation of the liner pipe, all material shall be removed from the pipe to the satisfaction of the Contract Administrator. Any voids remaining between the pipe and the excavation wall shall be grouted as soon as the pipe is rammed. The annular space between the liner pipe and the product shall be fully grouted with a water tight, expandable and stable grout.

7.04 Directional Drilling Installation

7.04.01 General

When strike alerts are provided on a drilling rig, they shall be activated during drilling and maintained at all times.

7.04.02 Site Preparation

The work site shall be graded or filled to provide a level working area for the drilling rig. No alterations beyond what is required for DD operations are to be made. All activities shall be confined to designated work areas.

7.04.03 Pilot Bore

The pilot bore shall be drilled along the bore path in accordance with the grade, alignment, and tolerances as indicated on the Contractor's submitted drilling plan to ensure that the product is installed to the line and

grade shown on the Contract Drawings. The Contractor's methods shall take into consideration the conditions at each crossing within the pipe alignment and shall be suitable to advance through such obstructions such as cobbles and boulders and address the potential for deflection off these obstruction and/or soil conditions.

In the event the pilot bore deviates from the submitted path, the Contract Administrator shall be notified. The Contract Administrator may require the Contractor to pullback and re-drill from the location along the bore path before the deviation.

In the event that a drilling fluid fracture, inadvertent returns, or loss of circulation occurs during pilot bore drilling operations, the Contract Administrator shall be advised of the event and action shall be taken in accordance with the Contractor's submitted contingency plan.

At the entry and exit points, there is potential for ravelling of the existing soil, fill and or weathered rock areas along the alignment. This is conventionally addressed by the use of drilling fluid. However, casing may be required. The Contractor's methods shall take into consideration the potential need to install sections of casing to manage ravelling at or near ground surface.

If a drill hole beneath the highway must be abandoned, the hole shall be backfilled with grout or bentonite to prevent future subsidence.

The Contractor shall maintain drilling fluid pressure and circulation throughout the DD process, including during the initial pilot bore and during the reaming process.

The Contractor shall at all times and for the entire length of the installation alignment be able to demonstrate the horizontal and vertical position of the alignment, the fluid volume used, return rates and pressures.

7.04.04 Drilling Fluid Fracture (Frac-Out)

In order to reduce the potential for hydraulic fracturing of the hole during directional drilling, a minimum depth of cover of 5m is normally maintained between the pipe and the ground surface. Sections of the pipe close to the exit pit with less than 5m cover shall be cased. The Contractor shall ensure that drilling fluid pressures are properly set and controlled to prevent frac-out, for the depth of cover available between the bottom of the pavement structure (bottom of the subbase material) and the top of the bore.

Since fluid loss normally occurs in fault zones, fracture zones, or seams of coarse material, fluid migration does not always gravitate to the surface, thus making detection difficult. Once a fluid loss is detected, the Contractor shall halt operations immediately and conduct a detailed examination of the drill path and implement measures to mitigate fluid loss. If no surface migration is evident, resume operation while paying particular attention to fluid monitoring.

In the event of a fluid migration to the surface occurring, the Contractor shall halt all operations immediately, isolate the migration site, and recover fluids. Once the fracture is controlled, continue drilling operations with the operator paying particular attention to the fracture points

7.04.05 Reaming

The bore shall be reamed using the appropriate tools to a diameter at least 50% greater than the outside diameter of the product.

7.04.06 Product Installation

7.04.06.01 General

The product shall be jointed according to manufacturer's recommendations. The length of the product to be pulled shall be jointed as one length before commencement of the continuous pulling operation.

The product shall be protected from damage during the pullback operation.

The minimum allowable bending radius for the product shall not be exceeded.

Product shall be allowed to recover before connections to new or existing facility are made. Product recovery time shall be according to manufacturers recommendations.

7.04.06.02 Pullback and Grouting

After successfully reaming the bore to the required diameter, the product shall be pulled through the bore path. Once the pullback operation has commenced, it shall continue without interruption until the product is completely pulled into bore unless otherwise approved by the Contract Administrator.

