



THURBER ENGINEERING LTD.

FINAL
FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGHWAY 11 UNDERPASS STRUCTURE
MUSKOKA RD 117, DISTRICT OF MUSKOKA
AGREEMENT NO. 5017-E-0003
Site No.: 42X-0174

G.W.P. 5138-13-00

Geocres No.: 31E-394

Report to:

McIntosh Perry Consulting Engineers Limited

Latitude: 45.086414
Longitude: -79.298560

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PART 1. FACTUAL INFORMATION

1 INTRODUCTION

This section of the report presents the factual findings obtained from a foundation investigation completed at the Muskoka Road 117 (Cedar Lane) crossing of Highway 11 located approximately 10.6 km north of Highway 118 within the District of Muskoka. Thurber Engineering Limited (Thurber) carried out the current field investigation as a sub-consultant to McIntosh Perry Consulting Engineers Ltd. (MPCE) under Assignment No. 5017-E-0003.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions influencing design and construction was developed in the course of the current investigation. The following historical foundation investigation report was obtained from the online Geocres library and reviewed in preparation of this report.

Ministry of Transportation and Communications (1977); Foundation Investigation and Design Report for Proposed Underpass Interchange at N. Jct. Hwy 11 & Hwy 117 Interchange, Site 42-174, Huntsville; Geocres No. 31E-87

2 SITE DESCRIPTION

The project includes an underpass structure that is a two span cast in place post tensioned voided concrete slab bridge. The existing underpass conveys Muskoka Road 117 in a west – east alignment over Highway 11.

The underpass (Structure No.42X-0174) has two spans of 33.5 m each, a road width of 9.1 m and an overall width of 10.0 m. The clearance under the structure is approximately 5.0 m. The structure is understood to have been constructed in 1979 and rehabilitated in 2001. The foundations are designed to consist of H-piles driven to refusal at the west abutment and H-piles driven to bedrock at the east abutment and pier. Wingwalls are present at the structure ends.

At the location of the underpass structure, Highway 11 includes two driving lanes plus a speed change lane in each direction. Highway 11 has a rural cross-section, paved

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shoulders and a grassed median. Ramp intersections are located on Muskoka Road 117 approximately 100 m from both ends of the structure.

The approach fill height is approximately 7.2 m with the Muskoka Road 117 road surface at approximate elevations 282.5 m and 283.7 m for the west and east approaches respectively. The existing Highway 117 embankment slopes are inclined at approximately 2H:1V. Reinforced concrete barrier walls are situated on each side of the deck as guardrails.

The land adjacent to the highway is densely vegetated with grasses, shrubs and trees. Traffic volumes on this section of Highway 11 are understood to be 17,600 AADT (2016).

Select photographs showing the existing conditions in the area of the underpass at the time of the field investigation are included in Appendix D for reference.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing program was carried out on April 30th, 2018. The field investigation consisted of advancing two boreholes identified as 18-1 and 18-2 near the abutments of the structure. The drilling was carried out using a truck mounted CME 55 drill rig equipped with hollow stem augers and casing. Prior to commencement of drilling, utility clearances were obtained in the vicinity of the borehole locations.

Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). The boreholes were sampled to a depth of 18.0 m (elev. 264.5 and 265.6 m, in Boreholes 18-1 and 18-2, respectively) below the existing ground surface.

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

The approximate borehole locations are shown on the Borehole Locations and Soil Strata Drawing included in Appendix A. The coordinates and elevation of the boreholes from the current investigation are provided on this drawing and on the individual Record of Borehole sheets. The northing and easting (MTM zone 10), elevation, and termination depth of the boreholes are summarized below in Table 3-1. The borehole elevations were surveyed relative to benchmark Pt. 303 (elev. 282.117 m), provided by MPCE, with a Nikon-AP-8 with an accuracy of +/- 1.5 mm. Horizontal locations were measured relative to existing site features.

Table 3-1: Borehole Summary

Borehole No.	Drilled Location	Northing (m)	Easting (m)	Ground Surface Elevation (m)	Termination Depth (m)
18-1	West of Structure, EB Lane	4 994 043.4	320 616.4	282.5	18.0
18-2	East of Structure, EB Lane	4 994 079.8	320 695.8	283.6	18.0

Following completion of the field investigation the boreholes were backfilled in accordance with MOE requirements (O.Reg. 903 as amended). Both boreholes were backfilled with granulars within the depth of pavement structure and capped with 150 mm of cold patch asphalt to reinstate the traveling surface.

4 LABORATORY TESTING

The recovered soil samples were subjected to visual identification and to natural moisture content determination. Selected samples were also subjected to gradation analysis (hydrometer and/or sieve) and Atterberg Limit testing. The results of these tests are summarized on the Record of Borehole sheets included in Appendix B. One sample of soil recovered from within each Borehole was selected and submitted for analytical testing of corrosivity parameters. All laboratory test results are provided in Appendix C.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix B and the Borehole Location and Soil Strata drawing included in Appendix A. A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following paragraphs. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description for interpretation of the site conditions. It must be recognized that the soil and groundwater conditions may vary between and beyond borehole locations.

In general terms, the site was found to be underlain by a pavement structure and sand fill overlying native sand and silty sand layers. Bedrock was not encountered within the depth of the current investigation.

The historic 1977 boreholes from Geocres Report 31E-87 have also been included in Appendix B and their locations indicated on Drawing No. 327702-A in Appendix A. The locations and ground surface elevation for these boreholes are approximate. The 1977 borehole records indicate the native soils as a loose to very dense silty sand to sandy silt. Bedrock was proven by coring at elevations of 266.8 and 267.4 m near the east abutment and at 270.7 m near the median pier. It is expected that near surface stratigraphic conditions have changed as a result of the bridge and embankment construction since these holes were drilled in 1977, therefore the historic documents have not been included in the following descriptions.

5.1 Embankment

5.1.1 Asphalt

Both boreholes were drilled through the existing Muskoka Road 117 approach embankments and encountered a layer of asphalt at the surface with a thickness of 75 to 100 mm.

5.1.2 Fill: Sand some gravel

Encountered below the asphalt was a layer of granular fill making up the pavement structure and consisting of sand with varying amounts of gravel. The underside depth of the granular fill was at 1.5 to 2.3 m (elev. 281.0 to 281.3 m) below the existing roadway.

SPT tests conducted in this fill gave N-values ranging from 16 to 33 blows indicating a relative density of compact to dense.

Recorded moisture contents ranged from 4 to 7%.

5.1.3 Fill: Sand with silt and gravel

Below the pavement structure in both Boreholes was a layer of fill consisting predominantly of sand with silt and gravel. The sand fill was 4.9 to 5.7 m thick and the underside of the sand fill was at 7.2 m (elev. 275.3 and 276.4 m) below the existing roadway surface in Boreholes 18-1 and 18-2, respectively.

The SPT tests conducted in this fill gave N-values typically ranging from 16 to 35 blows indicating a relative density of compact to dense. A single SPT N-value of 51 blows was encountered near the base of the layer in Borehole 18-2.

Recorded moisture contents ranged from 4 to 11%. The results of grain size analyses conducted on two samples of the sand fill are summarized below and are illustrated on Figure C1 in Appendix C.

Soil Particle	Percentage (%)
Gravel	14 – 15
Sand	76 – 77
Silt & Clay	9

5.2 Sand with Gravel (SP) to Silty Sand (SM)

Below the embankment in both boreholes was a native sand with varying amounts of silt and gravel. Both boreholes were terminated within this deposit at depth of 18.0 m below the road surface. Borehole 18-1 was terminated at elevation 264.5m and Borehole 18-2 was terminated at elevation 265.6 m. Encountered within this deposit at elevation 272.3 m in Borehole 18-1 was a 3.1 m thick layer containing appreciably more gravel and less silt.

The SPT tests conducted in the sand gave N-values generally ranging from 1 to 33 indicating a relative density ranging from very loose to dense. A single SPT N-value of 71 blows was encountered near the surface of the layer in Borehole 18-2.

Recorded moisture contents ranged from 2 to 25% with the values generally higher below elevation 271 m. The results of grain size analyses conducted on five samples of the native sand are summarized below and illustrated on Figure C2 in Appendix C.

Soil Particle	Percentage (%)
Gravel	0 – 25
Sand	71 – 89
Silt & Clay	4 – 18

5.3 Bedrock

Bedrock or a refusal stratum was not encountered within the depth of the current investigation.

5.4 Groundwater

The groundwater level measured within the open boreholes during drilling operations on April 30th, 2018 was recorded to be at an elevation of 270.5 and 272.5 m in Borehole 18-1 and 18-2, respectively.

These observations are considered short term and it should be noted that the groundwater level at the time of construction could be different and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after periods of significant and/or prolonged precipitation events.

