



FINAL REPORT

FOUNDATION INVESTIGATION REPORT

New Material Storage Facility at Gravenhurst Patrol Yard, Gravenhurst, ON

Agreement No. 5015-E-0007

Assignment No. 10

Geocres No. 31E-404

Prepared for:

Ontario Ministry of Transportation

Provincial Highways Management

Northeastern Region

Geotechnical Section

447 McKeown Avenue

North Bay, ON P1B 9S9

Ontario Ministry of Transportation

Pavements and Foundations Section

Materials Engineering and Research Office, Room 223, 2/F

145 Sir William Hearst Avenue

Toronto, ON M3M 0B6

EXP Services Inc.

July 26, 2019

Ministry of Transportation

Northeastern Region – Geotechnical Section

Foundation Investigation Report

Agreement No. 5015-E-0017

Assignment No. 10

Geocres No. 31E-404

Type of Document:

Final

Project Name:

New Material Storage Facility at Gravenhurst Patrol Yard, Gravenhurst, ON

Project Number:

ADM-00233185-K0

Prepared By:

Sugitha Anandakumar, M.Eng., EIT

Silvana Micic, Ph.D., P.Eng.

Reviewed By:

TaeChul Kim, M.E.Sc., P.Eng.

Stan E. Gonsalves, M.Eng., P.Eng.

EXP Services Inc.

56 Queen St, East, Suite 301

Brampton, ON L6V 4M8

Canada



Silvana Micic, Ph.D., P.Eng.
Senior Geotechnical Engineer



Stan E. Gonsalves, M.Eng., P.Eng.
Principal Engineer
MTO Designated Foundation Contact

Date Submitted:

07/26/2019

Table of Contents

1	FOUNDATION INVESTIGATION REPORT	1
1.1	Introduction	1
1.2	Site Description and Geological Setting	1
1.2.1	Site Description	1
1.2.2	Geological Setting	1
1.3	Available Documents of Previous Investigations	2
1.4	Investigation Procedures	2
1.4.1	Fieldwork	2
1.4.2	Laboratory Testing	4
1.5	Subsurface Conditions	4
1.5.1	Pavement Structure	4
1.5.2	Sand	5
1.5.3	Sandy Silt	6
1.5.4	Silty Sand	7
1.6	Groundwater Conditions	8
1.7	Chemical Analyses	8
1.8	Environmental Analyses	9
2	CLOSURE	10
3	LIMITATIONS AND USE OF REPORT	11

Appendices:

Appendix A	–	Photographs
Appendix B	–	Drawings
Appendix C	–	Borehole Logs
Appendix D	–	Laboratory Data
Appendix G	–	Records of Borehole from Previous Investigation

1 FOUNDATION INVESTIGATION REPORT

1.1 Introduction

This report presents the results of a geotechnical investigation carried out by EXP Services Inc. (EXP) for the proposed new material (including winter sand/salt) storage facility at the Gravenhurst Patrol Yard, located in Township of Muskoka, Northeastern Ontario. The work was undertaken under Agreement # 5015-E-0007, Assignment No. 10. The terms of reference (TOR) were as presented in the Ministry of Transportation (MTO) email received on March 12, 2019.

The purpose of this investigation is to establish existing subsurface conditions at the proposed location of the patrol yard structure within construction limits defined by MTO. The site-specific geotechnical investigation consisted of field investigation including visual inspection, drilling, soil sampling, and laboratory testing. Factual results of the investigation and laboratory testing are included in this report. The report has been prepared specifically and solely for the project described in the report.

1.2 Site Description and Geological Setting

1.2.1 Site Description

The Gravenhurst Patrol Yard is located on Highway 11, approximately 0.5 km south of the Muskoka Road 169, Gravenhurst, Township of Muskoka, Northeastern Ontario (see Key Map on Drawing 1, Appendix B). The site is bound by Highway 11 to the west.

A paved roadway lead from the site entrance on Highway 11 to existing 6-bay garages, which is located approximately 150 m northeast of the entrance gate. Gravel stock pile is present in the southwest area of the proposed material storage facility. The proposed new storage facility will be located approximately 250 m northeast from the site entrance.

The topography of the site is considered flat lying with elevations ranging from 255.5 to 255.7 m. The ground surface of the proposed material storage facility is paved from the east to west end of the facility. The area beyond the north, south and east boundary of the proposed facility consists of bush with mature trees. Photographs of the site are included in Appendix A.

1.2.2 Geological Setting

In accordance with the Ministry of Northern Development and Mines Map 2556, Quarternary Geology of Ontario, Southern Sheet, the site is generally glaciofluvial outwash deposits consisting of gravel and sand including proglacial river and deltaic deposits. In accordance with the Ministry of Northern Development and Mines Map 2544, Bedrock Geology of Ontario, Southern Sheet, the bedrock at the site consists of migmatitic rocks and gneisses of undetermined protolith consisting of layered biotite gneisses and migmatites, quartzofeldspathic gneisses, orthogneisses and paragneisses.

1.3 Available Documents of Previous Investigations

The available reports of the previous investigation for Gravenhurst Patrol Yard in the MTO GEOCREs library are:

1. Geocres No. 31D-120: "Foundation Investigation Report for Proposed S Gravenhurst Patrol Yard, Highway 11, Lot 2 & 3, Con. E.N.R., Township of Muskoka, District #11", November 4, 1963
2. Geocres No. 31D-581: "Foundation Investigation and Design Report, Sand/Salt Storage Structure, Gravenhurst Patrol Yard, Highway 11, Township of Muskoka W.O. 2014-11033 prepared by Golder Associates", dated November 10, 2014

The details of four boreholes completed by Golder Associates (Golder) for Gravenhurst Patrol Yard are outlined in Table 1.1 and the borehole locations are shown on Drawings in Appendix B. For the ground elevations mentioned in Table 1.1 the BM with elevation 257.308 m was used as noted in Golder's report. The borehole logs are included in Appendix G. As can be seen, the previous boreholes were drilled approximately 50 to 100 m southeast of the proposed location for the new storage building.

Table 1.1. Summary of boreholes completed by Golder Associates

BH #	MTM NAD83 Northing	MTM NAD83 Easting	Ground Elevation (m)	Borehole Depth (m)
BH-YARD1	4973399.2	315563.8	256.4	11.3
BH-YARD2	4973379.0	315663.4	256.4	11.3
BH-YARD3	4973372.9	315656.4	256.6	12.8
BH-YARD4	4973390.3	315642.6	256.8	12.8

1.4 Investigation Procedures

1.4.1 Fieldwork

The field investigation was performed between April 23 and 29, 2019. The field program consisted of drilling four (4) sampled boreholes (BH19-G-1 to BH19-G-4). The boreholes were strategically located at the patrol yard to provide the subsurface information for the design of the proposed material storage facility. The borehole locations are shown on Drawing 1 in Appendix B.

The borehole locations (referenced to the MTM NAD83 coordinate system) and their ground surface elevations were surveyed by EXP personnel, with reference to the temporary benchmark (TBM)

established on the top of grey hydro box on the concrete pillar adjacent to the light post. The elevation of the TBM was considered 256.8 m based on the drawing provided with TOR. The TBM location is shown on Drawing 1, in Appendix B.

The boreholes were advanced using a truck mounted CME-55 drill rig, equipped with a hollow stem auger. All borehole drilling and sampling operations were performed by a specialist drilling contractor, Landcore Drilling Services. The locations, elevations and depths of boreholes are shown below in Table 1.2.

Table 1.2. Locations, elevations and depths of boreholes completed by EXP Services Inc.

BH #	Location	MTM NAD83 Northing	MTM NAD83 Easting	Ground Elevation (m)	Borehole Depth (m)
BH19-G-1	NW of North Existing Dome	4973470.2	315709.1	255.6	15.6
BH19-G-2	NE of North Existing Dome	4973478.7	315738.3	255.7	16.1
BH19-G-3	SW of South Existing Dome	4973405.8	315729.9	255.5	16.4
BH19-G-4	SE of South Existing Dome	4973415.3	315759.1	255.6	15.7

During the drilling of the boreholes, soil samples were obtained using a 51 mm outside diameter (O.D.) split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures (ASTM D 1586), at intervals shown on the attached borehole logs (Appendix C). The original field (uncorrected) SPT “N” values were recorded on the borehole logs as recommended in the Canadian Foundation Engineering Manual (CFEM pg. 40) and used to provide an assessment of in-situ consistency of cohesive soils or relative density of non-cohesive soils. Water truck from Fowler Construction was used for soil sampling (wash boring).

Upon completion of the drilling operations, groundwater level measurements were carried out in the open holes. The groundwater levels encountered in the boreholes are shown on the borehole logs and presented below in Table 1.6. The boreholes were decommissioned by bentonite/cement mixtures in accordance with the Ministry of the Environment Regulation 903, as amended by Regulation 128/03 (the well regulation under the Ontario Water Resources Act).

The fieldwork was supervised by a member of EXP’s engineering staff who directed the drilling and sampling operation, logged borehole data in accordance with MTO and/or ASTM standards for soils classification, and retrieved soil samples for subsequent laboratory testing and identification.

All the recovered soil samples were placed in labelled moisture-proof bags and returned to EXP’s Sudbury and Brampton laboratory for additional visual, textual and olfactory examination, and sampling for laboratory testing.

1.4.2 Laboratory Testing

All samples returned to the laboratory were subjected to visual examination and classification. The laboratory testing program included the determination of natural moisture content, particle size distribution and Atterberg Limits tests for approximately 25% of the collected soil samples. Soil chemical (Corrosivity and Contamination) package tests were performed on two soil samples. All the laboratory tests were carried out in accordance with MTO and/or ASTM standards as appropriate.

The laboratory test results are provided on the attached borehole log sheets in Appendix C. The results of the grain size analyses are presented graphically in Appendix D.

1.5 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes advanced during this investigation, together with the results of the laboratory tests carried out on selected soil samples, are presented on the borehole log sheets in Appendix C. Laboratory test results are provided in Appendix D. The “Explanation of Terms Used in Report” preceding the borehole logs in Appendix C forms an integral part of and should be read in conjunction with this report.

A borehole location plan and stratigraphic section along the proposed material storage facility are provided in Appendix B. It should be noted that the stratigraphic boundaries indicated on the borehole logs and stratigraphic section are inferred from non-continuous sampling, observations of drilling progress and results of Standard Penetration Tests. These boundaries typically represent transitions from one soil type to another and should not be regarded as exact planes of geological change. Further, subsurface conditions may vary between and beyond the borehole locations.

In general, the stratigraphic sequence at the proposed structure site consists of top sand and gravel fill, underlain by native fine grained sand, followed by sandy silt and silty sand. The findings are generally consistent with those reported in the previous investigation reports, even though the locations of investigations are different. A summary of the soil and groundwater conditions encountered in the current boreholes is provided below.

1.5.1 Pavement Structure

Asphaltic concrete was encountered at the surface of all boreholes BH19-G-1 to BH19-G-4, and ranged in thickness from approximately 65 mm to 100 mm. Asphalt thicknesses may further vary beyond the borehole locations.

Sand and gravel fill with trace silt was encountered below the asphaltic concrete on all boreholes BH19-1 to BH19-G-4, and ranged in thickness from approximately 510 mm to 545 mm. The total thickness of pavement structure in all boreholes is 0.6 m.