A swivel shall be used between the reamer and the product being installed to prevent rotational forces from being transferred to the product. When specified in the Contract Documents, a weak link or breakaway connector shall be used to prevent excess pulling force from damaging the product.

The product shall be inspected for damage where visible at excavation pits and where it exits the bore. Any damage noted shall be rectified to the satisfaction of the Contract Administrator,

The pull back and reaming operations shall not exceed the fluid circulation rate capabilities. Reaming and back pulling operations shall be planned to insure that, once started, all reaming and back pulling operations are completed without stopping and within the permitted work hours.

The space between the pipe and the excavation walls shall be filled with grout.

7. 05 Tunnelling Installation

7.05.01 General

The method of tunnelling shall be selected by the Contractor and shall be submitted to the Contract Administrator prior to commencement of the work for information purposes.

Excavation of native soil and fill shall be done in a manner to control groundwater inflow to the excavation and to prevent loss of ground into the excavation.

Methods of excavating the tunnel shall be capable of fully supporting the face and shall accommodate the removal of boulders and other oversize objects from the face. Continuous ground support shall be maintained during excavation.

As the excavation progresses, the Contractor shall continuously monitor (every 2m) indications of support distress, such as cracking, deflection or failure of support system and subsidence of ground near the excavation.

The Contractor shall advance the ventilation system as a regular part of the normal excavation cycle.

The Contractor shall provide lighting in accordance with OHSA requirements for the entire length of the tunnel.

The tunnel is to be kept sufficiently dry at all times to permit work to be performed in a safe and satisfactory manner.

The Contractor shall maintain clean working conditions at all times in tunnels.

In the event that excavation threatens to endanger personnel, the Work, or adjacent property, the Contractor shall cease excavation. The Contractor shall then evaluate methods of construction and revise as necessary to ensure the safe continuation of the work.

The Contractor shall maintain tunnel excavation line and grade to provide for construction of final lining within specified tolerances.

7.05.01 Tunnelling Method

The tunnelling method shall be suitable to provide face support in changing ground conditions that may be encountered during the progress of the work. The selection of the tunnelling method should consider the soil conditions at each pipe crossing and the presence of obstructions, such as cobbles and boulders, with respect to the tunnel alignment.

7.05.02 Primary Liner (Support System)

Primary support systems shall prevent deterioration, loosening, or unravelling of ground surfaces exposed by excavation.

The primary liner support system shall be designed and installed to achieve the intended performance requirements.

Primary liner support system shall maintain the safety of personnel, minimize ground movement into the excavation, ensure stability and maintain strength of ground surrounding the excavation.

The primary liner shall be designed to support all subsurface conditions and hydrostatic pressures and to withstand any additional loads caused by installation and grouting, and shall ensure that no ground loading or other loading will be placed on the new work until after design strength has been reached.

The primary liner shall be installed so that the exterior is as tight as possible to the excavated surface of the tunnel and allows the placement of the full design thickness of the secondary lining.

Primary support systems shall be compatible with the encountered ground conditions, with the method of excavation, with methods for control of water, and with placement of the permanent lining.

All voids between the primary lining and the surface of the excavation shall be filled with cement grout. If an unexpanded liner is used, the space outside the liner plates shall be grouted at least daily.

7.05.03 Secondary Liner

7.05.03.01 Placing of Grout

The void outside the finished secondary liner shall be filled with cement grout according to the Contractor's submission.

Grout shall not be placed until the lining has achieved 85% of its specified strength or 30 MPa. Grouting shall be limited to such sequences and programs as are necessary to avoid damaging any part of the works or any other structure or property.

7.06 Instrumentation Monitoring

The work specified in this Section includes furnishing and installing instruments for monitoring of settlement and ground stability.

Surface settlement markers for monitoring ground stability shall be installed at the pavement/ground surface level on the shoulder, side slope and pavement at not greater than 5 m intervals along the tunnel alignment and as an array of three in ground (1.5 m depth) measurement points on the shoulder of the highway perpendicular to the alignment. The equipment and procedures used for settlement monitoring during construction must be capable of surveying the settlement point elevations to within ± 1 mm of the actual elevation.