5.5 Analytical Testing

Two samples of soil were submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate, sulphide and chloride concentrations, resistivity and conductivity. The analysis results are summarized in the table below:

Borehole (sample)	Depth (mbgs)	Sulphate (µg/g)	pH (-)	Resistivity (Ohm-cm)	Conductivity (uS/cm)	Chloride (µg/g)	Sulphide %
18-1 (SS13)	12.2 – 12.8	12	5.84	7,500	133	82	<0.02
18-2 (SS12)	10.7 – 11.3	9	6.14	4,270	234	113	<0.02

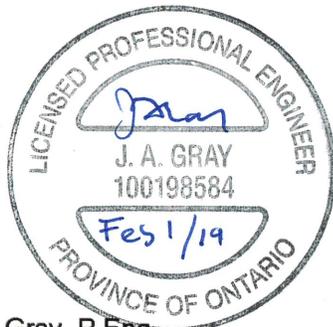
6 MISCELLANEOUS

Borehole locations were selected by Thurber relative to the bridge abutments and other site features. The as-drilled locations and ground surface elevation of the boreholes were surveyed by Thurber following completion of the field program. Base plan drawings and survey benchmarks were provided by MPCE.

George Downing Estate Drilling Ltd. of Hawkesbury, Ontario supplied and operated the drilling equipment to conduct the drilling, soil sampling, in-situ testing and decommissioning of the boreholes. The field investigation was supervised on a full time basis by Mr. Sean O'Bryan. of Thurber. Overall supervision of the field investigation program was provided by Mr. Stephen Peters, P.Eng.

Routine geotechnical laboratory testing was completed by Thurber's laboratory in Ottawa, Ontario. Analytical testing was completed by Paracel Laboratories in Ottawa, Ontario.

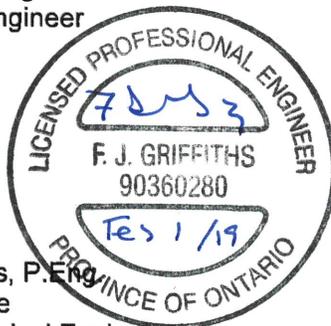
Interpretation of the factual data and preparation of this report were carried out by Mr. Justin Gray, P.Eng. and Mr. Stephen Peters, P.Eng. The report was reviewed by Dr. Fred Griffiths, P.Eng and Dr. P.K. Chatterji, P.Eng. a Designated Principal Contact for MTO Foundation Projects.



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PART 2. ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 INTRODUCTION

This section of the report provides an interpretation of the factual data from Part 1 of this report and presents geotechnical recommendations to assist the project team in the design of the proposed underpass rehabilitation works at the Muskoka Road 117 (Cedar Lane) crossing of Highway 11 located approximately 10.6 km north of Highway 118 within the District of Muskoka. The discussion and recommendations presented in this report are based on the information provided by McIntosh Perry Consulting Engineers Ltd. (MPCE) and on the factual data obtained during the course of the investigation.

This foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation and shall not be used or relied upon for any other purposes or by any other parties including the construction or design-build contractor. The construction or design-build contractor must make their own interpretation based on the factual data in Part 1 of the report. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Contractors must make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

In general terms, the site was found to be underlain by a pavement structure and sand fill overlying native sand and silty sand deposits. Bedrock was not encountered within the depth of the current investigation. The short-term groundwater level was recorded in the open boreholes to be at an elevation ranging from 270.5 to 272.5 m on April 30th, 2018.

7.1 Proposed Structure Rehabilitations

At the time of preparation of this final Foundation Investigation and Design Report, the proposed rehabilitation of the underpass structure, as described in the TPA, is to include the removal and replacement of asphalt and waterproofing, patching the concrete in the deck surface, replacing the expansion joints and repairing deteriorated concrete. It is a possibility that the pier may be retrofitted to withstand new crash guidelines.

It is understood that the modifications will not add any further loading to the existing foundations.

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8 GEOTECHNICAL RECOMMENDATIONS

The approach embankments range from 6.7 to 7.2 m in height above the adjacent ground level, with a clearance of approximately 5.0 m above Highway 11. On each end of the bridge structure, temporary protection systems are being considered to allow excavation behind the abutments while maintaining one lane of traffic on Muskoka Road 117. In accordance with the RFP, geotechnical recommendations are provided herein for temporary protection systems and reinstatement of the highway embankments.

8.1 Excavation

All temporary excavation must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of OHSA, the existing fills above the water table may be classified as Type 3. The existing fills and cohesionless soils below the water table are classified as Type 4 soil.

Newly placed granular fill constructed in accordance with OPSS 501 and the rehabilitation contract can be considered to be Type 2 soil.

It is anticipated that there will be space restrictions and excavations will need to be carried out within a protection system. Further discussion is presented in Section 8.2.

8.2 Temporary Protection Systems

Temporary Protection Systems will be required during construction and must be implemented in accordance with OPSS.PROV 539 and designed for Performance Level 2 (maximum 25 mm horizontal deflection). The actual pressure distribution acting on the shoring system is a function of the construction sequence and the relative flexibility of the wall and these factors must be considered when designing the shoring system. An interlocking sheet pile system or a soldier pile and lagging system are considered to be two feasible options. Bracing may be required depending on depth of excavation.

Native deposits of loose silty sand were encountered below the embankment. These loose deposits are sensitive to disturbance and vibrations. Using vibratory methods could induce settlement of the bridge approach embankments. If the Temporary Protection Systems extends below the existing fill materials, vibratory equipment should not be permitted at this site for installation or removal of the temporary protections system. The sheet piles could be left in place provided they are cut-off in accordance with OPSS.PROV 539. Suggested wording for an NSSP is provided in Appendix E. However, if the base of the Temporary Protection Systems remain within the fill materials, vibratory equipment could be permitted at this site for installation and/or removal of the system. Although not encountered within the boreholes, the Contractor should be aware that cobbles or obstructions could be present in the fill. A suggested NSSP to alert the Contractor is provided in Appendix E.

Typical lateral earth pressure coefficients for the soils encountered at this site are provided in Section 8.3.

Temporary protection systems are the responsibility of the Contractor and should be designed by a licensed Professional Engineer experienced in such designs and retained by the Contractor. The designer must undertake an assessment of the foundation soils ability

to support the weight of cranes and/or other construction equipment used during the installation of the protection systems and the rehabilitation works.

8.3 Lateral Earth Pressures

Lateral earth pressures parameters provided in Table 8-1 and in the text below are based on the assumption that the backfill is fully drained so that there are no unbalanced hydrostatic pressures. If adequate drainage cannot be confirmed, the potential for buildup of hydrostatic pressures should be considered in design.

Lateral earth pressures acting on vertical structures should be computed in accordance with the CHBDC but generally are given by the following expression:

$$p_h = K * (\gamma h + q)$$

where:

- p_h = horizontal pressure on the wall at depth h (kPa)
- K = earth pressure coefficient (see table below)
- γ = unit weight of retained soil (must adjust for groundwater level)
- h = depth below top of fill where pressure is computed (m)
- q = value of any surcharge (kPa)

A lateral earth pressure due to backfill compaction should be added to the calculated lateral earth pressure in accordance with Clause 6.12.3 of the CHBDC. Typical earth pressure coefficients for backfill are shown in Table 8-1.

Table 8-1. Static Earth Pressure Coefficients with Horizontal Backfill and a Vertical Wall

Condition	Earth Pressure Coefficient (K)			
	OPSS Granular A or OPSS Granular B Type II $\phi = 35^\circ$, $\gamma = 22.8 \text{ kN/m}^3$	OPSS Granular B Type I $\phi = 32^\circ$, $\gamma = 21.2 \text{ kN/m}^3$	OPSS SSM and Existing Sand Fill and Native Sand $\phi = 30^\circ$, $\gamma = 21.0 \text{ kN/m}^3$	Native Silty Sand $\phi = 30^\circ$, $\gamma = 19.0 \text{ kN/m}^3$
Active, K_A (Movement away from Soil Mass)	0.27	0.31	0.33	0.33
At Rest, K_O (Non-Yielding Wall)	0.43	0.47	0.50	0.50
Passive, K_P (Movement towards Soil Mass)	3.7	3.3	3.0	3.0
Soil Group ^(*)	“medium dense sand”	“loose to medium dense sand”	“loose sand”	“loose sand”

Note: (*) for use with Figure C6.16 of the Commentary to the CHBDC.

The parameters in the table above correspond to full mobilization of active and passive earth pressures and require certain relative movements between a vertical wall and adjacent soil to produce these conditions. The values to be used in design can be assessed from Figure C6.16 of the Commentary to the CHBDC using the soil group designation as outlined in Table 8-1. Active pressures should be used for unrestrained walls. For rigid structures, it is recommended that at-rest horizontal earth pressures be used for design. Where ground surfaces are sloped behind the walls, the coefficients provided in the Table 8-1 are not applicable.

8.4 Embankment Design and Reinstatement

8.4.1 Embankment Reconstruction

It is recommended that where the existing embankment has been removed as part of the rehabilitation work, it be reinstated in accordance with OPSS 902 and OPSD 3101.150 and consist of free draining, non- frost susceptible granular materials such as Granular A material meeting the requirements of OPSS.PROV 1010 and should be placed and compacted as per OPSS.PROV 501.

Pavement structure reinstatement should follow the recommendations provided in the Pavement Design Report (completed by others).