Laboratory testing performed on selected sample consisted of moisture content and grain size distribution tests. The test results are as follow:

Moisture Content:

- 1% to 5%

Grain Size Distribution:

- 18% to 26% gravel;
- 59% to 67% sand;
- 21% silt; and
- 2% clay.

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix C. The result of grain size distribution tests performed by EXP is also provided on Figure 1, in Appendix D.

1.5.2 Sand

A layer of native sand was encountered in all boreholes, below the pavement structure in all drilled boreholes (BH19-G-1 to BH19-G-4). The approximate elevations of the surface and base of the deposit and the thickness of deposit as encountered in boreholes are summarized in Table 1.3 below:

Table 1.3. Summary of sand layer

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)
	Top	Bottom		
BH19-G-1	255.0	246.8	0.6	8.2
BH19-G-2	255.1	246.9	0.6	8.2
BH19-G-3	254.9	246.5	0.6	8.4
BH19-G-4	255.0	246.6	0.6	8.4

The composition of this layer is fine grained sand, with trace to some gravel, trace to some silt and trace clay. The material is brown to brown/grey in color with dark grey molting with depth, and moist to wet. The SPT "N" values within this layer were between 19 and 76 blows per 300 mm penetration, suggesting compact to very dense compactness condition.

Laboratory testing performed on selected sample consisted of moisture content and grain size distribution tests. The test results are as follow:

Moisture Content:

- 3% to 30%

Grain Size Distribution:

- 0% to 17% gravel;
- 63% to 97% sand;
- 3% to 18% silt; and
- 0% to 3% clay

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix C. The result of grain size distribution tests performed by EXP is also provided on Figure 2, in Appendix D.

1.5.3 Sandy Silt

A layer of sandy silt was encountered in boreholes BH19-G-1, BH19-G-3 and BH19-G-4 below native sand. The approximate elevations of the surface and base of the deposit and the thickness of deposit as encountered in boreholes are summarized in Table 1.4 below:

Table 1.4. Summary of sandy silt layer

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)
	Top	Bottom		
BH19-G-1	246.8	245.0	8.8	1.8
BH19-G-3	246.5	243.5	9.0	3.0
BH19-G-4	246.6	245.0	9.0	1.6

The composition of this layer is fine-grained sandy silt, with trace clay. The material is brown/grey in color, and wet. The SPT “N” values within this layer were between 11 and 93 blows per 300 mm penetration, suggesting compact to very dense compactness condition.

Laboratory testing performed on selected sample consisted of moisture content and grain size distribution tests. The test results are as follow:

Moisture Content:

- 16% to 20%

Grain Size Distribution:

- 0% to % gravel;
- 27 to 38% sand;
- 57% to 66% silt; and
- 5% to 7% clay

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix C. The result of grain size distribution tests performed by EXP is also provided on Figure 3, in Appendix D.

1.5.4 Silty Sand

A layer of silty sand was encountered in all boreholes, below native sand in borehole BH19-G-2 and below sandy silt in boreholes BH19-G-1, BH19-G-3 and BH19-G-4. Boreholes BH19-G-2 and BH19-G-3 was extended deeper with Dynamic Cone Penetration Test (DCPT) until DCPT refusal (100 blows per 229 mm and 279 mm penetration respectively). All the boreholes are terminated within this layer. The approximate elevations of the surface and base of the deposit and the thickness of deposit as encountered in boreholes are summarized in Table 1.5 below:

Table 1.5. Summary of silty sand layer

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)
	Top	Bottom		
BH19-G-1	245.0	240.0	5.0	10.6
BH19-G-2	246.9	239.6	7.3	8.8
BH19-G-3	243.5	239.1	4.4	12.0
BH19-G-4	245.0	239.9	5.1	10.6

The composition of this layer is fine-grained silty sand with trace clay. The material is grey in color, and wet. The SPT “N” values within this layer were between 23 blows per 300 mm and 117 blows per 190 mm penetration, suggesting compact to very dense compactness condition.

Laboratory testing performed on selected sample consisted of moisture content and grain size distribution tests. The test results are as follow:

Moisture Content:

- 14% to 24%

Grain Size Distribution:

- 0% gravel;
- 42 to 66% sand;
- 32% to 57% silt; and
- 1% to 2% clay

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix C. The result of grain size distribution tests performed by EXP is also provided on Figure 4, in Appendix D.

1.6 Groundwater Conditions

Information regarding groundwater levels at the site was obtained by measuring water levels in the open holes of all the boreholes after completion of drilling. The groundwater levels measured in the boreholes are shown on Table 1.6 and on the borehole logs. Water levels measured in open boreholes might not be stabilized due to the relatively short period of observation.

Table 1.6 Groundwater data

Borehole	Date of Drilling	Ground surface Elevation (m)	Groundwater Elevation (m)	Groundwater Depth (m)
BH19-G-1	4/29/2019	255.6	253.5	2.1
BH19-G-2	4/25/2019	255.7	252.8	2.9
BH19-G-3	4/24/2019	255.5	252.8	2.7
BH19-G-4	4/23/2019	255.6	253.5	2.1

During investigation, few hours after borehole drilling, the unstabilized groundwater level was measured within the sand deposit approximately 2.1 m below ground surface (Elev. 253.5 m). Seasonal variations in the water tables should be expected, with higher levels occurring during wetter periods of the year and lower levels during drier periods.

1.7 Chemical Analyses

One (1) soil sample was selected for chemical analyses, and were sent via courier, in a secure cooler under chain of custody, to AGAT Laboratories., a CALA-certified and accredited laboratory in Mississauga, Ontario.

The sample SS3 from borehole BH19-G-1 was analyzed for corrosivity chemical analysis. The analytical results are summarized in Table 1.7 below and are presented in Appendix D.

Table 1.7. Corrosivity chemical analysis

Sample Identification	pH (unitless)	Soluble Chloride (ppm)	Soluble Sulphate (ppm)	Resistivity (ohm-cm)	Conductivity (mS/cm)	Redox Potential (mV)
BH19-G-1-SS3 Sand	6.83	6	14	18900	0.053	233 to 249

1.8 Environmental Analyses

In addition to corrosivity testing, one (1) sample of native sand materials from borehole BH19-G-1 (SS2) was analyzed for metals and general inorganics parameters and BTEX/ Petroleum Hydrocarbons (PHCs) – (F1-F4). The analytical results (Certificate of Analysis) are compiled in Appendix D.

July 26, 2019

2 CLOSURE


A subsurface investigation is a limited sampling of a site; the subsurface conditions have been established only at the test hole locations. Should conditions at the site be encountered which differ from those reported at the test locations, we require that we be notified immediately in order to assess this additional information and our recommendations, as appropriate. It may then be necessary to perform additional investigation and analysis.

Contractors bidding on or undertaking any proposed work at this site should, relative to the subsurface conditions, decide on their own investigations, if deemed necessary, as well as their own interpretations of the factual results provided herein, so they may draw their own conclusions as to how the subsurface conditions may affect them.

This Foundation Investigation Report has been prepared by Sugitha Anandakumar, M.Eng., EIT and Silvana Micic, Ph.D., P.Eng., and reviewed by TaeChul Kim, M.E.Sc., P.Eng. and Stan E. Gonsalves, M.Eng., P.Eng., MTO Designated Foundation Contact. The field investigation was conducted by Phillips Laframboise.

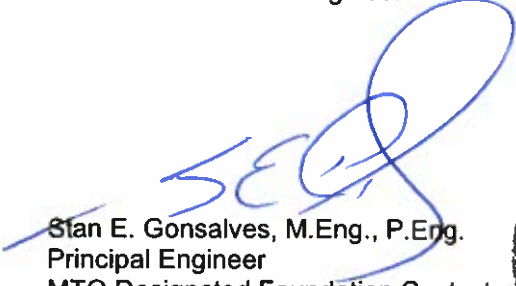
EXP Services Inc.


Sugitha Anandakumar, M.Eng., EIT
Technical Specialist


Silvana Micic, Ph.D., P.Eng.
Senior Geotechnical Engineer




TaeChul Kim, M.E.Sc., P.Eng.
Senior Geotechnical/Foundation Engineer


Stan E. Gonsalves, M.Eng., P.Eng.
Principal Engineer
MTO Designated Foundation Contact



Encl.

3 LIMITATIONS AND USE OF REPORT

BASIS OF REPORT

This report ("Report") is based on site conditions known or inferred by the geotechnical investigation undertaken as of the date of the Report. Should changes occur which potentially impact the geotechnical condition of the site, or if construction is implemented more than one year following the date of the Report, the recommendations of EXP may require re-evaluation.

The Report is provided solely for the guidance of design engineers and on the assumption that the design will be in accordance with applicable codes and standards. Any changes in the design features which potentially impact the geotechnical analyses or issues concerning the geotechnical aspects of applicable codes and standards will necessitate a review of the design by EXP. Additional field work and reporting may also be required.

Where applicable, recommended field services are the minimum necessary to ascertain that construction is being carried out in general conformity with building code guidelines, generally accepted practices and EXP's recommendations. Any reduction in the level of services recommended will result in EXP providing qualified opinions regarding the adequacy of the work. EXP can assist design professionals or contractors retained by the Client to review applicable plans, drawings, and specifications as they relate to the Report or to conduct field reviews during construction.

Contractors contemplating work on the site are responsible for conducting an independent investigation and interpretation of the borehole results contained in the Report. The number of boreholes necessary to determine the localized underground conditions as they impact construction costs, techniques, sequencing, equipment and scheduling may be greater than those carried out for the purpose of the Report.

Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates are based on investigations performed in accordance with the standard of care set out below and require the exercise of judgment. As a result, even comprehensive sampling and testing programs implemented with the appropriate equipment by EXPerienced personnel may fail to locate some conditions. All investigations or building envelope descriptions involve an inherent risk that some conditions will not be detected. All documents or records summarizing investigations are based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated. Some conditions are subject to change over time. The Report presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, these should be disclosed to EXP to allow for additional or special investigations to be undertaken not otherwise within the scope of investigation conducted for the purpose of the Report.

RELIANCE ON INFORMATION PROVIDED

The evaluation and conclusions contained in the Report are based on conditions in evidence at the time of site inspections and information provided to EXP by the Client and others. The Report has been prepared for the specific site, development, building, design or building assessment objectives and purpose as communicated by the Client. EXP has relied in good faith upon such representations,

information and instructions and accepts no responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of any misstatements, omissions, misrepresentation or fraudulent acts of persons providing information. Unless specifically stated otherwise, the applicability and reliability of the findings, recommendations, suggestions or opinions EXPRESSED in the Report are only valid to the extent that there has been no material alteration to or variation from any of the information provided to EXP.

STANDARD OF CARE

The Report has been prepared in a manner consistent with the degree of care and skill exercised by engineering consultants currently practicing under similar circumstances and locale. No other warranty, EXPRESSED or implied, is made. Unless specifically stated otherwise, the Report does not contain environmental consulting advice.

COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment form part of the Report. This material includes, but is not limited to, the terms of reference given to EXP by its client ("Client"), communications between EXP and the Client, other reports, proposals or documents prepared by EXP for the Client in connection with the site described in the Report. In order to properly understand the suggestions, recommendations and opinions EXPRESSED in the Report, reference must be made to the Report in its entirety. EXP is not responsible for use by any party of portions of the Report.