Surface settlement markers shall be hardened steel markers treated or coated to resist corrosion, with an exposed convex head having a minimum diameter of 12 mm and similar to surveyor's PK nails. Markers shall be rigidly affixed so as not to move relative to the surface to which it is attached. Traffic shall be managed by the contractor using short term lane closures in accordance with the Ontario Traffic Manual (OTM).

In general, settlement monitoring points shall be 12-18 mm rebar encased in a 50-70 mm, SCH40 PVC pipe, set to a depth of 1.5 m below ground surface. The assembly shall be placed in a drill hole and backfilled with uniform sand as shown on the Contract Drawings.

The Contractor shall install all surface settlement instruments a minimum of one week prior to the start of works.

The surface settlement instruments shall be clearly labelled for easy identification.

The Contractor shall submit to the Contract Administrator a site plan showing the locations of the monitoring points, a geodetic survey of the settlement monitoring points including station, offset and elevation recorded at the following time intervals:

- Three consecutive readings at least one week prior to commencement of the work (Baseline Reading);
- Once per shift during tunnelling operations period; and
- Weekly after completion of the work for one month, or until such time at which all parties agree that further movement has stopped.

All readings shall be submitted to the Contract Administrative for information purposes on a weekly basis. Each report shall include all survey data collected in tabular and graphical format as plots of time versus settlement in comparison to survey data collected prior to commencement of the work.

7.07 Criteria for Assessment of Roadway Subsidence/Heave

Based on the monitoring of ground movement as specified in Subsection 4.02, the following represents trigger levels that define magnitude of movement and corresponding action:

- Review Level: If a maximum value of 10 mm relative to the baseline readings is reached, the Contractor shall review or modify the method, rate of sequence of construction or ground stabilization measures to mitigate further ground displacement.

  If the Review Level is exceeded, the Contractor shall immediately notify the CA and review and discuss response actions. The Contractor shall submit a plan of action to prevent Alert Levels from being reached. All construction work shall be continued such that the Alert Level is not reached.

- Alert Level: If a maximum value of 15 mm relative to the baseline readings is reached, the Contractor shall cease construction operations, inform the Contract Administrator and execute pre-planned measures to secure the site, to mitigate further movements and to assure safety of public and maintain traffic.
  - No construction shall take place until all the following conditions are satisfied:
    - The cause of the settlement has been identified.
    - The Contractor submits a corrective/preventive plan.
    - Any corrective and/or preventive measure deemed necessary by the Contractor is implemented.
    - The CA deems it is safe to proceed.

The Contractor shall avoid damaging instrumentation during construction. Instrumentation that is damaged as a result of the Contractor's operation shall be repaired or replaced by the Contractor within one business day. The costs for replacement/repair shall be borne by the Contractor.

At the completion of the job, the Contractor shall abandon all instrumentations installed during the course of the Work.

9. MEASUREMENT FOR PAYMENT

Measurement shall be by Plan Quantity Payment as may be revised by Adjusted Plan Quantity Payment in metres, following along the centre line of the pipes from centre to centre of maintenance holes or chambers (catch basins) or from/to the end of the pipe where no maintenance hole or chamber is installed, of the actual length of pipe installed by trenchless methods.

10. BASIS OF PAYMENT

Payment at the contract price shall be full compensation for providing all labour, equipment and materials required for excavation (regardless of material encountered), dewatering, sheathing and shoring, supply and installation of pipe liners, settlement monitoring and instrumentations site restoration and for all other work necessary to complete the installation as specified.

Payment for the rigid or flexible pipe conduits installed inside the pipe liners shall be paid separately under the appropriate tender items.

Where a protection system is made necessary because of the Contractor's operations (e.g. choice of trenchless installation method), the cost shall be included in this item and shall be full compensation for all labour, equipment and materials required to carry out the work including subsequently removing the temporary protection system and performing any necessary restoration work.