Compaction equipment, used adjacent to the bridge structure, must be restricted in accordance with OPSS.PROV 501. Care must be exercised when compacting the fill adjacent to the walls in order not to damage the structures. Embankment reconstruction after bridge rehabilitation should be carried out in accordance with OPSS.PROV 206.

The embankment should be reinstated with side slopes of 2H:1V (or flatter) if they are constructed using the above mentioned granular fill.

8.4.2 Embankment Settlement and Stability

The condition of the existing embankment slopes was examined in the field during the field investigation and no evidence of instability (tension cracks etc.) was noted at that time.

It is understood that the existing embankment geometry will not change following rehabilitation and therefore no permanent grade raise or embankment widening is proposed. Provided proper construction methods are used, no long term or global stability issues are anticipated for embankments reinstated at this site. Material stockpiling above the existing grades is a temporary construction measure and the stability implications are the responsibility of the Contractor. The selection and safe placement of construction equipment (such as cranes) are also the Contractor's responsibility.

As no permanent grade raise is anticipated negligible settlement is expected to occur in the soils underlying the reinstated approach fills.

The magnitude of the embankment compression constructed with granular materials is in the order of 0.5% of the embankment height and is expected to occur during and following fill placement.

8.5 Cement Type and Corrosion Potential

Analytical tests were completed to determine the potential for degradation of the concrete in the presence of soluble sulphates and the potential for corrosion of exposed steel. The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater at the site. Soluble sulphate concentrations less than 1000 µg/g generally indicate that a low degree of sulphate attack is expected for concrete in contact with soil and groundwater. The class of concrete selected should consider the effects of road de-icing salts.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment. The tests results provided in Section 5.5 may be used to aid in the selection of coatings and corrosion protection systems for buried steel objects. The corrosive effects of road de-icing salts should also be considered.

9 CONSTRUCTION CONSIDERATIONS

9.1 Surface and Groundwater Control

Excavation for the rehabilitation is not expected to intersect the groundwater. Embankment reinstatement and structure backfilling required as part of the underpass structure rehabilitation must be carried out in the dry. The Contractor must be prepared to control the surface water flow at this site to permit construction in a dry and stable excavation. Temporary surface water control measures will be required to remain operational during construction until the structure rehabilitation is completed and backfilled.

9.2 Scour Protection and Erosion Control

Based on the subsurface conditions encountered in the boreholes, the embankment materials are considered to have low susceptibility to erosion as per the Wischmeier Nomograph.

Slope protection and drainage measures will be required to ensure the long-term surficial stability of the reinstatement of the embankment slopes. Slope vegetation should be established as soon as possible after completion of the embankment fills in order to control surficial erosion in general accordance with OPSS.PROV 804. The contractor should provide silt fences and erosion control blankets, as required, throughout the duration of the construction to prevent silt/sediment from running off the site as per OPSS 805.

10 CONSTRUCTION CONCERNS

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

- The Contractor's selection of construction equipment and methodology must include assessment of the capability of the existing embankment to support the proposed construction equipment and any temporary fill.

The successful performance of the rehabilitated structure will depend largely upon good workmanship and quality control during construction.

11 CLOSURE

Engineering analysis and preparation of this report were carried out by Mr. Justin Gray, P.Eng. and Mr. Stephen Peters, P.Eng. The report was reviewed by Dr. Fred Griffiths, P.Eng and Dr. P.K. Chatterji, P.Eng a Designated Principal Contact for MTO Foundation Projects.

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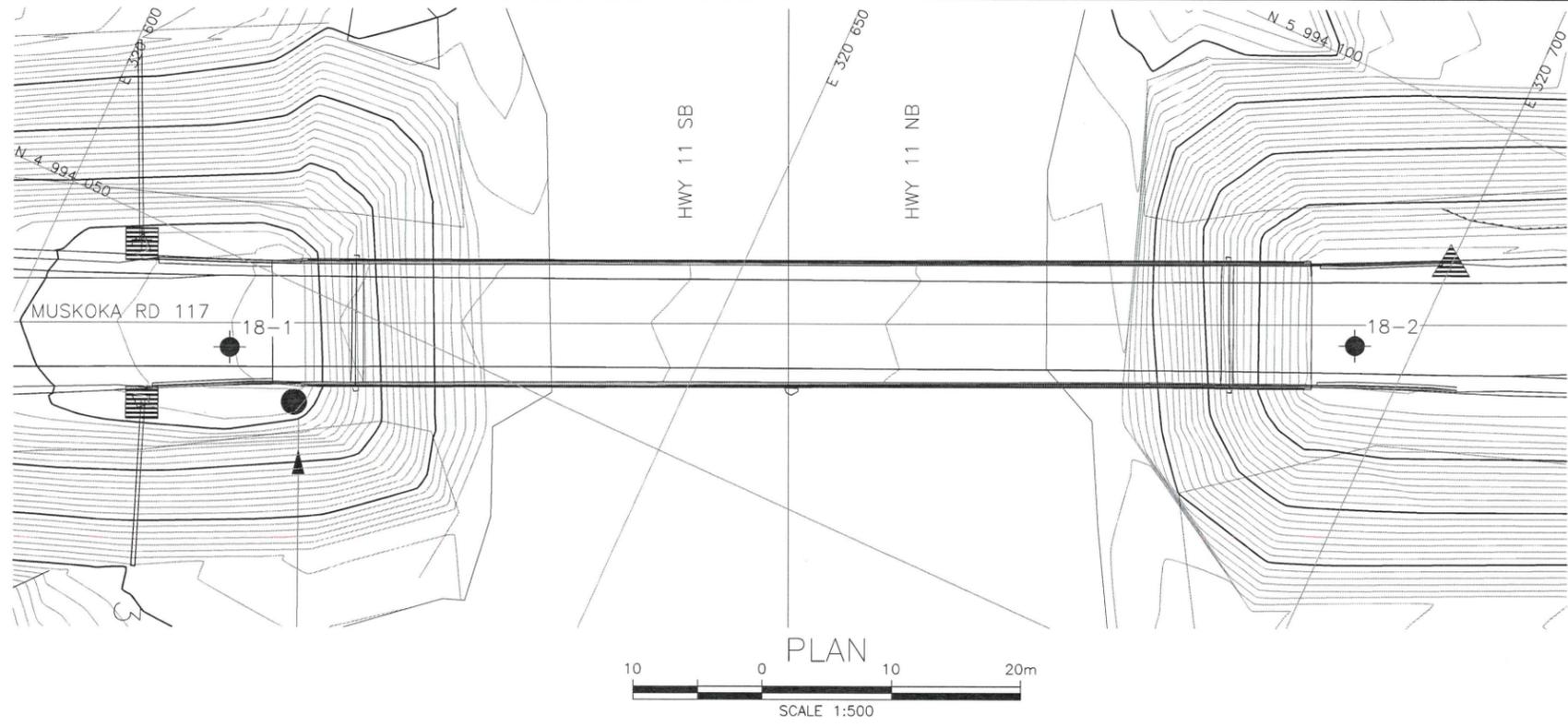


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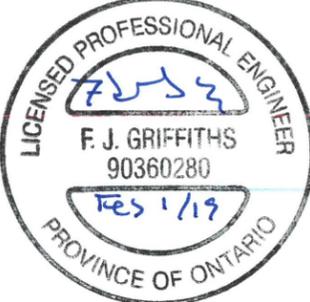
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Appendix A.

Borehole Location Plan and Stratigraphic Drawings



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AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