USE OF REPORT

The information and opinions EXPRESSED in the Report, or any document forming part of the Report, are for the sole benefit of the Client. No other party may use or rely upon the Report in whole or in part without the written consent of EXP. Any use of the Report, or any portion of the Report, by a third party are the sole responsibility of such third party. EXP is not responsible for damages suffered by any third party resulting from unauthorised use of the Report.

REPORT FORMAT

Where EXP has submitted both electronic file and a hard copy of the Report, or any document forming part of the Report, only the signed and sealed hard copy shall be the original documents for record and working purposes. In the event of a dispute or discrepancy, the hard copy shall govern. Electronic files transmitted by EXP have utilize specific software and hardware systems. EXP makes no representation about the compatibility of these files with the Client's current or future software and hardware systems. Regardless of format, the documents described herein are EXP's instruments of professional service and shall not be altered without the written consent of EXP.

Appendix A – Photographs

July 26, 2019



Photo 1. Gravenhurst Patrol Yard - Borehole BH19-G-1, facing northwest



Photo 2. Gravenhurst Patrol Yard- Existing sand dome; Borehole BH19-G-2, facing southwest

July 26, 2019



Photo 3. Gravenhurst Patrol Yard - Borehole BH19-G-3, facing northwest



Photo 4. Gravenhurst Patrol Yard - Existing sand dome; Borehole BH19-G-4, facing east

Appendix B – Drawings



CONT. No. 5015-E-0007 GWP No. - Assignment No. 10	
Various Patrol Yards, Sudbury and North Bay Areas PATROL YARD AT GRAVENHURST ON HWY 11 BOREHOLE LOCATION PLAN AND SOIL STRATA	SHEET 1

	exp Services Inc.
--	-------------------

KEY PLAN



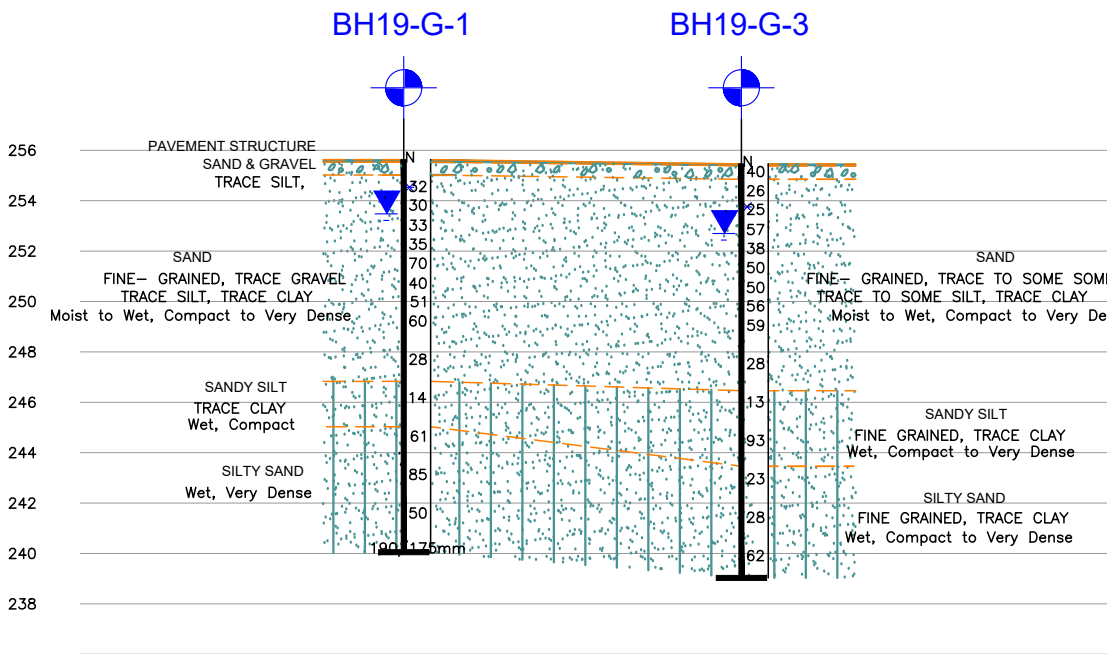
LEGEND	
	Borehole Location
	Existing Borehole Location
	Standard Penetration Test (Blows/0.3 m)
	Groundwater level measured in open hole
	Temporary Bench Mark (Elev. 256.82m)

SOIL STRATA SYMBOLS	
	PAVEMENT STRUCTURE
	SAND
	SAND AND GRAVEL
	SILTY SAND/ SANDY SILT

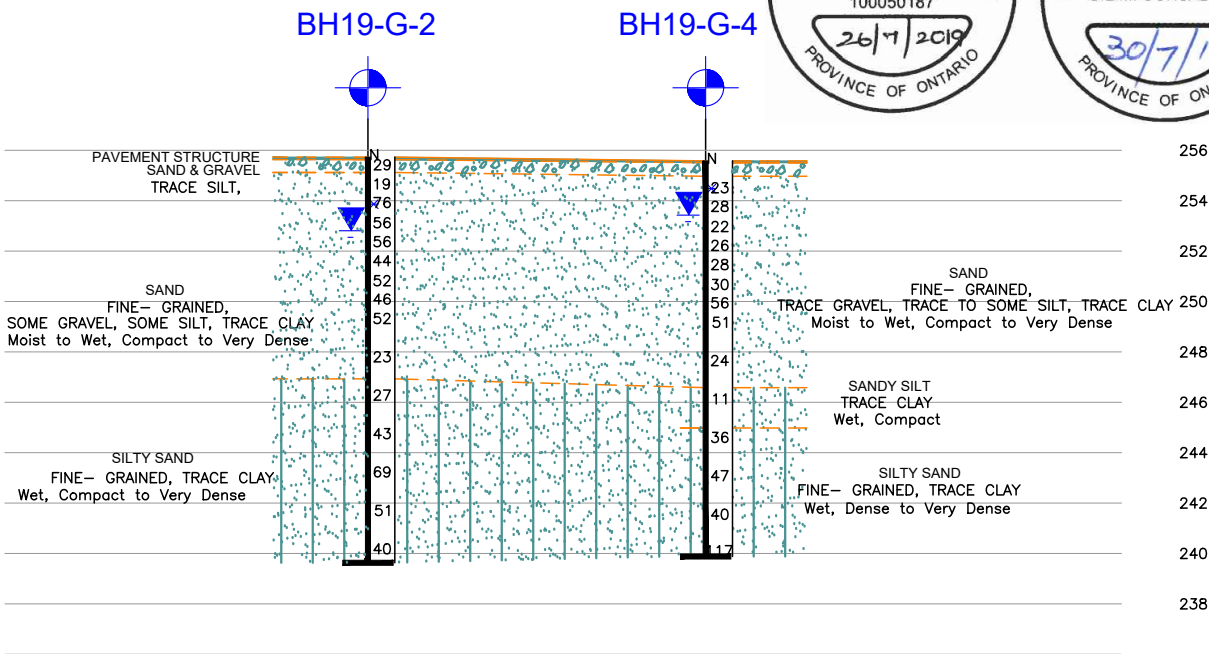
BH No.	ELEV.	MTM CO-ORDINATES (ZONE ON-10)	
		NORTHING	EASTING
BH19-G-1	255.6	4973470.2	315709.1
BH19-G-2	255.7	4973478.7	315738.3
BH19-G-3	255.5	4973405.8	315729.9
BH19-G-4	255.6	4973415.3	315759.1

NOTES		
This drawing is for subsurface information only. The proposed structure details/ works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents		
The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in the report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.		
SCALE: HOR 0 5 30 m VERT 0 1 6 m		
	SM	SUBMISSION FOR MTO REVIEW
DATE	BY	DESCRIPTION
		GEOCRES NO. 31E-404
		PROJECT NO. ADM-00233185-K0
SUBM'D SH	CHECKED SM	DATE Jul. 26, 19
DRAWN SH	CHECKED SM	APPROVED SG DWG. 1

PLAN



SECTION A-A'



SECTION B-B'



July 26, 2019

Appendix C – Borehole Logs

Explanation of Terms Used on Borehole Records

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil: mixture of soil and humus capable of supporting good vegetative growth.

Peat: fibrous fragments of visible and invisible decayed organic matter.

Fill: where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc.; none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

Till: the term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Terminology describing soil structure:

Desiccated: having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.

Stratified: alternating layers of varying material or color with the layers greater than 6 mm thick.

Laminated: alternating layers of varying material or color with the layers less than 6 mm thick.

Fissured: material breaks along plane of fracture.

Varved: composed of regular alternating layers of silt and clay.

Slickensided: fracture planes appear polished or glossy, sometimes striated.

Blocky: cohesive soil that can be broken down into small angular lumps which resist further breakdown.

Lensed: inclusion of small pockets of different soil, such as small lenses of sand scattered through a mass of clay; not thickness.

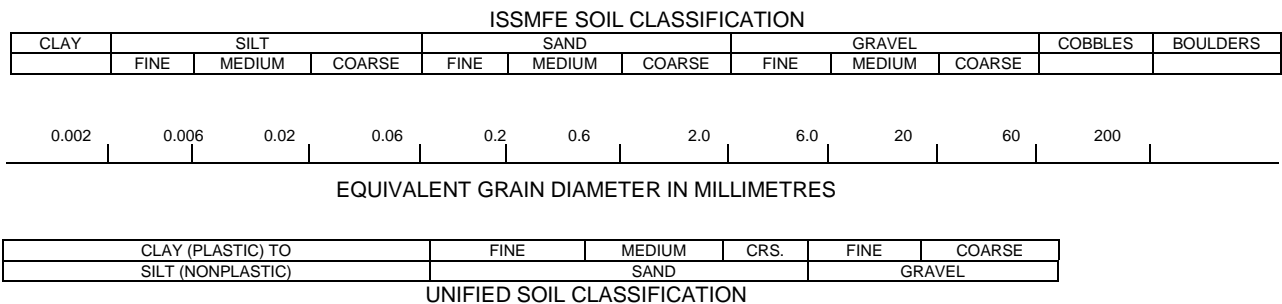
Seam: a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

Homogeneous: same color and appearance throughout.

Well Graded: having wide range in grain sized and substantial amounts of all predominantly on grain size.

Uniformly Graded: predominantly on grain size.

All soil sample descriptions included in this report follow generally the ASTM D2487-11 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) with some modification to reflect current MTO practices. The system divides soils into three major categories: (1) coarse grained, (2) fine-grained, and (3) highly organic. The soil is then subdivided based on either gradation or plasticity characteristics. The system provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification. The classification excludes particles larger than 76 mm. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually in accordance with ASTM D2488-09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems. Others may use different classification systems; one such system is the ISSMFE Soil Classification.



Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present and as described below in accordance with Canadian Foundation Engineering Manual (CFEM):

Table a: Percent or Proportion of Soil

	Criteria
Trace	1% - 10%
Some	10% - 20%
Little	20% - 35%
Some	>35% and main fraction

The standard terminology to describe cohesionless soils includes the compactness as determined by the Standard Penetration Test 'N' value:

Table b: Apparent Density of Cohesionless Soil

	'N' Value (blows/0.3 m)
Very Loose	N<5
Loose	5≤N<10
Compact	10≤N<30
Dense	30≤N<50
Very Dense	50≤N

The standard terminology to describe cohesive soils includes consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests or similar field and laboratory analysis, Standard Penetration Test 'N' values can also be used to provide an approximate indication of the consistency and shear strength of fine grained, cohesive soils:

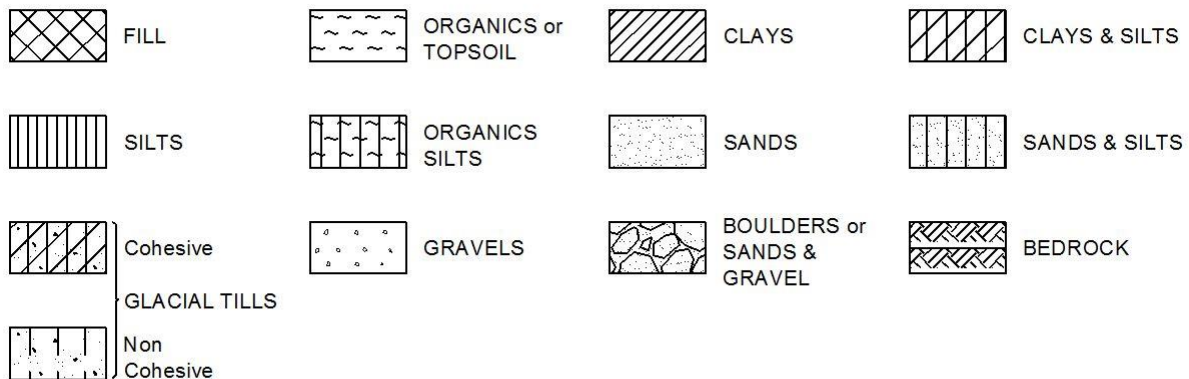
Table c: Consistency of Cohesive Soil

Consistency	Vane Shear Measurement (kPa)	'N' Value
Very Soft	<12.5	<2
Soft	12.5-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

Note: 'N' Value - The Standard Penetration Test records the number of blows of a 140 pound (64kg) hammer falling 30 inches (760mm), required to drive a 2 inch (50.8mm) O.D. split spoon sampler 1 foot (305mm). For split spoon samples where full penetration is not achieved, the number of blows is reported over the sampler penetration in meters (e.g. 50/0.15).

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:



WATER LEVEL MEASUREMENT



Open Borehole or Test Pit



Monitoring Well, Piezometer or Standpipe

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	Split spoon sample (obtained from the Standard Penetration Test)
WS	Wash sample
BS	Bulk sample
TW	Thin wall sample or Shelby tube
PS	Piston sample
AS	Auger sample
VT	Vane test
GS	Grab sample
HQ, NQ, etc.	Rock core samples obtained with the use of standard size diamond drilling bits

STRESS AND STRAIN

u_w	kPa	Pore water pressure
r_u	1	Pore pressure ratio
σ	kPa	Total normal stress
σ'	kPa	Effective normal stress
τ	kPa	Shear stress
$\sigma_1, \sigma_2, \sigma_3$	kPa	Principal stresses
ε	%	Linear strain
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	%	Principal strains
E	kPa	Modulus of linear deformation
G	kPa	Modulus of shear deformation
μ	1	Coefficient of friction

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	Coefficient of volume change
c_c	1	Compression index
c_s	1	Swelling index
c_r	1	Recompression index
c_v	m ² /s	Coefficient of consolidation
H	m	Drainage path
T_v	1	Time factor
U	%	Degree of consolidation
σ'_{v0}	kPa	Effective overburden pressure
σ'_p	kPa	Preconsolidation pressure
τ_f	kPa	Shear strength
c'	kPa	Effective cohesion intercept
ϕ'	—°	Effective angle of internal friction
c_u	kPa	Apparent cohesion intercept
ϕ_u	—°	Apparent angle of internal friction
τ_R	kPa	Residual shear strength
τ_r	kPa	Remoulded shear strength
S_t	1	Sensitivity = c_u/τ_r

PHYSICAL PROPERTIES OF SOIL

P_s	kg/m ³	Density of solid particles
γ_s	kN/m ³	Unit weight of solid particles
ρ_w	kg/m ³	Density of water
γ_w	kN/m ³	Unit weight of water
ρ	kg/m ³	Density of soil
γ	kN/m ³	Unit weight of soil
ρ_d	kg/m ³	Density of dry soil
γ_d	kN/m ³	Unit weight of dry soil
ρ_{sat}	kg/m ³	Density of saturated soil
γ_{sat}	kN/m ³	Unit weight of saturated soil
ρ'	kg/m ³	Density of submerged soil
γ'	kN/m ³	Unit weight of submerged soil
e	1, %	Void ratio
n	1, %	Porosity
w	1, %	Water content
S_r	%	Degree of saturation
W_L	%	Liquid limit
W_P	%	Plastic limit
W_s	%	Shrinkage limit
I_p	%	Plasticity index = $(W_L - W_P)$
I_L	%	Liquidity index = $(W - W_P)/I_p$
I_C	%	Consistency index = $(W_L - W)/I_p$
e_{max}	1, %	Void ratio in loosest state
e_{min}	1, %	Void ratio in densest state
I_D	1	Density index = $(e_{max} - e)/(e_{max} - e_{min})$
D	mm	Grain diameter
D_n	mm	N percent - diameter
C_u	1	Uniformity coefficient
h	m	Hydraulic head or potential
q	m ³ /s	Rate of discharge
v	m/s	Discharge velocity
i	1	Hydraulic gradient
k	m/s	Hydraulic conductivity
j	kN/m ³	Seepage force



Brampton, Ontario

RECORD OF BOREHOLE No 19-G-1

1 OF 2

METRIC

W.P. _____ LOCATION Gravenhurst Patrol Yard, Highway 11, Gravenhurst ON, MTM ON10 ORIGINATED BY PL
 DIST Muskoka HWY 11 BOREHOLE TYPE CME 55, Hollow stem auger drill COMPILED BY LC/SA
 DATUM Geodetic DATE 2019.04.29 - 2019.04.29 LATITUDE 44.901142 LONGITUDE 79.3618653 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _P W W _L										
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x P. PENETROMETER												
255.6	Ground Surface					▽		20	40	60	80	100								
255.6 0.1	PAVEMENT STRUCTURE 100 mm asphaltic concrete - over 510 mm sand and gravel, trace silt		1	AS											○					26 67 (7)
255.0	SAND fine-grained, trace gravel, trace silt, trace clay, dark grey mottling with depth, brown to brown/grey, moist to wet, compact to very dense		2	SS	32										○					
0.6			3	SS	30											○				
	- becoming wet		4	SS	33											○				
			5	SS	35											○				6 83 10 1
			6	SS	70											○				
			7	SS	40											○				
			8	SS	51											○				0 93 5 2
			9	SS	60											○				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO GRAVENHURST BH LOGS V1.GPJ ONTARIO MTO.GDT 7/23/19

Brampton, Ontario

RECORD OF BOREHOLE No 19-G-1										2 OF 2		METRIC					
W.P. _____			LOCATION Gravenhurst Patrol Yard, Highway 11, Gravenhurst ON, MTM ON10				ORIGINATED BY PL										
DIST Muskoka HWY 11			BOREHOLE TYPE CME 55, Hollow stem auger drill				COMPILED BY LC/SA										
DATUM Geodetic			DATE 2019.04.29 - 2019.04.29		LATITUDE 44.901142		LONGITUDE 79.3618653		CHECKED BY SM								
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			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL P. PENETROMETER									
	SILTY SAND grey, wet, very dense (continued)		13	SS	85		243										
								242									
					14	SS	50										
									241								
240.0 15.6	End of borehole at 15.6 m depth.		15	SS	190/ 175mm												
Notes: 1. Groundwater level was measured at 2.13 m below ground surface upon completion of drilling.																	

ONTARIO MTO GRAVENHURST BH LOGS V1.GPJ ONTARIO MTO.GDT 7/23/19

Brampton, Ontario

RECORD OF BOREHOLE No 19-G-2

1 OF 2

METRIC

W.P. _____ LOCATION Dwight Patrol Yard, Highway 60, Dwight ON, MTM ON10 ORIGINATED BY PL
 DIST Muskoka HWY 11 BOREHOLE TYPE CME 55, Hollow stem auger drill COMPILED BY LC/SA
 DATUM Geodetic DATE 2019.04.25 - 2019.04.25 LATITUDE 44.901218 LONGITUDE 79.3614954 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER								
255.7	Ground Surface						20	40	60	80	100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		
255.0	PAVEMENT STRUCTURE 100 mm asphaltic concrete		1	SS	29							○				18 59 21 2
255.1	- over 510 mm sand and gravel, trace silt															
0.6	SAND fine-grained, some gravel, some silt, trace clay, dark grey mottling with depth, brown to brown/grey, moist to wet, compact to very dense		2	SS	19							○				
			3	SS	76							○				
	- becoming wet		4	SS	56							○				17 62 18 3
			5	SS	56							○				
			6	SS	44							○				
			7	SS	52							○				
			8	SS	46							○				
			9	SS	52							○				
			10	SS	23								○			
246.9	SILTY SAND fine-grained, trace clay, grey, wet, compact to very dense		11	SS	27								○			
8.8																
			12	SS	43								○			0 66 32 2

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO GRAVENHURST BH LOGS V1.GPJ ONTARIO MTO.GDT 7/23/19

2 OF 2

METRIC

W.P.	LOCATION			Dwight Patrol Yard, Highway 60, Dwight ON, MTM ON10		ORIGINATED BY	PL
DIST	Muskoka	HWY	11	BOREHOLE TYPE	CME 55, Hollow stem auger drill	COMPILED BY	LC/SA
DATUM	Geodetic			DATE	2019.04.25 - 2019.04.25	LATITUDE	44.901218
						LONGITUDE	79.3614954
						CHECKED BY	SM

[illegible]

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

Brampton, Ontario

RECORD OF BOREHOLE No 19-G-3

1 OF 2

METRIC

W.P. _____ LOCATION Dwight Patrol Yard, Highway 60, Dwight ON, MTM ON10 ORIGINATED BY PL
 DIST Muskoka HWY 11 BOREHOLE TYPE CME 55, Hollow stem auger drill COMPILED BY LC/SA
 DATUM Geodetic DATE 2019.04.24 - 2019.04.24 LATITUDE 44.900563 LONGITUDE 79.3616033 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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			W _P W W _L							
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER										
255.5	Ground Surface					▽		20	40	60	80	100						
255.4	PAVEMENT STRUCTURE 100 mm asphaltic concrete		1	SS	40		255								○			
254.9	- over 535 mm sand and gravel, trace silt						254								○			
254.9	SAND fine-grained, trace to some gravel, trace to some silt, dark grey mottling throughout, brown to brown/grey, moist to wet, compact to very dense		2	SS	26		253								○			
0.6			3	SS	25		252								○			
	- becoming wet		4	SS	57		251								○			
			5	SS	38		250								○			
			6	SS	50		249								○			
			7	SS	50		248								○			
			8	SS	56		247								○			
			9	SS	59		246								○			
							245											
246.5	SANDY SILT fine-grained, trace clay, grey, wet, compact to very dense		11	SS	13	244								○				
9.0			12	SS	93													
243.5																		

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO GRAVENHURST BH LOGS V1.GPJ ONTARIO MTO.GDT 7/23/19

Brampton, Ontario

RECORD OF BOREHOLE No 19-G-3

2 OF 2

METRIC

W.P. _____ LOCATION Dwight Patrol Yard, Highway 60, Dwight ON, MTM ON10 ORIGINATED BY PL
 DIST Muskoka HWY 11 BOREHOLE TYPE CME 55, Hollow stem auger drill COMPILED BY LC/SA
 DATUM Geodetic DATE 2019.04.24 - 2019.04.24 LATITUDE 44.900563 LONGITUDE 79.3616033 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL P. PENETROMETER		WATER CONTENT (%) W _P W W _L				GR	SA	SI	CL																
12.0	SILTY SAND fine-grained, trace clay, grey, wet, compact to very dense						243																										
			13	SS	23											242																	
			14	SS	28																				241								
																	240																
	15	SS	62																														
239.1 16.4	End of borehole at 16.4 m depth.																																
	Notes: 1. Groundwater level was measured at 2.74 m below ground surface upon completion of drilling.																																