Payment for connecting intercepted drains and service connections shall be made on the following basis:

(a) Where such drains and service connections are shown on the contract drawings the cost of connections shall be included in the contract price for pipe installation.

(b) Where such drains and service connections are not shown on the contract drawings, the cost of connections will be considered an allowable extra to the contract.

Payment for removal of boulders/obstructions greater than an equivalent 0.3 m in diameter shall be on a time and materials basis. The Contractor shall inform the Contract Administrator when boulders/obstructions are encountered and prior to removal to allow for proper and accurate tracking of time and material charges.

Notes to Designer:

Under Section 7.01.06, minimum horizontal and vertical clearances to existing facilities shall be identified in the Contract Documents. Clearances shall be measured from the nearest edge of the largest cut diameter required to the nearest edge of the facility being paralleled or crossed. The number of exposures required to monitor work progress shall be specified in the Contract Documents.

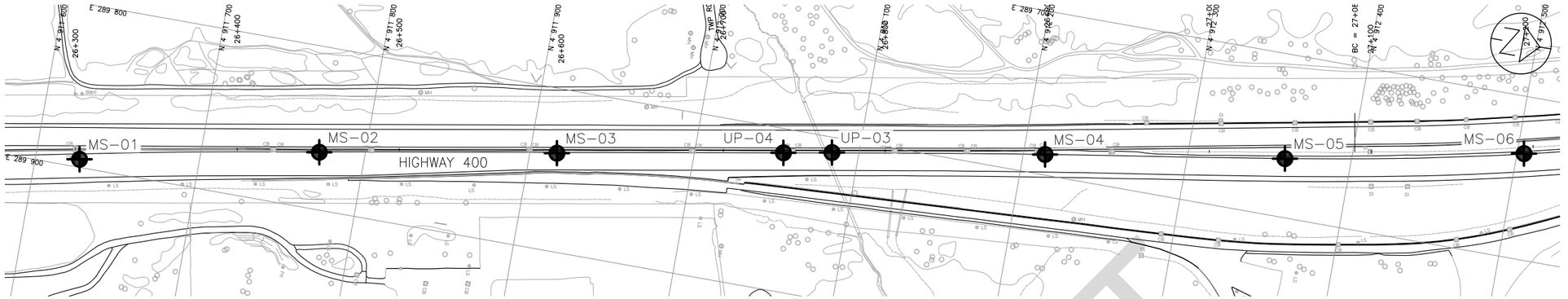
Appendix D

Borehole Locations Drawing

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

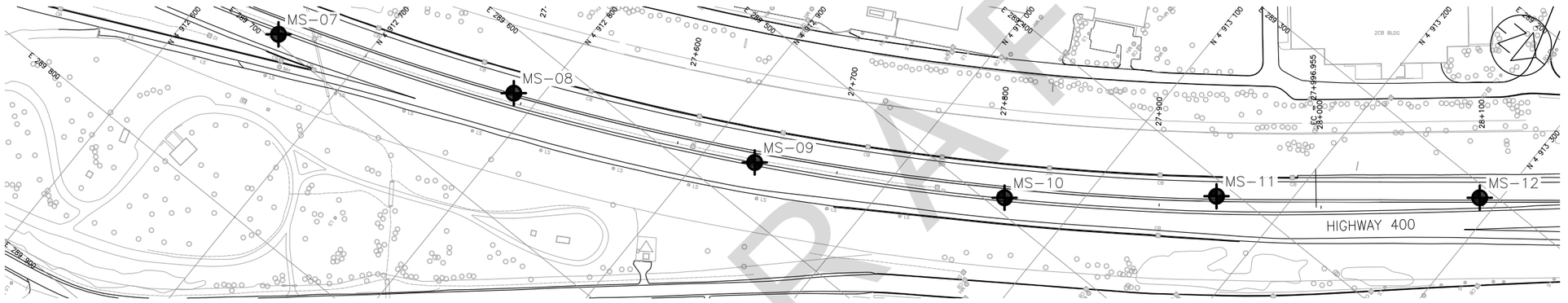
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN

60 0 60 120m

SCALE 1:3000



PLAN

60 0 60 120m

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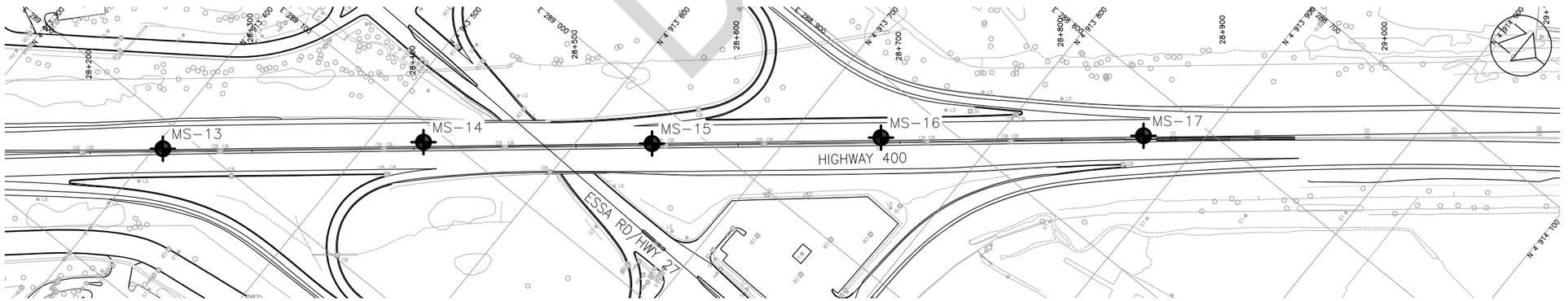


PLAN

60 0 60 120m

SCALE 1:3000

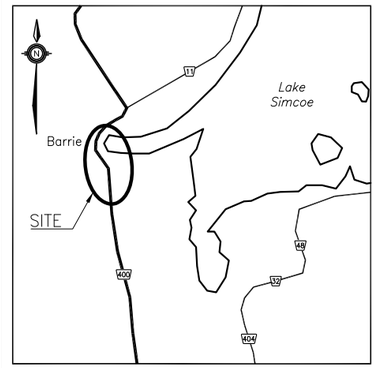
CONT No
WP No

HIGHWAY 400
HARVIE ROAD
BBPR
BOREHOLE LOCATION PLAN

SHEET

HATCH

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

- Borehole
- Borehole and Cone

NO	ELEVATION	NORTHING	EASTING
MS-01	297.9	4 911 627.1	289 895.1
MS-02	295.5	4 911 772.0	289 864.8
MS-03	293.1	4 911 916.5	289 839.6
MS-04	289.8	4 912 213.3	289 787.5
MS-05	289.2	4 912 359.5	289 764.0
MS-06	288.4	4 912 504.3	289 735.0
MS-07	286.6	4 912 650.0	289 695.4
MS-08	283.3	4 912 785.7	289 632.1
MS-09	278.2	4 912 928.2	289 571.7
MS-10	273.3	4 913 061.7	289 491.5
MS-11	269.6	4 913 162.8	289 408.4
MS-12	264.6	4 913 289.6	289 306.9
MS-13	260.2	4 913 404.4	289 214.8
MS-14	255.2	4 913 526.8	289 110.3
MS-15	251.0	4 913 637.0	289 022.2
MS-16	246.9	4 913 744.4	288 930.4
MS-17	241.9	4 913 869.6	288 827.4
UP-03	290.7	4 912 083.6	289 809.4
UP-04	290.9	4 912 054.1	289 814.8

-NOTES-

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

GEOCRES No.

REVISIONS			
	DATE	BY	DESCRIPTION

DESIGN	MRA	CHK	PKC	CODE	LOAD
DRAWN	MFA	CHK	MRA	SITE	STRUCT

DATE APR 2017
DWG 1

FILENAME: H:\Drafting\11000\11398\TED-11398-BHPL-WS.dwg
PLOTDATE: 4/10/2017 1:49 PM

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