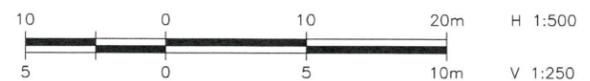
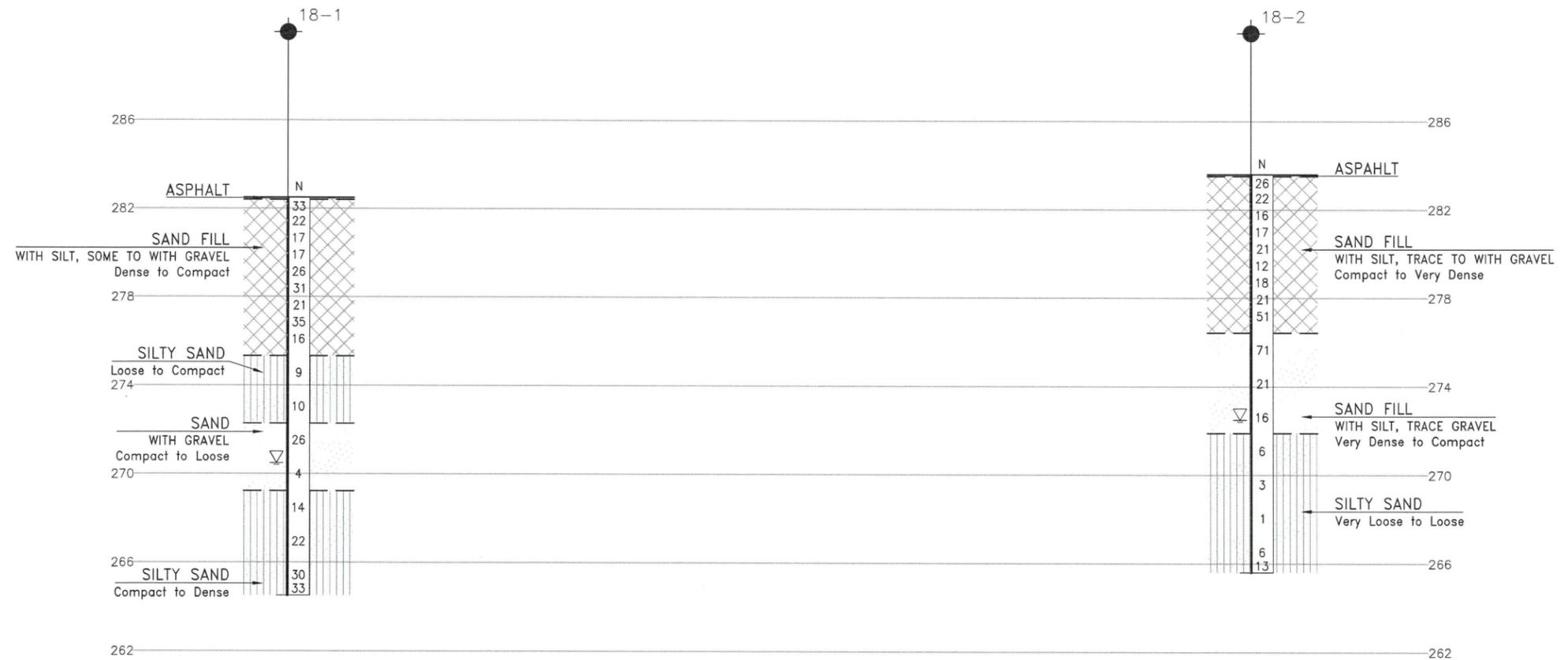


CONT No 2019-XXXX
WP No 5138-13-01

MUSKOKA RD 117
UNDERPASS
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
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McINTOSH PERRY



KEYPLAN
LEGEND

- Borehole
- Borehole & Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
18-1	282.5	4 994 043.4	320 616.4
18-2	283.6	4 994 079.8	320 695.8

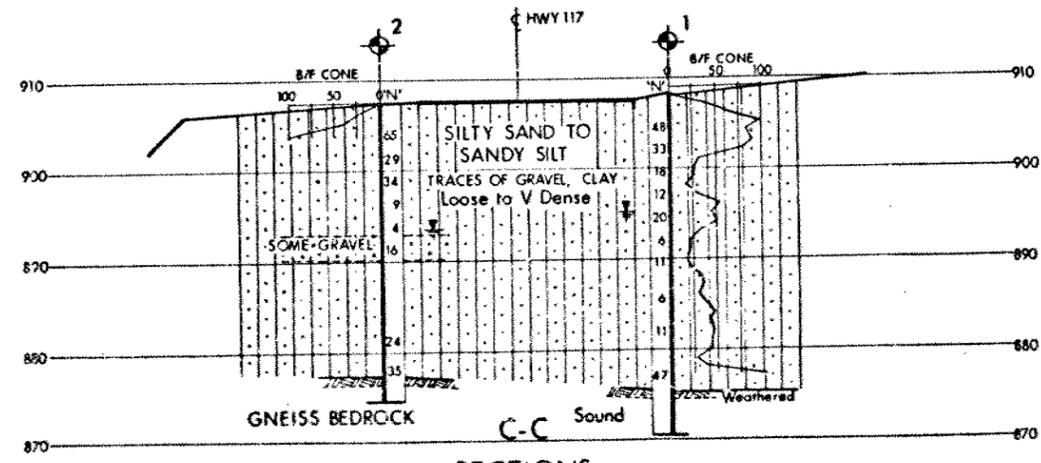
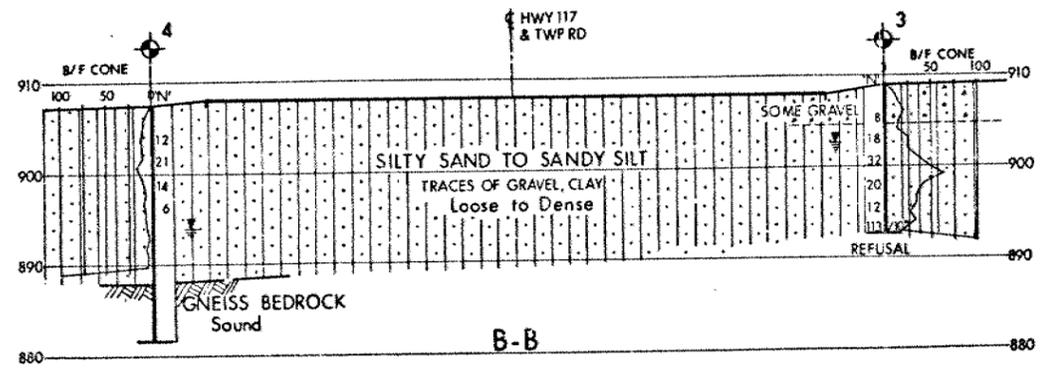
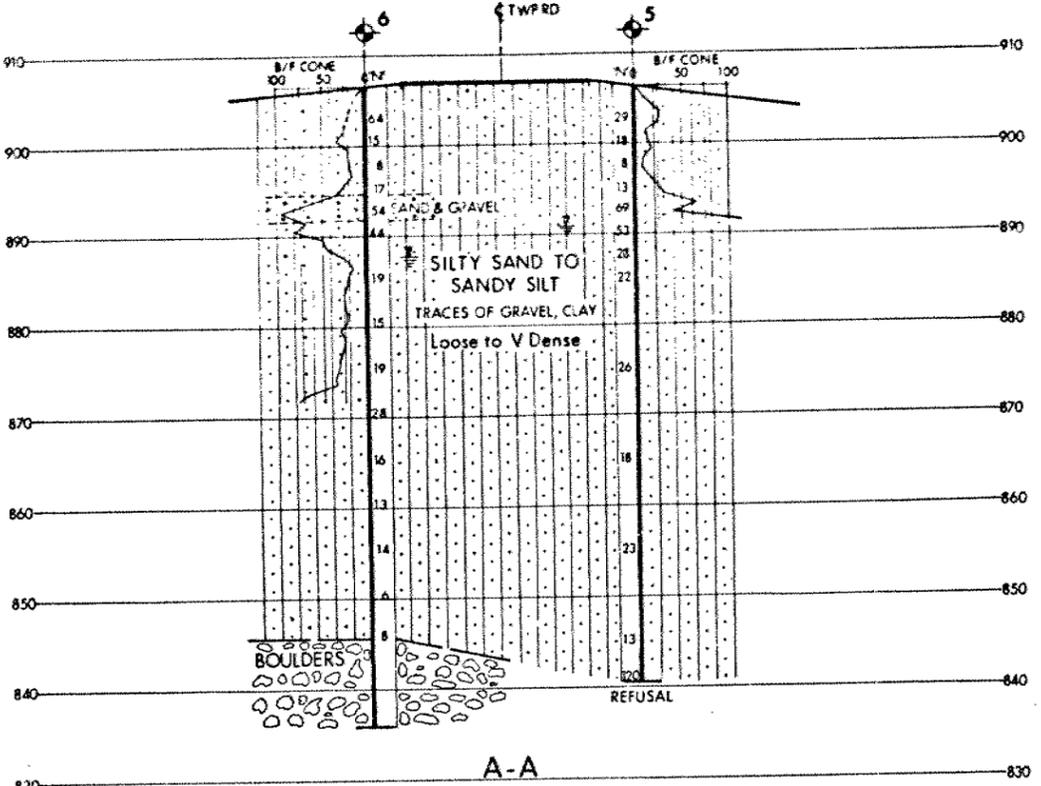
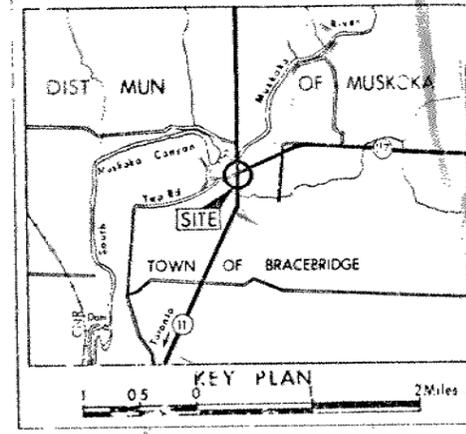
- NOTES-
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
 - This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
 - Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 31E-394