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

Brampton, Ontario

1 OF 2

METRIC

W.P.	LOCATION			Dwight Patrol Yard, Highway 60, Dwight ON, MTM ON10	ORIGINATED BY	PL	
DIST	Muskoka	HWY	11	BOREHOLE TYPE	CME 55, Hollow stem auger drill	COMPILED BY	LC/SA
DATUM	Geodetic	DATE	2019.04.23 - 2019.04.23	LATITUDE	44.900648	LONGITUDE	79.3612334
				CHECKED BY	SM		

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER						
255.6	Ground Surface					▽								GR SA SI CL
250.0	PAVEMENT STRUCTURE 65 mm asphaltic concrete - over 545 mm sand and gravel, trace silt		1	AS										
255.0	SAND fine-grained, trace gravel, trace to some silt, dark grey mottling throughout, brown to brown/grey, moist to wet, compact to very dense - becoming wet		2	SS	23									
0.6			3	SS	28									
			4	SS	22									
			5	SS	26									
			6	SS	28									
			7	SS	30									
			8	SS	56									
			9	SS	51									
246.6	SANDY SILT trace clay, brown/grey, wet, compact		11	SS	11									
9.0														
245.0	SILTY SAND fine-grained, trace clay, grey, wet, dense to very dense		12	SS	36									
10.6														

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

ONTARIO MTO GRAVENHURST BH LOGS V1.GPJ ONTARIO MTO.GDT 7/23/19

Brampton, Ontario

2 OF 2

METRIC

W.P.	LOCATION	Dwight Patrol Yard, Highway 60, Dwight ON, MTM ON10	ORIGINATED BY	PL
DIST Muskoka HWY 11	BOREHOLE TYPE	CME 55, Hollow stem auger drill	COMPILED BY	LC/SA
DATUM Geodetic	DATE	2019.04.23 - 2019.04.23	LATITUDE	44.900648
			LONGITUDE	79.3612334
			CHECKED BY	SM

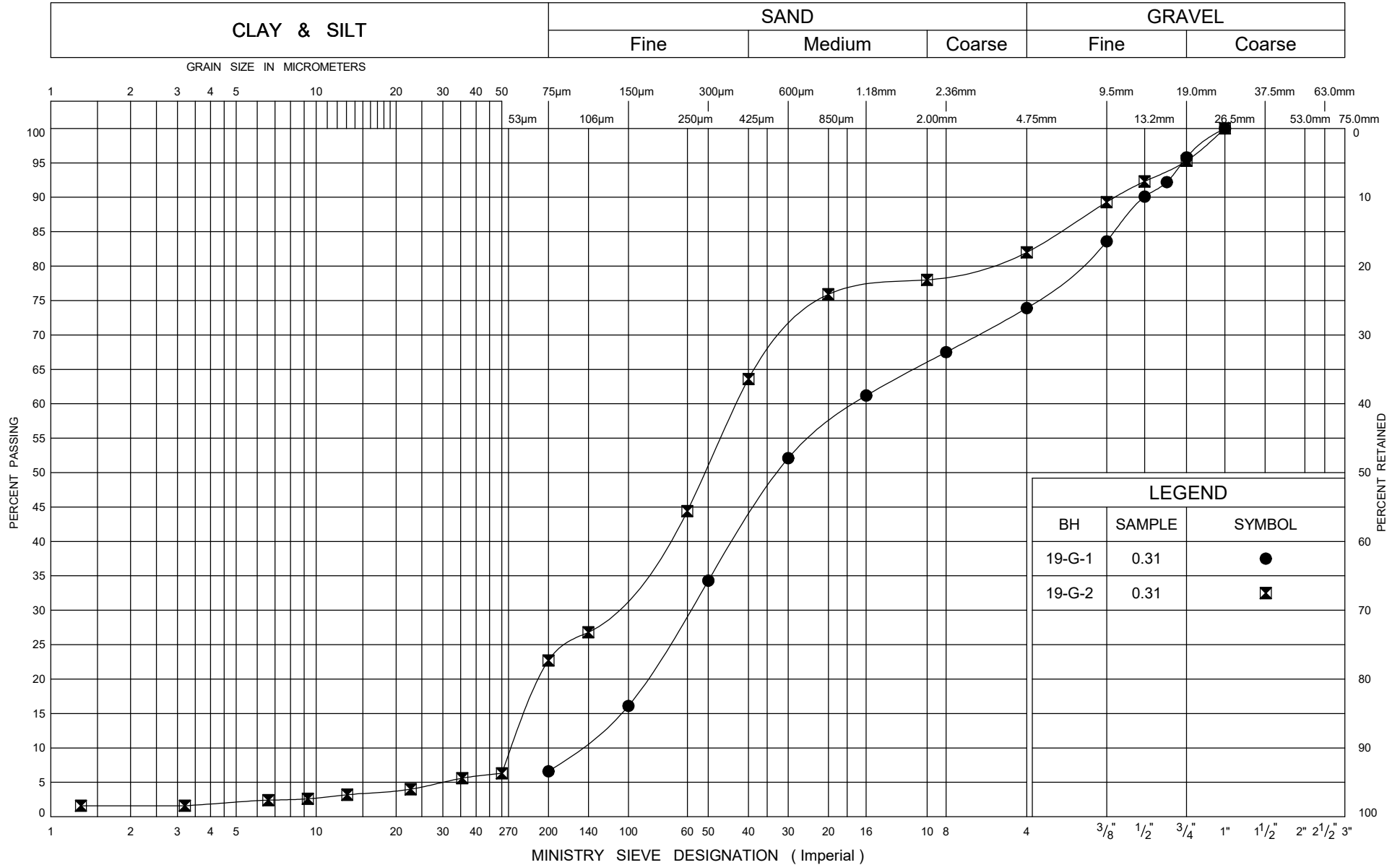
[illegible]

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

ONTARIO MTO GRAVENHURST BH LOGS V1.GPJ ONTARIO MTO.GDT 7/23/19

Appendix D – Laboratory Data

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

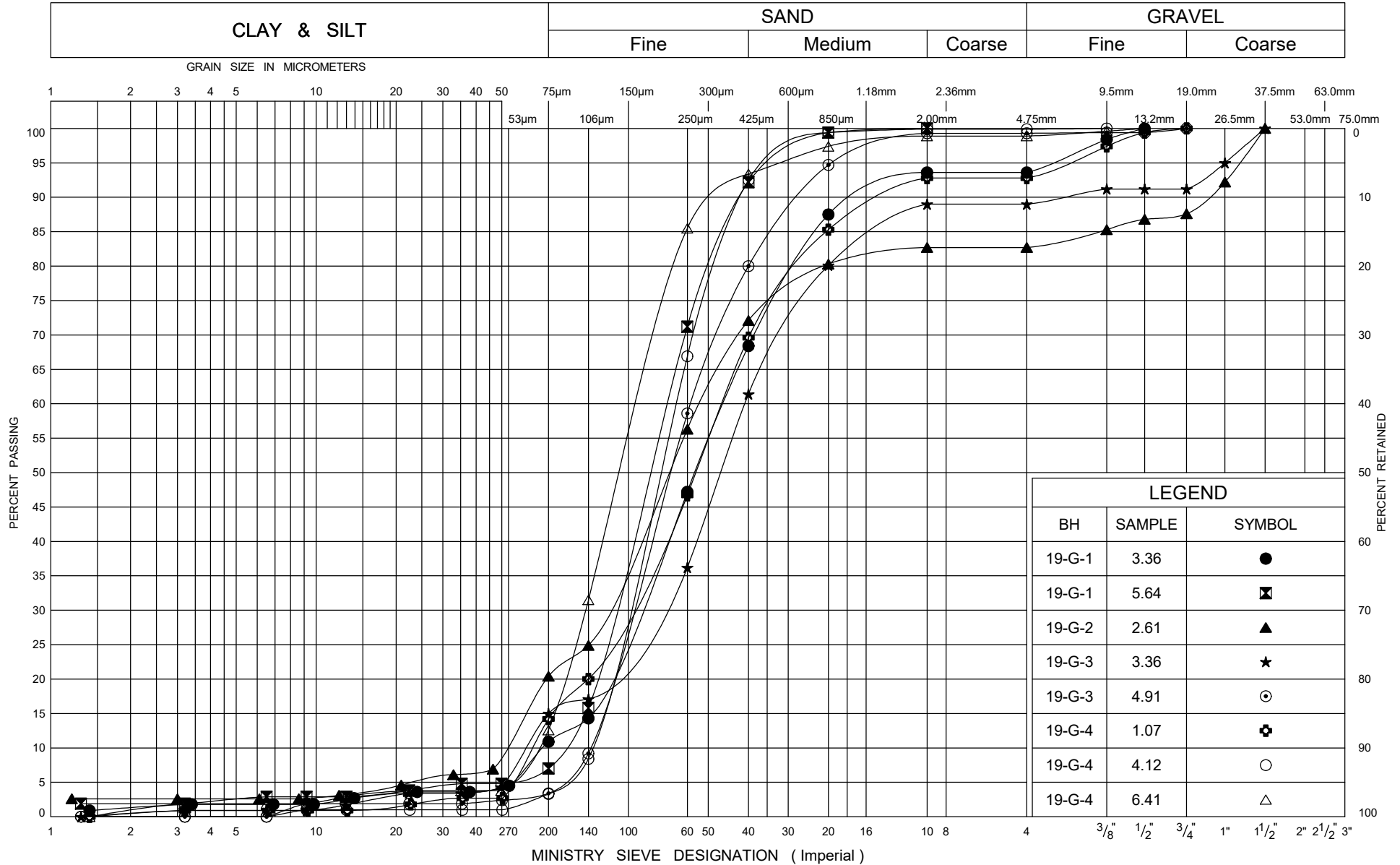
Sand and Gravel (Fill)