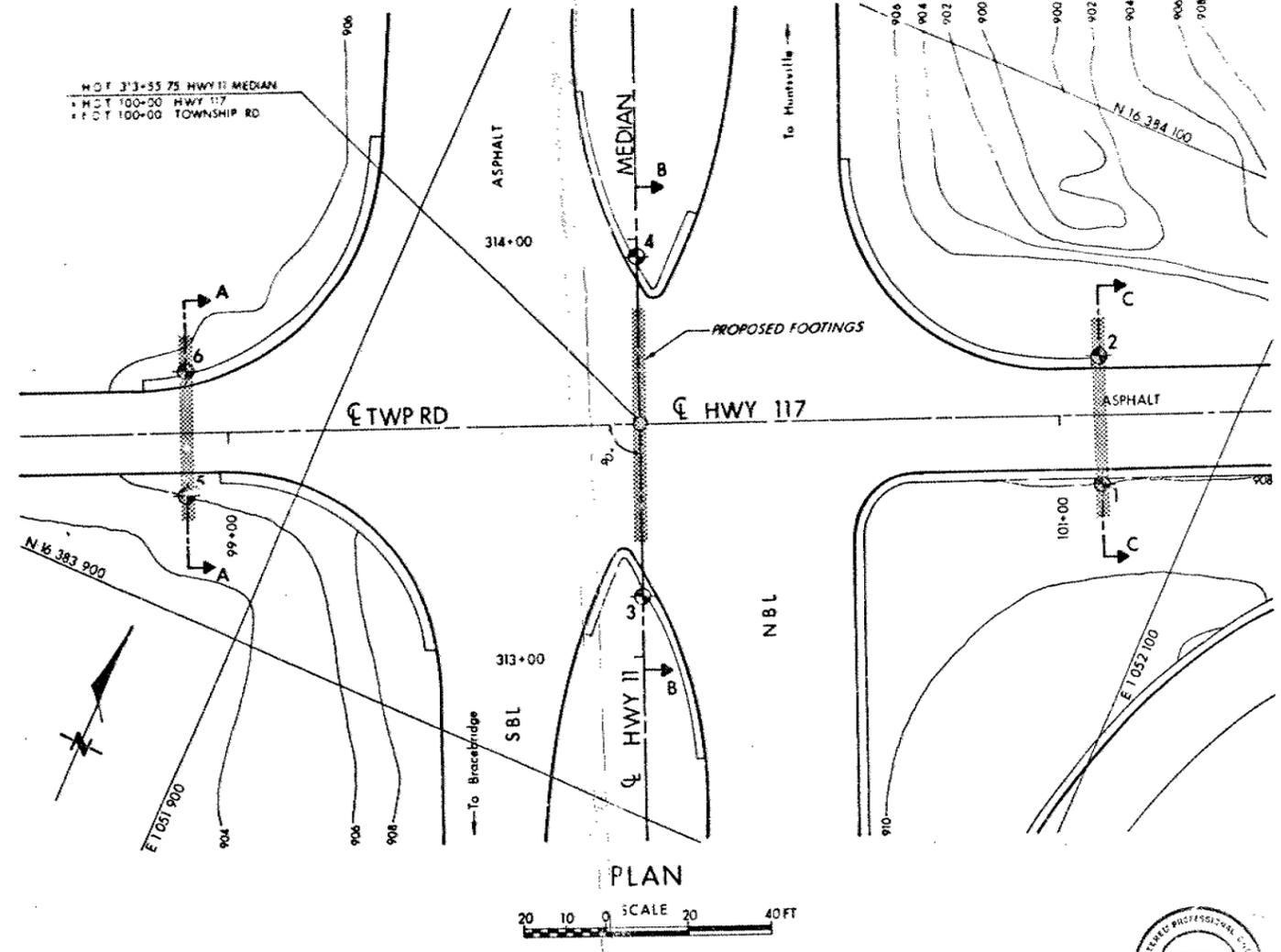
DATE	BY	DESCRIPTION
DESIGN	KE	CHK SP CODE LOAD DATE FEB 2019
DRAWN	AN	CHK KE SITE 42X-0174/BQ/STRUCT DWG R3-02



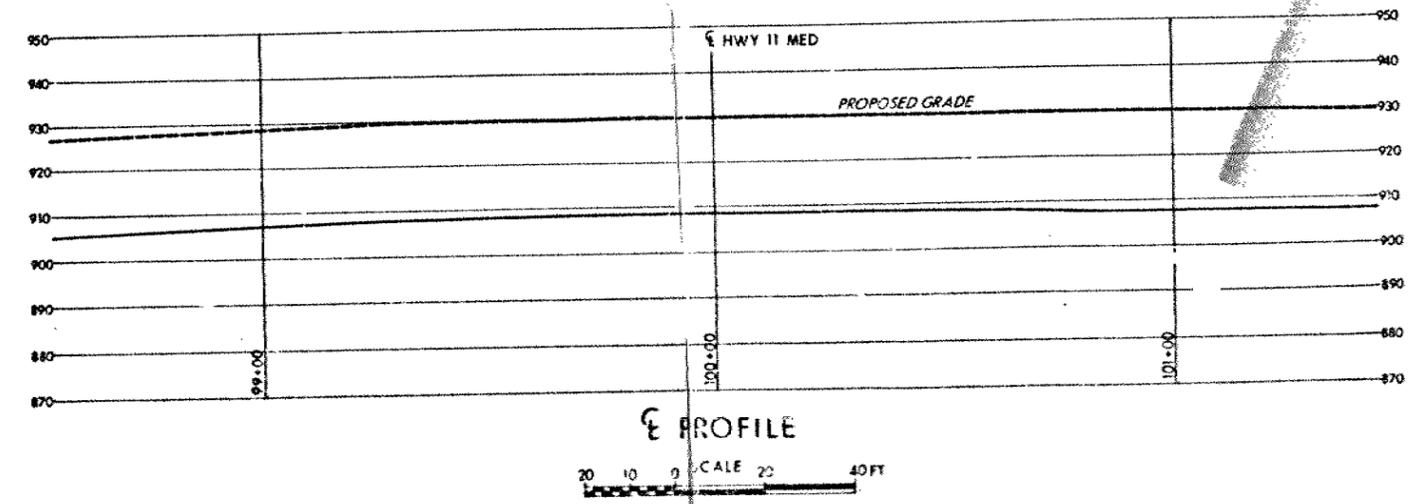
BORE HOLE LOCATIONS & SOIL STRATA



SECTIONS
SCALE 10 5 0 10 20 FT



PLAN



PROFILE

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N* Blows/ft (Std Pen Test 350ft lbs energy)
- CONE* Blows/ft (60° Cone, 350ft lbs energy)
- WL at time of investigation Mar & Apr 1977

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	908.2	16 384 017	1052 076
2	907.3	16 384 045	1052 064
3	909.0	16 383 949	1051 987
4	907.5	16 384 023	1051 953
5	906.3	16 383 927	1051 876
6	906.6	16 383 954	1051 863

-NOTE-
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

Appendix B.

Record of Borehole Sheets



SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

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

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

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

RECOVERY:

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

N-VALUE:

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

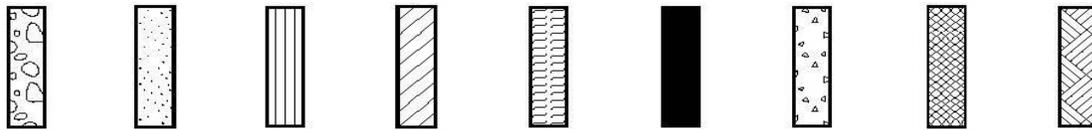
DYNAMIC CONE PENETRATION TEST (DCPT):

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



STRATA PLOT:

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



Boulders
Cobbles
Gravel Sand Silt Clay Organics Asphalt Concrete Fill Bedrock

TEXTURING CLASSIFICATION OF SOILS

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

TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

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

SAMPLE TYPES

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

TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

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



MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note - W_L = Liquid Limit



EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

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

TERMS

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

DISCONTINUITY SPACING

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

STRENGTH CLASSIFICATION

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

RECORD OF BOREHOLE No 18-1

1 OF 2

METRIC

GWP# 5138-13-00 LOCATION Lat: 45.086193°, Long: -79.299082° HWY 11 UP at Muskoka Rd 117, MTM Zone 10: N 4 994 043.4 E 320 616.4 ORIGINATED BY SOB
 HWY 11 BOREHOLE TYPE CME55 Truck with HSA / NW Casing COMPILED BY KE
 DATUM Geodetic DATE 2018.04.30 - 2018.04.30 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
282.5	ASPHALT (100 mm)	[Hatched]													
0.0	SAND some gravel dense to compact, brown, moist FILL	[Cross-hatched]	1	SS	33										
0.1			2	SS	22										
281.0	SAND with silt and gravel compact to dense, brown, moist FILL	[Cross-hatched]	3	SS	17										
1.5			4	SS	17										
			5	SS	26										
			6	SS	31										15 76 9 (SI+CL)
			7	SS	21										
			8	SS	35										
			9	SS	16										
			10	SS	9										
			11	SS	10										0 82 18 (SI+CL)
275.3	SILTY SAND (SM) loose to compact, grey-brown, moist	[Dotted]													
7.2															

DOUBLE LINE 20244_MUSKOKARD117.GPJ_2012TEMPLATE(MTO).GDT_22/1/19

Continued Next Page

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

RECORD OF BOREHOLE No 18-1

2 OF 2

METRIC

GWP# 5138-13-00 LOCATION Lat: 45.086193°, Long: -79.299082° HWY 11 UP at Muskoka Rd 117, MTM Zone 10: N 4 994 043.4 E 320 616.4 ORIGINATED BY SOB
 HWY 11 BOREHOLE TYPE CME55 Truck with HSA / NW Casing COMPILED BY KE
 DATUM Geodetic DATE 2018.04.30 - 2018.04.30 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
	Continued From Previous Page						20 40 60 80 100								
272.3															
10.2	SAND (SP) with gravel compact to loose, brown, moist		12	SS	26									25 71 4 (SI+CL)	
	wet below 12.0 m														
				13	SS	4									
															Switch to Casing
269.2															
13.3	SILTY SAND (SM) compact to dense, brown, wet		14	SS	14										
				15	SS	22									
				16	SS	30									
				17	SS	33									0 87 13 (SI+CL)
264.5															
18.0	End of Borehole Water level at 12.0 m (elev. 270.5 m)														

DOUBLE LINE 20244_MUSKOKARD117.GPJ_2012TEMPLATE(MTO).GDT_22/1/19

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

RECORD OF BOREHOLE No 18-2

1 OF 2

METRIC

GWP# 5138-13-00 LOCATION Lat: 45.086519°, Long: -79.298073° HWY 11 BOREHOLE TYPE CME55 Truck with HSA / NW Casing ORIGINATED BY SOB
 DATUM Geodetic DATE 2018.04.30 - 2018.04.30 COMPILED BY KE CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60						80
283.6	ASPHALT (75 mm)	[Cross-hatched]														
0.0	SAND trace to some gravel compact, brown, moist FILL	[Cross-hatched]	1	SS	26											
0.1			2	SS	22											
			3	SS	16											
281.3	SAND with silt and gravel compact, brown, moist FILL	[Cross-hatched]	4	SS	17											
2.3			5	SS	21											
			6	SS	12											
			7	SS	18											
			8	SS	21											
			9	SS	51											14 77 9 (SI+CL)
276.4	SAND (SP-SM) with silt trace gravel very dense to compact, brown, moist	[Dotted]														
7.2			10	SS	71										6 89 5 (SI+CL)	
			11	SS	21											

DOUBLE LINE 20244_MUSKOKARD17.GPJ_2012TEMPLATE(MTO).GDT_22/1/19

Continued Next Page

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

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 1

WP 32-77-02 LOCATION Co-ords. N 16,384,017; E 1,052,076 ORIGINATED BY JM
 DIST 11 HWY 11 BORING DATE March 23,24,25,28, 1977 COMPILED BY JM
 DATUM Geodetic BOREHOLE TYPE Cont.' Flight Auger & BXL Rock Coring CHECKED BY [Signature]
 & Cone Test

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w $w_p \quad w \quad w_L$ WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N° VALUES					
908.2	Ground Level									
0.0	Silty Sand to Sandy silt Traces of gravel, clay Loose to Dense	[Strat. Plot]	1	SS	48	[D.C.P. Plot]	[Liquid Limit, Plastic Limit, Water Content]	[Unit Weight]	2 94 (4)	
			2	SS	33					
			3	SS	18					
			4	SS	12					
			5	SS	20					
			6	SS	6					
			7	SS	11					
			8	SS	-					
			9	SS	6					
			10	SS	11					
			11	SS	47					
875.4	Weathered		12	BXL RC	84%				0 36 63 1	
32.8	Gneiss Bedrock Sound		13	BXL RC	94%				0 67 32 1	
870.4									0 93 (7)	
37.8	End of Borehole									

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 2

WP 32-77-02 LOCATION Co-ords. N 16,384,045; E 1,052,064 ORIGINATED BY JM
 DIST 11 HWY 11 BORING DATE March 29,30,31, 1977 COMPILED BY JM
 DATUM Geodetic BOREHOLE TYPE Cont.' Flight Auger & BXL Rock Coring CHECKED BY [Signature]
& Cone Test

SOIL PROFILE		STRAT. PLOT	SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
907.3	Ground Level															
0.0	Silty Sand to Sandy Silt Traces of gravel, clay - Some - Gravel Loose to Very Dense		1	SS	65										0 14 85 1	
			2	SS	29	900										
				3	SS	34										
				4	SS	9										
				5	SS	4										
				6	SS	16	890									25 70 (5)
				7	WS	-										
				8	SS	24	880									
				9	SS	35										
877.2		Weathered														
30.1 874.2	Gneiss Bedrock Sound		10	BXL RC	97%											
33.1	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 3

WP 32-77-02 LOCATION Co-ords. N 16,383,949; E 1,051,987 ORIGINATED BY JM
 DIST 11 HWY 11 BORING DATE April 1,7,12, 1977 COMPILED BY JM
 DATUM Geodetic BOREHOLE TYPE Cont.' Flight Auger & Cone Test CHECKED BY GP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT				LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			UNIT WEIGHT γ	REMARKS % GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	VALUES		20	40	60	80	100	SHEAR STRENGTH w_p ——— w ——— w_L ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT % 10 20 30
909.0	Ground Level															
0.0	Some Gravel		1	SS	8										21 74 (5)	
	Silty Sand to Sandy Silt		2	SS	18										0 86 13 1	
	Trace of clay		3	SS	32											
	Loose to Dense		4	SS	20											
			5	SS	12											
892.7			6	SS	113	10"									0 38 62 0	
16.3	End of Borehole (Refusal)					890										

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 4

WP 32-77-02 LOCATION Co-ords. N 16,384,023; E 1,051,953 ORIGINATED BY JM
 DIST 11 HWY 11 BORING DATE April 1,11,12, 1977 COMPILED BY JM
 DATUM Geodetic BOREHOLE TYPE Cont.' Flight Auger & BXL Rock Coring CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS				
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L			GR	SA	SI	CL
907.5	Ground Level																			
0.0	Silty Sand Traces of gravel, clay Loose to Compact		1	SS	12	900 890												0 93 (7)		
			2	SS	21															
			3	SS	14															
			4	SS	6															
			5	SS	-															7 72 20 1
			6	SS	-															
888.0																				
19.5	Gneiss Bedrock Sound		7	RC	100 %															
881.7			8	RC	100 %															
25.8	End of Borehole																			

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 5

WP 32-77-02 LOCATION Co-ords. N 16,383,927; E 1,051,876 ORIGINATED BY JM
 DIST 11 HWY 11 BORING DATE April 1,5,6,7, 1977 COMPILED BY JM
 DATUM Geodetic BOREHOLE TYPE Cont.' Flight Auger & Cone Test CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w w_p — w — w_L WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
906.3	Ground Level									
0.0	Silty Sand to Sandy Silt Traces of gravel, clay Loose to Very Dense	[Strat. Plot]	1	SS	29					7 78 14 1
			2	SS	18		4 73 22 1			
			3	SS	8					
			4	SS	13					
			5	SS	69					
			6	SS	53					
			7	SS	28					
			8	SS	22					
			9	SS	26					
			10	SS	18					
			11	SS	23					
			12	SS	13					
			13	WS						
			14	SS	120					
840.3										
66.0	End of Borehole (Refusal)									

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 6

WP 32-77-02 LOCATION Co-ords. N 16,383,954; E 1,051,863 ORIGINATED BY JM
 DIST 11 HWY 11 BORING DATE March 31, April 1,4, 1977 COMPILED BY JM
 DATUM Geodetic BOREHOLE TYPE Cont.' Flight Auger, Wash Bore & BXL Rock CHECKED BY EP
Coring & Cone Test

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
906.6	Ground Level															
0.0	Silty Sand to Sandy Silt		1	SS	64										0 72 27 1	
			2	SS	15											
			3	SS	8											
			4	SS	17											
	Sand & Gravel		5	SS	54										45 51 (4)	
	Traces of gravel, clay		6	SS	44											
			7	SS	19											
			8	SS	15										3 29 67 1	
			9	SS	19											
	Loose to Very Dense		10	SS	28											
			11	SS	16										0 82 18 0	
			12	SS	13											
			13	SS	14											
			14	SS	6											
845.6			15	SS	8										0 67 31 2	
61.0	Boulders (Refusal to conventional boring methods)		16	BXL RC	12%											
836.0																
70.6	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

Appendix C.