FIG No 1

W P

5015-E-0007, Assignment 10

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

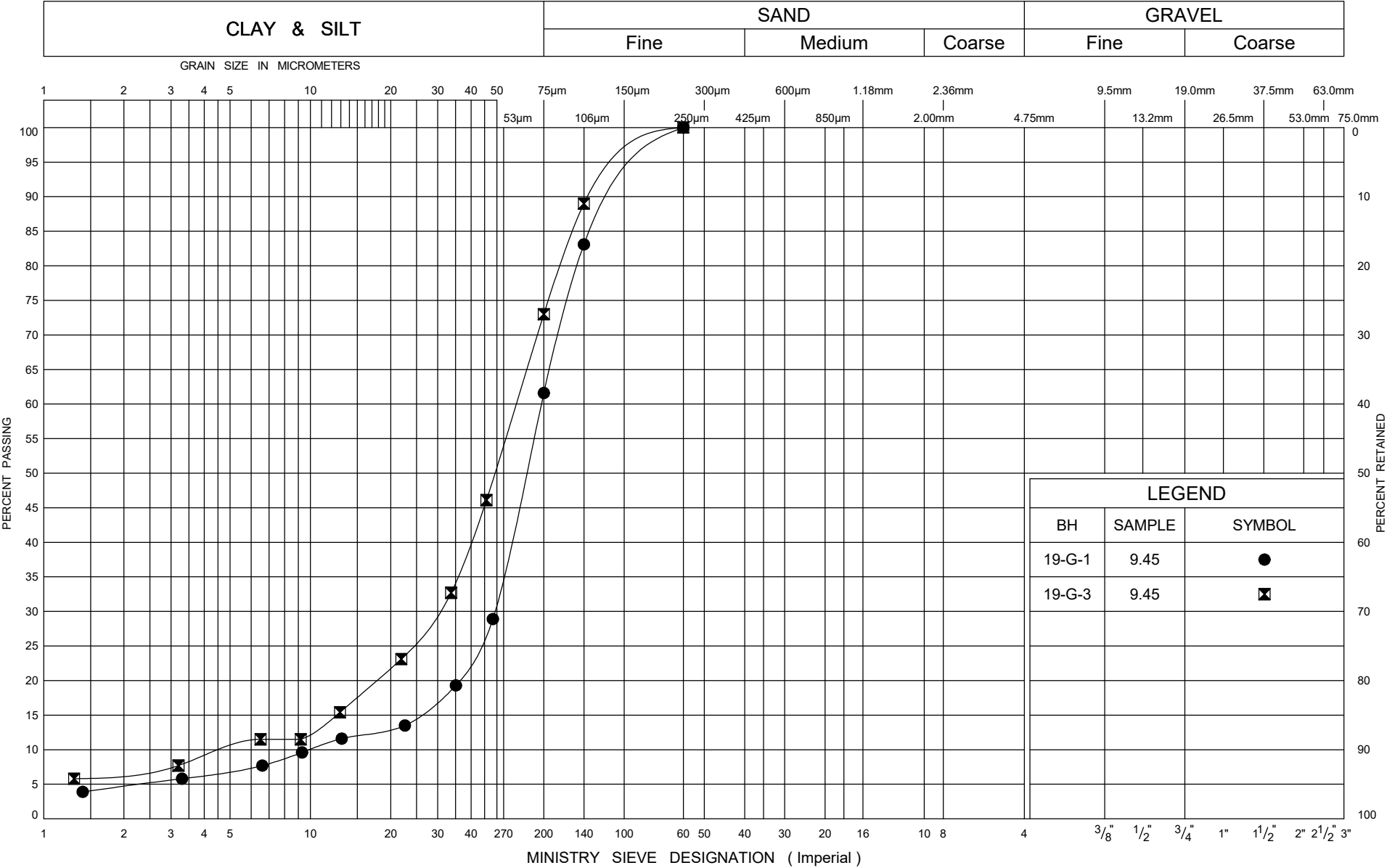
Sand

FIG No 2

W P

5015-E-0007, Assignment 10

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

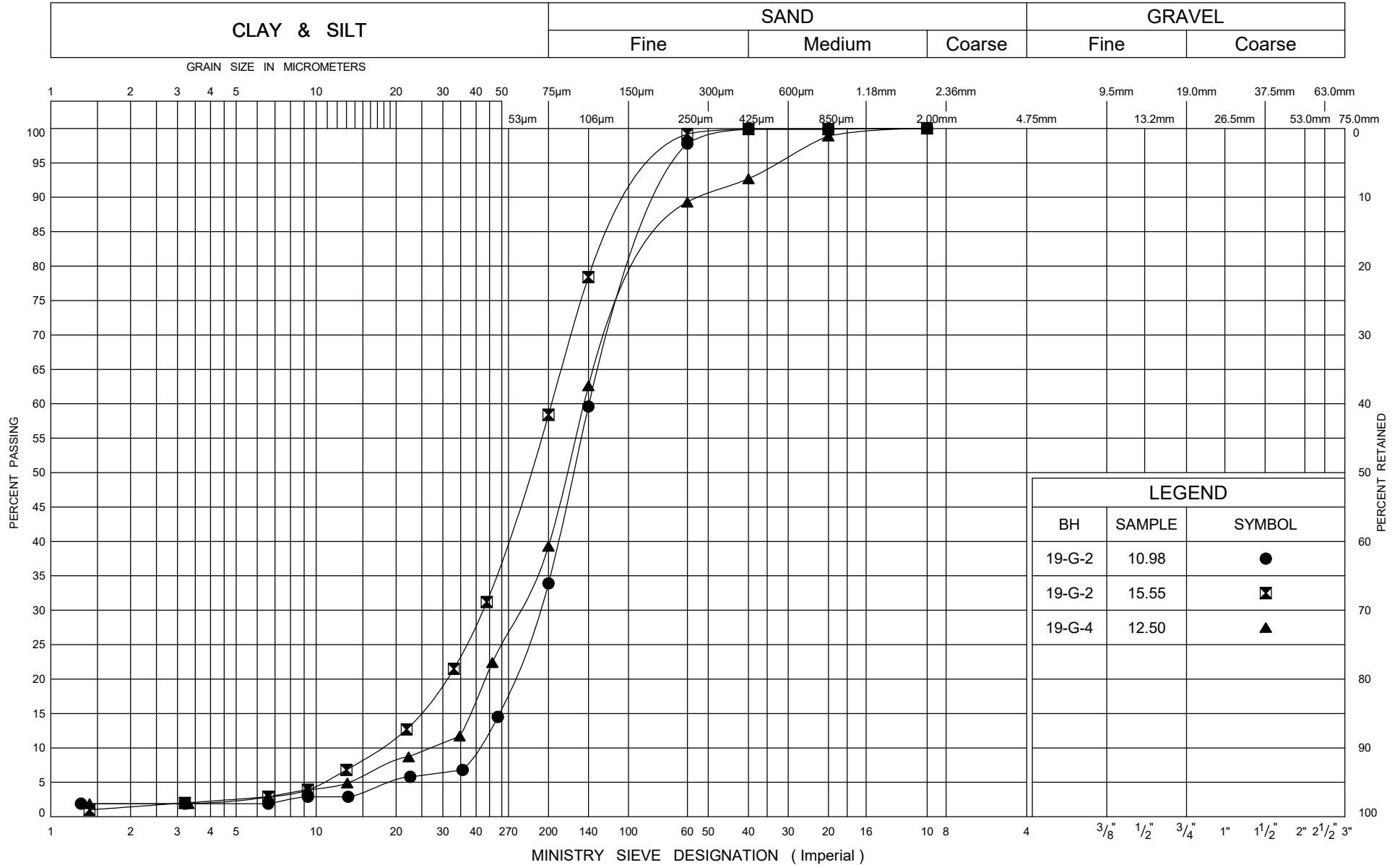
Sandy Silt

FIG No 3

W P

5015-E-0007, Assignment 10

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

Silty Sand

FIG No 4

W P

5015-E-0007, Assignment 10

**CLIENT NAME: EXP. SERVICES INC.
885 REGENT ST
SUDBURY, ON P3E5M4
(705) 674-9681**

ATTENTION TO: Ian MacMillan

PROJECT: ADM-00233185-K0

AGAT WORK ORDER: 19U464857

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Supervisor

TRACE ORGANICS REVIEWED BY: Pinkal Patel, Report Reviewer

DATE REPORTED: May 15, 2019

PAGES (INCLUDING COVER): 10

VERSION*: 2

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

***NOTES**

VERSION 2: Partial report for sample "19-H-1-SS2" issued May 14, 2019.

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.



Certificate of Analysis

AGAT WORK ORDER: 19U464857

PROJECT: ADM-00233185-K0

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: EXP. SERVICES INC.

SAMPLING SITE:

ATTENTION TO: Ian MacMillan

SAMPLED BY:

Corrosivity Package

DATE RECEIVED: 2019-05-08

DATE REPORTED: 2019-06-15

		SAMPLE DESCRIPTION:		19-D-2-SS4	19-PS-2-SS3	19-G-1-SS3	19-P-2-SS3	
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	
		DATE SAMPLED:		2019-05-08	2019-05-08	2019-05-08	2019-05-08	
Parameter	Unit	G / S	RDL	182124	182125	182126	RDL	182127
Sulfide (S2-)	%		0.05	<0.05	<0.05	<0.05	0.05	<0.05
Chloride (2:1)	µg/g		2	8	160	6	40	7470
Sulphate (2:1)	µg/g		2	26	15	14	40	157
pH (2:1)	pH Units		NA	6.04	6.26	6.83	NA	6.86
Electrical Conductivity (2:1)	mS/cm		0.005	0.040	0.368	0.053	0.005	13.4
Redox Potential 1	mV		5	204	142	233	5	255
Redox Potential 2	mV		5	228	179	245	5	247
Redox Potential 3	mV		5	214	181	249	5	259
Resistivity (2:1)	ohm.cm		1	25000	2720	18900	1	75

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

182124-182126 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter.

*Sulphide analyzed at AGAT 5623 McAdam

PI note: Redox Potential is not an accredited parameter.

Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results.

182127 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter.

*Sulphide analyzed at AGAT 5623 McAdam

PI note: Redox Potential is not an accredited parameter.

Elevated RDL indicates the degree of sample dilution prior to the analysis in order to keep analytes within the calibration range of the instrument and to reduce matrix interference.

Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Anamjot Bhela




AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 19U464857

PROJECT: ADM-00233185-K0

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: EXP. SERVICES INC.

ATTENTION TO: Ian MacMillan

SAMPLING SITE:

SAMPLED BY:

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE RECEIVED: 2019-05-08

DATE REPORTED: 2019-05-13

		SAMPLE DESCRIPTION:		19-G-1-SS2	19-PS-1-SS2	19-P-1-SS2	19-D-2-SS2
		SAMPLE TYPE:		Soil	Soil	Soil	Soil
		DATE SAMPLED:		2019-05-08	2019-05-08	2019-05-08	2019-05-08
Parameter	Unit	G / S	RDL	182119	182121	182122	182123
Antimony	µg/g		0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g		1	<1	1	<1	<1
Barium	µg/g		2	35	32	40	27
Beryllium	µg/g		0.5	<0.5	<0.5	<0.5	<0.5
Boron	µg/g		5	<5	<5	<5	<5
Boron (Hot Water Soluble)	µg/g		0.10	<0.10	<0.10	<0.10	<0.10
Cadmium	µg/g		0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g		2	8	14	8	9
Cobalt	µg/g		0.5	3.2	4.9	1.9	4.5
Copper	µg/g		1	12	28	4	10
Lead	µg/g		1	4	2	1	1
Molybdenum	µg/g		0.5	<0.5	<0.5	<0.5	<0.5
Nickel	µg/g		1	6	10	4	6
Selenium	µg/g		0.4	0.6	<0.4	0.7	<0.4
Silver	µg/g		0.2	<0.2	<0.2	<0.2	<0.2
Thallium	µg/g		0.4	<0.4	<0.4	<0.4	<0.4
Uranium	µg/g		0.5	<0.5	<0.5	0.6	<0.5
Vanadium	µg/g		1	19	36	10	26
Zinc	µg/g		5	22	21	11	16
Chromium VI	µg/g		0.2	<0.2	<0.2	<0.2	<0.2
Cyanide	µg/g		0.040	<0.040	<0.040	<0.040	<0.040
Mercury	µg/g		0.10	<0.10	<0.10	<0.10	<0.10
Electrical Conductivity	mS/cm		0.005	0.099	5.02	0.137	0.052
Sodium Adsorption Ratio	NA		NA	1.30	50.5	5.73	0.438
pH, 2:1 CaCl2 Extraction	pH Units		NA	5.59	5.81	7.18	5.12

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

182119-182123 EC was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract prepared at 2:1 ratio. SAR is a calculated parameter.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:





Certificate of Analysis

AGAT WORK ORDER: 19U464857

PROJECT: ADM-00233185-K0

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: EXP. SERVICES INC.

ATTENTION TO: Ian MacMillan

SAMPLING SITE:

SAMPLED BY:

O. Reg. 153(511) - PHCs F1 - F4 (Soil)

DATE RECEIVED: 2019-05-08

DATE REPORTED: 2019-05-13

		SAMPLE DESCRIPTION:		19-G-1-SS2	19-H-1-SS2	19-PS-1-SS2	19-P-1-SS2	19-D-2-SS2
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2019-05-08	2019-05-08	2019-05-08	2019-05-08	2019-05-08
Parameter	Unit	G / S	RDL	182119	182120	182121	182122	182123
Benzene	µg/g	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Toluene	µg/g	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ethylbenzene	µg/g	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Xylene Mixture	µg/g	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
F1 (C6 to C10)	µg/g	5	<5	<5	<5	<5	<5	<5
F1 (C6 to C10) minus BTEX	µg/g	5	<5	<5	<5	<5	<5	<5
F2 (C10 to C16)	µg/g	10	<10	<10	<10	<10	<10	<10
F3 (C16 to C34)	µg/g	50	<50	<50	<50	<50	<50	<50
F4 (C34 to C50)	µg/g	50	<50	<50	<50	<50	<50	<50
Gravimetric Heavy Hydrocarbons	µg/g	50	NA	NA	NA	NA	NA	NA
Moisture Content	%	0.1	12.7	25.6	12.2	11.7	12.8	
Surrogate	Unit	Acceptable Limits						
Terphenyl	%	60-140		112	96	87	120	100

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

182119-182123

Results are based on sample dry weight.
The C6-C10 fraction is calculated using Toluene response factor.
Xylenes is a calculated parameter. The calculated value is the sum of m&p-Xylene and o-Xylene.
C6-C10 (F1 minus BTEX) is a calculated parameter. The calculated value is F1 minus BTEX.
The C10 - C16, C16 - C34, and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and n-C34.
Gravimetric Heavy Hydrocarbons are not included in the Total C16-C50 and are only determined if the chromatogram of the C34 - C50 hydrocarbons indicates that hydrocarbons >C50 are present.
The chromatogram has returned to baseline by the retention time of nC50.
Total C6 - C50 results are corrected for BTEX contribution.
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
nC6 and nC10 response factors are within 30% of Toluene response factor.
nC10, nC16 and nC34 response factors are within 10% of their average.
C50 response factor is within 70% of nC10 + nC16 + nC34 average.
Linearity is within 15%.
Extraction and holding times were met for this sample.
Fractions 1-4 are quantified with the contribution of PAHs. Under Ontario Regulation 153, results are considered valid without determining the PAH contribution if not requested by the client.
Quality Control Data is available upon request.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Jinkal Patel

Quality Assurance

CLIENT NAME: EXP. SERVICES INC.

AGAT WORK ORDER: 19U464857

PROJECT: ADM-00233185-K0

ATTENTION TO: Ian MacMillan

SAMPLING SITE:

SAMPLED BY:

Soil Analysis															
RPT Date:			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

O. Reg. 153(511) - Metals & Inorganics (Soil)

Antimony	182264		<0.8	<0.8	NA	< 0.8	91%	70%	130%	95%	80%	120%	94%	70%	130%
Arsenic	182264		3	3	NA	< 1	101%	70%	130%	94%	80%	120%	98%	70%	130%
Barium	182264		109	110	0.9%	< 2	105%	70%	130%	100%	80%	120%	116%	70%	130%
Beryllium	182264		<0.5	<0.5	NA	< 0.5	99%	70%	130%	98%	80%	120%	76%	70%	130%
Boron	182264		7	7	NA	< 5	101%	70%	130%	104%	80%	120%	76%	70%	130%
Boron (Hot Water Soluble)	182264		0.31	0.33	NA	< 0.10	113%	60%	140%	100%	70%	130%	102%	60%	140%
Cadmium	182264		<0.5	<0.5	NA	< 0.5	99%	70%	130%	101%	80%	120%	99%	70%	130%
Chromium	182264		30	31	3.3%	< 2	103%	70%	130%	102%	80%	120%	112%	70%	130%
Cobalt	182264		10.0	10.3	3.0%	< 0.5	105%	70%	130%	105%	80%	120%	103%	70%	130%
Copper	182264		20	20	0.0%	< 1	95%	70%	130%	101%	80%	120%	97%	70%	130%
Lead	182264		9	9	0.0%	< 1	105%	70%	130%	104%	80%	120%	100%	70%	130%
Molybdenum	182264		<0.5	<0.5	NA	< 0.5	108%	70%	130%	100%	80%	120%	98%	70%	130%
Nickel	182264		25	25	0.0%	< 1	103%	70%	130%	108%	80%	120%	110%	70%	130%
Selenium	182264		0.5	0.5	NA	< 0.4	103%	70%	130%	92%	80%	120%	96%	70%	130%
Silver	182264		<0.2	<0.2	NA	< 0.2	99%	70%	130%	99%	80%	120%	95%	70%	130%
Thallium	182264		<0.4	<0.4	NA	< 0.4	101%	70%	130%	113%	80%	120%	107%	70%	130%
Uranium	182264		0.5	0.5	NA	< 0.5	112%	70%	130%	116%	80%	120%	121%	70%	130%
Vanadium	182264		41	43	4.8%	< 1	103%	70%	130%	112%	80%	120%	111%	70%	130%
Zinc	182264		52	52	0.0%	< 5	93%	70%	130%	102%	80%	120%	103%	70%	130%
Chromium VI	182119	182119	<0.2	<0.2	NA	< 0.2	108%	70%	130%	100%	80%	120%	102%	70%	130%
Cyanide	182122	182122	<0.040	<0.040	NA	< 0.040	98%	70%	130%	99%	80%	120%	104%	70%	130%
Mercury	182264		<0.10	<0.10	NA	< 0.10	127%	70%	130%	109%	80%	120%	110%	70%	130%
Electrical Conductivity	182119	182119	0.099	0.108	8.7%	< 0.005	109%	90%	110%	NA			NA		
Sodium Adsorption Ratio	182119	182119	1.30	1.38	6.0%	NA	NA			NA			NA		
pH, 2:1 CaCl2 Extraction	182119	182119	5.59	5.61	0.4%	NA	100%	80%	120%	NA			NA		

Comments: NA signifies Not Applicable.

Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL

pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Corrosivity Package

Sulfide (S2-)	182124	182124	< 0.05	< 0.05	NA	< 0.05	100%	80%	120%						
Chloride (2:1)	178497		10	9	NA	< 2	93%	80%	120%	89%	80%	120%	89%	70%	130%
Sulphate (2:1)	178497		10	9	NA	< 2	92%	80%	120%	93%	80%	120%	97%	70%	130%
pH (2:1)	182124	182124	6.04	6.01	0.5%	NA	99%	90%	110%	NA			NA		
Electrical Conductivity (2:1)	182119	182119	0.099	0.108	8.7%	< 0.005	109%	90%	110%	NA			NA		
Redox Potential 1	1					< 5	100%	70%	130%		70%	130%		70%	130%

Quality Assurance

CLIENT NAME: EXP. SERVICES INC.

PROJECT: ADM-00233185-K0

SAMPLING SITE:

AGAT WORK ORDER: 19U464857

ATTENTION TO: Ian MacMillan

SAMPLED BY:

Soil Analysis (Continued)

RPT Date:			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE		MATRIX SPIKE			
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits	Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower		Upper	Lower		Upper	Lower

Comments: NA signifies Not Applicable.

Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL

Certified By:




Quality Assurance

CLIENT NAME: EXP. SERVICES INC.

AGAT WORK ORDER: 19U464857

PROJECT: ADM-00233185-K0

ATTENTION TO: Ian MacMillan

SAMPLING SITE:

SAMPLED BY:

Trace Organics Analysis

RPT Date:			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE		MATRIX SPIKE			
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits	Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower		Upper	Lower		Upper	Lower

O. Reg. 153(511) - PHCs F1 - F4 (Soil)

Benzene	174969		< 0.02	< 0.02	NA	< 0.02	90%	60%	130%	85%	60%	130%	89%	60%	130%
Toluene	174969		< 0.05	< 0.05	NA	< 0.05	88%	60%	130%	89%	60%	130%	86%	60%	130%
Ethylbenzene	174969		< 0.05	< 0.05	NA	< 0.05	101%	60%	130%	87%	60%	130%	79%	60%	130%
Xylene Mixture	174969		< 0.05	< 0.05	NA	< 0.05	97%	60%	130%	81%	60%	130%	82%	60%	130%
F1 (C6 to C10)	174969		< 5	< 5	NA	< 5	96%	60%	130%	86%	85%	115%	80%	70%	130%
F2 (C10 to C16)	173534		< 10	< 10	NA	< 10	100%	60%	130%	95%	80%	120%	70%	70%	130%
F3 (C16 to C34)	173534		< 50	< 50	NA	< 50	104%	60%	130%	98%	80%	120%	76%	70%	130%
F4 (C34 to C50)	173534		< 50	< 50	NA	< 50	95%	60%	130%	87%	80%	120%	116%	70%	130%

Comments: When the average of the sample and duplicate results is less than 5x the RDL, the Relative Percent Difference (RPD) will be indicated as Not Applicable (NA).

Certified By:



Method Summary

CLIENT NAME: EXP. SERVICES INC.

PROJECT: ADM-00233185-K0

SAMPLING SITE:

AGAT WORK ORDER: 19U464857

ATTENTION TO: Ian MacMillan

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sulfide (S2-)	MIN-200-12025	ASTM E1915-09	GRAVIMETRIC
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Redox Potential 1	INOR-93-6066	G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 2	INOR-93-6066	G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 3	INOR-93-6066	G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Resistivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Antimony	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Arsenic	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Barium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Beryllium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron (Hot Water Soluble)	MET-93-6104	EPA SW 846 6010C; MSA, Part 3, Ch.21	ICP/OES
Cadmium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Cobalt	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Copper	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Lead	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Molybdenum	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Nickel	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Selenium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Silver	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Thallium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Uranium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Vanadium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Zinc	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium VI	INOR-93-6029	SM 3500 B; MSA Part 3, Ch. 25	SPECTROPHOTOMETER
Cyanide	INOR-93-6052	MOE CN-3015 & E 3009 A;SM 4500 CN	TECHNICON AUTO ANALYZER
Mercury	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Electrical Conductivity	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010C	ICP/OES
pH, 2:1 CaCl2 Extraction	INOR-93-6031	MSA part 3 & SM 4500-H+ B	PH METER

Method Summary

CLIENT NAME: EXP. SERVICES INC.