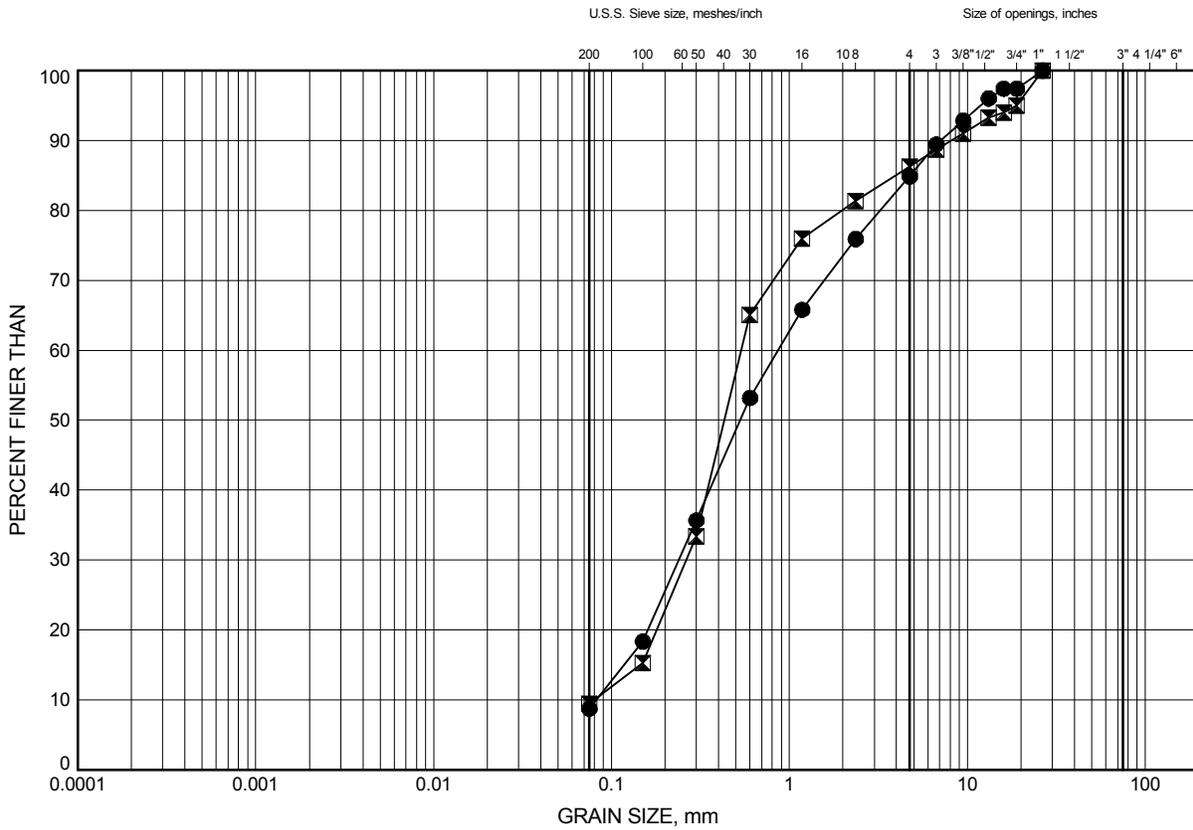
Laboratory Testing

Appendix C.1
Particle Size Analysis Figures

Hwy's 11 and 118 - Muskoka Road 117
GRAIN SIZE DISTRIBUTION

FIGURE C1

FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-1	4.1	278.4
⊠	18-2	3.4	280.2

GRAIN SIZE DISTRIBUTION - THURBER 20244_MUSKOKARD117.GPJ 7/1/19

Date ..January 2019.....
 GWP# ..5138-13-00.....

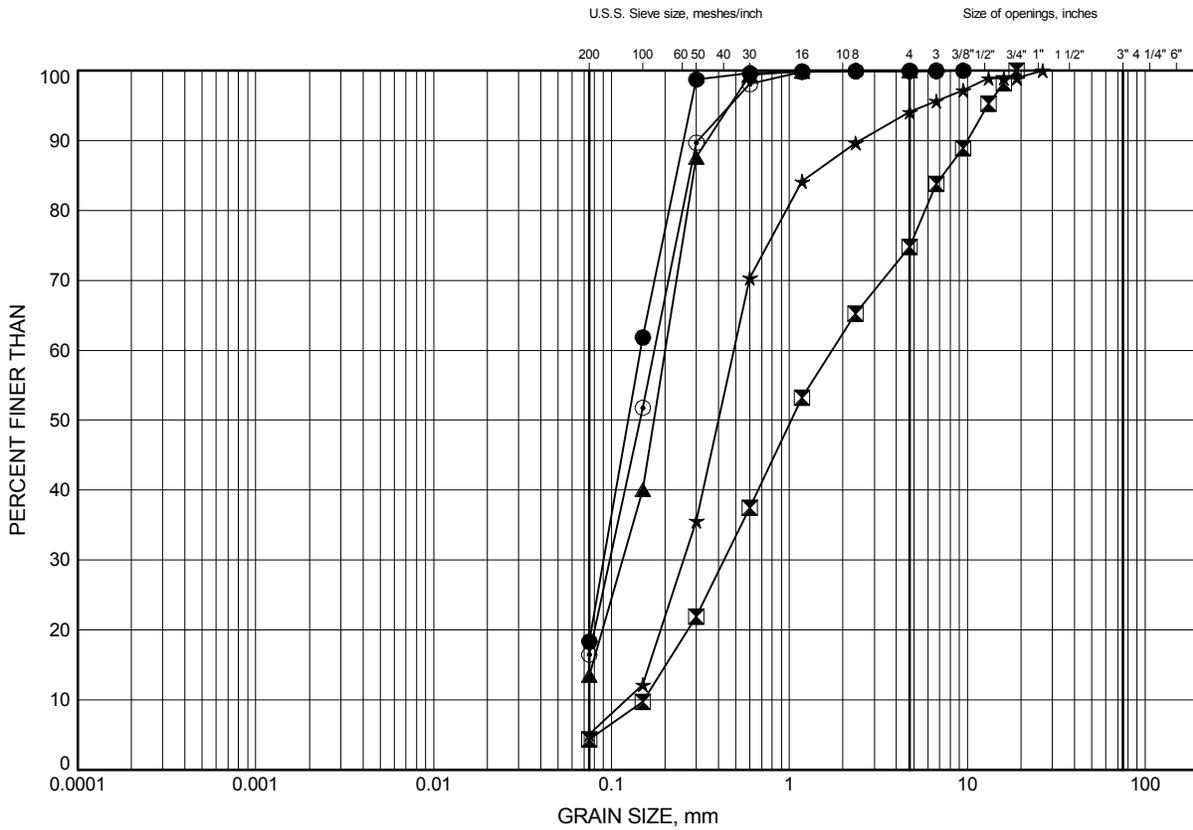


Prep'dKE.....
 Chkd.SP.....

Hwy's 11 and 118 - Muskoka Road 117
GRAIN SIZE DISTRIBUTION

FIGURE C2

SAND with Gravel (SP) to SILTY SAND (SM)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-1	9.4	273.1
⊠	18-1	11.0	271.5
▲	18-1	17.7	264.8
★	18-2	7.9	275.7
⊙	18-2	14.0	269.6

GRAIN SIZE DISTRIBUTION - THURBER 20244_MUSKOKARD117.GPJ 7/1/19

Date ..January 2019.....
 GWP# ..5138-13-00.....



Prep'dKE.....
 Chkd.SP.....

Appendix C.2
Analytical Testing Results

Certificate of Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Suite 104
Ottawa, ON K1B 4S5
Attn: Katya Edney

Client PO:
Project: HWY 11 + 118
Custody: 39845

Report Date: 10-May-2018
Order Date: 4-May-2018

Order #: 1818669

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Parcel ID	Client ID
1818669-01	Road 117 18-1'ss13 40-42'
1818669-02	Road 117 18-2 'SS12 35-37'
1818669-03	Fraserburg '18-1SS10 22'6-24'6"
1818669-04	Fraserburg'18-2 SS12A 35-36'6"
1818669-05	Road 2 '18-1 SS9 20-22'
1818669-06	Road 2 '18-2 SS10 25-27'
1818669-07	Bullens '18-1 SS11 23'3"-25'3"
1818669-08	Road 3 18-1 SS10 25-27'
1818669-09	Road 3 18-2 SS10 25-27'
1818669-10	Siding 18-2SS5 10-12'
1818669-11	Siding 18-3 SS5 10-12'

Approved By:

Dale Robertson, BSc
Laboratory Director

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 10-May-2018

Order Date: 4-May-2018

Project Description: HWY 11 + 118

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	8-May-18	8-May-18
Conductivity	MOE E3138 - probe @25 °C, water ext	8-May-18	9-May-18
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	7-May-18	7-May-18
Resistivity	EPA 120.1 - probe, water extraction	8-May-18	9-May-18
Solids, %	Gravimetric, calculation	7-May-18	7-May-18

Certificate of Analysis
 Client: Thurber Engineering Ltd.
 Client PO:

Report Date: 10-May-2018

Order Date: 4-May-2018

Project Description: HWY 11 + 118

Client ID:	Road 117 18-1'ss13 40-42'	Road 117 18-2 'SS12 35-37'	Fraserburg 18-1SS10 22'6-24'6"	Fraserburg'18-2 SS12A 35-36'6"
Sample Date:	04/30/2018 09:00	04/30/2018 09:00	04/29/2018 09:00	04/29/2018 09:00
Sample ID:	1818669-01	1818669-02	1818669-03	1818669-04
MDL/Units	Soil	Soil	Soil	Soil

Physical Characteristics

% Solids	0.1 % by Wt.	83.9	83.9	68.9	70.1
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General Inorganics

Conductivity	5 uS/cm	133	234	469	262
pH	0.05 pH Units	5.84	6.14	5.56	5.32
Resistivity	0.10 Ohm.m	75.0	42.7	21.3	38.1

Anions

Chloride	5 ug/g dry	82	113	246	120
Sulphate	5 ug/g dry	12	9	51	10

Client ID:	Road 2 '18-1 SS9 20-22'	Road 2 '18-2 SS10 25-27'	Bullens '18-1 SS11 23'3"-25'3"	Road 3 18-1 SS10 25-27'
Sample Date:	04/28/2018 09:00	05/01/2018 09:00	04/21/2018 09:00	04/27/2018 09:00
Sample ID:	1818669-05	1818669-06	1818669-07	1818669-08
MDL/Units	Soil	Soil	Soil	Soil

Physical Characteristics

% Solids	0.1 % by Wt.	87.0	72.7	77.5	80.3
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General Inorganics

Conductivity	5 uS/cm	218	1780	400	61
pH	0.05 pH Units	6.41	5.76	7.44	6.39
Resistivity	0.10 Ohm.m	45.8	5.61	25.0	164

Anions

Chloride	5 ug/g dry	124	1170	23	21
Sulphate	5 ug/g dry	7	10	200	11

Client ID:	Road 3 18-2 SS10 25-27'	Siding 18-2SS5 10-12'	Siding 18-3 SS5 10-12'	-
Sample Date:	04/27/2018 09:00	04/24/2018 09:00	04/23/2018 09:00	-
Sample ID:	1818669-09	1818669-10	1818669-11	-
MDL/Units	Soil	Soil	Soil	-

Physical Characteristics

% Solids	0.1 % by Wt.	82.5	79.5	72.3	-
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General Inorganics

Conductivity	5 uS/cm	158	2120	428	-
pH	0.05 pH Units	6.44	6.34	6.13	-
Resistivity	0.10 Ohm.m	63.1	4.71	23.4	-

Anions

Chloride	5 ug/g dry	83	1590	154	-
Sulphate	5 ug/g dry	9	19	76	-

Certificate of Analysis
 Client: Thurber Engineering Ltd.
 Client PO:

Report Date: 10-May-2018
 Order Date: 4-May-2018
 Project Description: HWY 11 + 118

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	5	ug/g						
Sulphate	ND	5	ug/g						
General Inorganics									
Conductivity	ND	5	uS/cm						
Resistivity	ND	0.10	Ohm.m						

Certificate of Analysis
 Client: **Thurber Engineering Ltd.**
 Client PO:

Report Date: 10-May-2018
 Order Date: 4-May-2018
 Project Description: **HWY 11 + 118**

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	55.9	5	ug/g dry	55.6			0.7	20	
Sulphate	23.4	5	ug/g dry	22.9			2.1	20	
General Inorganics									
Conductivity	443	5	uS/cm	424			4.4	6.2	
pH	7.77	0.05	pH Units	7.77			0.0	10	
Resistivity	22.6	0.10	Ohm.m	23.6			4.4	20	
Physical Characteristics									
% Solids	98.2	0.1	% by Wt.	98.0			0.2	25	

Certificate of Analysis
 Client: Thurber Engineering Ltd.
 Client PO:

Report Date: 10-May-2018

Order Date: 4-May-2018

Project Description: HWY 11 + 118

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	149	5	ug/g	55.6	93.2	78-113			
Sulphate	119	5	ug/g	22.9	95.8	78-111			

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 10-May-2018
Order Date: 4-May-2018
Project Description: HWY 11 + 118

Qualifier Notes:

Login Qualifiers :

Container(s) - Bottle and COC sample ID don't match -

*Applies to samples: Road 117 18-1'ss13 40-42', Road 117 18-2 'SS12 35-37', Fraserburg '18-1SS10 22'6-24'6',
Bullens '18-1 SS11 23'3"-25'3"*

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

Source Result: Data used as source for matrix and duplicate samples

%REC: Percent recovery.

RPD: Relative percent difference.

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

Subcontracted Analysis

Thurber Engineering Ltd.
2460 Lancaster Rd, Suite 104
Ottawa, ON K1B 4S5
Attn: Katya Edney

Tel: (613) 247-2121
Fax: (613) 247-2185

Paracel Report No **1818669**
Client Project(s): **HWY 11 + 118**
Client PO:
Reference: **Standing Offer**
CoC Number: **39845**

Order Date: 04-May-18
Report Date: 15-May-18

Sample(s) from this project were subcontracted for the listed parameters. A copy of the subcontractor's report is attached

Parcel ID	Client ID	Analysis
1818669-01	Road 117 18-1'ss13 40-42'	Sulphide, solid
1818669-02	Road 117 18-2 'SS12 35-37'	Sulphide, solid
1818669-03	Fraserburg '18-1SS10 22'6-24'6"	Sulphide, solid
1818669-04	Fraserburg'18-2 SS12A 35-36'6"	Sulphide, solid
1818669-05	Road 2 '18-1 SS9 20-22'	Sulphide, solid
1818669-06	Road 2 '18-2 SS10 25-27'	Sulphide, solid
1818669-07	Bullens '18-1 SS11 23'3"-25'3"	Sulphide, solid
1818669-08	Road 3 18-1 SS10 25-27'	Sulphide, solid
1818669-09	Road 3 18-2 SS10 25-27'	Sulphide, solid
1818669-10	Siding 18-2SS5 10-12'	Sulphide, solid
1818669-11	Siding 18-3 SS5 10-12'	Sulphide, solid



SGS Canada Inc.

P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2H0
Phone: 705-652-2000 FAX: 705-652-6365

15-May-2018

Paracel Laboratories

Attn : Dale Robertson

300-2319 St.Laurent Blvd.
Ottawa, ON
K1G 4K6,

Phone: 613-731-9577
Fax:613-731-9064

Date Rec. : 08 May 2018
LR Report: CA13203-MAY18
Reference: Project#: 1818669

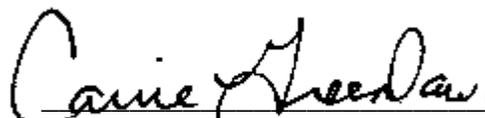
Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Sample ID	Sample Date & Time	Sulphide %
1: Analysis Start Date		14-May-18
2: Analysis Start Time		13:09
3: Analysis Completed Date		14-May-18
4: Analysis Completed Time		14:54
5: QC - Blank		< 0.02
6: QC - STD % Recovery		101%
7: QC - DUP % RPD		ND
8: RL		0.02
9: Road 117 18-1'ss13 40-42'	30-Apr-18	< 0.02
10: Road 117 18-2 'SS12 35-37'	30-Apr-18	< 0.02
11: Fraserburg '18-1SS10 22'6-24'6"	29-Apr-18	< 0.02
12: Fraserburg '18-2 SS12A 35-36'6"	29-Apr-18	< 0.02
13: Road 2 '18-1 SS9 20-22'	28-Apr-18	< 0.02
14: Road 2 '18-2 SS10 25-27'	01-May-18	< 0.02
15: Bullens '18-1 SS11 23'3"-25'3"	21-Apr-18	0.40
16: Road 3 18-1 SS10 25-27'	27-Apr-18	< 0.02
17: Road 3 18-2 SS10 25-27'	27-Apr-18	< 0.02
18: Siding 18-2SS5 10-12'	24-Apr-18	< 0.02
19: Siding 18-3 SS5 10-12'	23-Apr-18	< 0.02

RL - SGS Reporting Limit



Carrie Greenlaw
Project Specialist
Environmental Services, Analytical

Appendix D.

Site Photographs

HIGHWAY 11 UNDERPASS STRUCTURE
MUSKOKA RD 117, DISTRICT OF MUSKOKA



Photo 1. Muskoka Road 117 Underpass Structure from west



Photo 2. Looking west along Muskoka Road 117 from west approach

HIGHWAY 11 UNDERPASS STRUCTURE
MUSKOKA RD 117, DISTRICT OF MUSKOKA



Photo 3. Looking west along Muskoka Road 117 from east approach



Photo 4. Looking south towards Highway 11 from Muskoka Road 117

Appendix E.

List of Special Provisions and OPSS Documents Referenced in this Report

1. The following Special Provisions and OPSS Documents are referenced in this report:

OPSS.PROV 206	Construction Specification for Grading
OPSS.PROV 501	Construction Specification for Compacting
OPSS.PROV 539	Construction Specification for Temporary Protection Systems
OPSS.PROV 804	Construction Specification for Seed and Cover
OPSS. 805	Construction Specification for Temporary Erosion and Sediment Control Measures
OPSS 902	Construction Specification for Excavating and Backfilling Structures
OPSS.PROV 1010	Material Specification for Aggregates Base, Subbase, Select Subgrade, and Backfill Material
OPSD 3101.150	Walls, Abutment, Backfill, Minimum Granular Requirement

2. Suggested text for a NSSP on “Installation of Temporary Protection System”

Vibratory equipment is not permitted for installation or removal of temporary protection systems below elevation 276.4 m.

3. Suggested text for a NSSP on “Obstructions”

Obstructions such as cobbles and boulders may be encountered in the embankment during excavation and installation of traffic protection systems. Such obstructions may impede the work from reaching the design depth of installation. The Contractor shall be prepared to remove, drill through and/or penetrate these obstructions and extend the work to the design depths.