PROJECT: ADM-00233185-K0

SAMPLING SITE:

AGAT WORK ORDER: 19U464857

ATTENTION TO: Ian MacMillan

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Benzene	VOL-91-5009	EPA SW-846 5035 & 8260D	P&T GC/MS
Toluene	VOL-91-5009	EPA SW-846 5035 & 8260D	P&T GC/MS
Ethylbenzene	VOL-91-5009	EPA SW-846 5035 & 8260D	P&T GC/MS
Xylene Mixture	VOL-91-5009	EPA SW-846 5035 & 8260D	P&T GC/MS
F1 (C6 to C10)	VOL-91-5009	CCME Tier 1 Method	P&T GC/FID
F1 (C6 to C10) minus BTEX	VOL-91-5009	CCME Tier 1 Method	P&T GC/FID
F2 (C10 to C16)	VOL-91-5009	CCME Tier 1 Method	GC/FID
F3 (C16 to C34)	VOL-91-5009	CCME Tier 1 Method	GC/FID
F4 (C34 to C50)	VOL-91-5009	CCME Tier 1 Method	GC/FID
Gravimetric Heavy Hydrocarbons	VOL-91-5009	CCME Tier 1 Method	BALANCE
Moisture Content	VOL-91-5009	CCME Tier 1 Method	BALANCE
Terphenyl	VOL-91-5009		GC/FID



Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Report Information:

Company: exp
Contact: Ian Macmillan @ exp.com
Address: Sudbury
Phone: _____ Fax: _____
Reports to be sent to: Ian Macmillan @ exp.com
1. Email: _____
2. Email: _____

Project Information:

Project: ADM-00233185-KO
Site Location: MTO
Sampled By: PL
AGAT Quote #: SOA PO: _____
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Company: _____
Contact: _____
Address: _____
Email: _____
Bill To Same: Yes ☒ No ☐

Regulatory Requirements:

(Please check all applicable boxes)

☐ Regulation 153/04

Table Indicate One

☐ Ind/Corn

☐ Res/Park

☐ Agriculture

Soil Texture (Check One)

☐ Coarse

☐ Fine

☐ Sewer Use

☐ Sanitary

☐ Storm

Region Indicate One

☐ MISA

☐ Regulation 558

☐ CCME

☐ Prov. Water Quality Objectives (PWQO)

☐ Other

Indicate One

Is this submission for a
Record of Site Condition?

☐ Yes

☒ No

Report Guideline on
Certificate of Analysis

☐ Yes

☒ No

Sample Matrix Legend

B Biota
GW Ground Water
O Oil
P Paint
S Soil
SD Sediment
SW Surface Water

Field Filtered - Metals, Hg, CrVI

0. Reg 153

All Metals ☐ 153 Metals (excl. Hydrides)

Hydride Metals ☐ 153 Metals (incl. Hydrides)

ORPs: ☐ B-HWS ☐ Cl- ☐ CN

☐ C* ☐ EC ☐ FOC ☐ Hg

☐ pH ☐ SAR

Full Metals Scan

Regulation/Custom Metals

Nutrients: ☐ TP ☐ NH₃ ☐ TKN

☐ NO₃ ☐ NO₂ ☐ NO₂+NO₃

Volatiles: ☐ VOC ☒ BTEX ☐ THM

PHCs F1 - F4

ABNs

PAHs

PCBs: ☐ Total ☐ Aroclors

Organochlorine Pesticides

TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs

Sewer Use

Corrosivity

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Y / N	Metals and Inorganics	0. Reg 153	Full Metals Scan	Regulation/Custom Metals	Nutrients	Volatiles	PHCs F1 - F4	ABNs	PAHs	PCBs	Organochlorine Pesticides	TCLP	Sewer Use	Corrosivity
19-G-1-SS2	May 8/19		5	S	No rush		<input checked="" type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>							
19-H-1-SS2			2	S	Rush 2 day - no M&I		<input checked="" type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>							
19-PS-1-SS2			5	S	No rush		<input checked="" type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>							
19-P-1-SS2							<input checked="" type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>							
19-D-2-SS2							<input checked="" type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>							
19-D-2-SS4							<input checked="" type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>							
19-PS-2-SS3							<input checked="" type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>							
19-G-1-SS3							<input checked="" type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>							
19-P-2-SS3							<input checked="" type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>							

Samples Relinquished By (Print Name and Sign):

Samples Relinquished By (Print Name and Sign):

Samples Relinquished By (Print Name and Sign):

Date

Date

Date

Time

Time

Time

Samples Received By (Print Name and Sign):

Samples Received By (Print Name and Sign):

Samples Received By (Print Name and Sign):

Date

Date

Date

Time

Time

Time

Page 1 of 1

No: T 087566

Appendix G – Records of Borehole from Previous Investigation



LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
$\ln x$,	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a)	Index Properties
$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
C_v	coefficient of consolidation (vertical direction)
C_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

* Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1
2

$$\tau = c' + \sigma' \tan \phi'$$

$$\text{shear strength} = (\text{compressive strength})/2$$



LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; N_d :

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Density Index	N
Relative Density	Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils Consistency

	c_u, s_u	
	kPa	psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000





IV. SOIL TESTS

w	water content
w _p	plastic limit
w _l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D _R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO ₄	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.





V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand




PROJECT		14-1181-0014		RECORD OF BOREHOLE No BH-YARD1		1 OF 1		METRIC									
W.O.		2014-11033		LOCATION		N 4973399.2; E 315653.8		ORIGINATED BY									
DIST		HWY 11		BOREHOLE TYPE		108 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY									
DATUM		GEODETIC		DATE		September 3, 2014		CHECKED BY									
								SEMP									
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			SHEAR STRENGTH kPa									
256.4	GROUND SURFACE							20	40	60	80	100					
0.0	Sand to Sand and gravel, trace silt (FILL) Compact to dense Brown Moist		1	SS	33		256									32 61 (7)	
			2	SS	24		255										0 96 (4)
			3	SS	20		254										
			4	SS	26		253										
			5	SS	43		252										
252.8	SAND, trace silt Compact to dense Grey Moist to wet		6	SS	24		251										0 96 4 0
3.6							250										
	Sand heaving inside augers at 6.1 m depth.		7	SS	25		249										
			8	SS	46		248										
247.7	Sandy SILT, trace clay Compact Brown Wet		9	SS	20		247										
8.7						246											
			10	SS	21											0 28 68 4	
245.1	END OF BOREHOLE																
11.3	Notes: 1. Water level at a depth of 3.8 m below ground surface (Elev. 252.6 m) upon completion of drilling.																

SUD-MTO 001 14-1181-0014.GPJ GAL-MISS.GDT 29/09/14 DATA INPUT:

PROJECT		14-1181-0014		RECORD OF BOREHOLE No BH-YARD2		1 OF 1		METRIC												
W.O.		2014-11033		LOCATION		N 4973379.0; E 315663.4		ORIGINATED BY												
DIST		HWY 11		BOREHOLE TYPE		108 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY												
DATUM		GEODETIC		DATE		September 3, 2014		CHECKED BY												
								SEMP												
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR	SA	SI	CL
							20 40 60 80 100	20 40 60 80 100	20 40 60	W _p	W	W _L	20 40 60							
256.4	GROUND SURFACE																			
0.0	Sand to Sandy gravel, trace silt (FILL) Compact to very dense Brown Moist		1	SS	58		256													
	Recycled asphalt noted in Samples 1 and 2.		2	SS	59															
			3	SS	19		255													
			4	SS	23		254													
			5	SS	29		253													
252.7	SAND, trace silt Compact to dense Brown Moist to wet		6	SS	31		252													
3.7			7	SS	34		251													
			8	SS	38		250													
			9	SS	5		249													
			10	SS	22		248													
247.7	Sandy SILT, trace clay Loose to compact Grey Wet						247													
8.7							246													
245.1	END OF BOREHOLE																			
11.3	Notes: 1. Water level at a depth of 3.8 m below ground surface (Elev. 252.6 m) upon completion of drilling.																			

PROJECT 14-1181-0014		RECORD OF BOREHOLE No BH-YARD3				1 OF 1 METRIC												
W.O. 2014-11033		LOCATION N 4973372.9; E 315656.4				ORIGINATED BY DM												
DIST _____ HWY 11		BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers				COMPILED BY MT												
DATUM GEODETIC		DATE September 4, 2014				CHECKED BY SEMP												
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
256.6	GROUND SURFACE							20	40	60	80	100						
0.0	Sand, trace to some gravel and silt (FILL) Compact to very dense Brown to black Moist Recycled asphalt noted in Samples 1 and 2.		1	SS	47		256											
			2	SS	87		255											
			3	SS	17													
			4	SS	18		254											
			5	SS	29		253											
252.9	SAND, trace silt Compact to dense Brown Moist to wet		6	SS	32		252											
3.7							251											
			7	SS	34		250											
			8	SS	27		249											
							248											
247.9	SILT and SAND, trace clay Loose to compact Grey Wet		9	SS	9		247											
8.7						246												
	Layer of SILT of slight plasticity at 10.7 m depth.		10	SS	10	245												
						244												
			11	SS	26													
243.8	END OF BOREHOLE																	
12.8	Notes: 1. Water level at a depth of 4.3 m below ground surface (Elev. 252.3 m) upon completion of drilling.																	

SUD-MTO 001 14-1181-0014.GPJ GAL-MISS.GDT 29/09/14 DATA INPUT:

PROJECT		14-1181-0014		RECORD OF BOREHOLE No BH-YARD4		1 OF 1 METRIC												
W.O.		2014-11033		LOCATION		N 4973390.3; E 315642.6												
DIST		HWY 11		BOREHOLE TYPE		108 mm I.D. Continuous Flight Hollow Stem Augers												
DATUM		GEODETIC		DATE		September 5, 2014												
						ORIGINATED BY DM												
						COMPILED BY MT												
						CHECKED BY SEMP												
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)	
256.8	GROUND SURFACE							20	40	60	80	100						
0.0	Sand, trace silt, trace gravel (FILL) Compact Brown Moist Recycled asphalt noted in Sample 1.		1	SS	66		256										5 90 (5)	
			2	SS	29		255											
			3	SS	10		254											0 97 (3)
			4	SS	26		253											
			5	SS	29		252											
253.1	SAND, trace silt Dense Grey to brown Wet		6	SS	31			251										
3.7			7	SS	44			250										0 93 (7)
			8	SS	39			249										
248.1	SILT and SAND, trace clay Loose to compact Grey Wet		9	SS	18			248										
8.7								247										
	Zone of CLAYEY SILT to SILT at 10.7 m depth.		10	SS	6			246										0 51 45 4
							245											
244.0	END OF BOREHOLE		11	SS	18		244											
12.8	Notes: 1. Water level at a depth of 4.0 m below ground surface (Elev. 252.8 m) upon completion of drilling.																	

SUD-MTO 001 14-1181-0014.GPJ GAL-MISS.GDT 29/09/14 DATA INPUT: