506 GLADSTONE AVE – GEOTECHNICAL REPORT

Project No.: CP-17-0605

Prepared for:

TC United Group
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April 2018

McINTOSH PERRY

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GEOTECHNICAL INVESTIGATION and
FOUNDATION DESIGN RECOMMENDATION REPORT
506 Gladstone Ave, Ottawa, Ontario

1.0 INTRODUCTION

This report presents the factual findings obtained from a geotechnical investigation performed at the above-mentioned site, for the proposed construction of a three-story mixed use building in Ottawa, Ontario. The field work was carried out on March 4, 2018 and comprised of three boreholes advanced to a maximum depth of 7.4 m below existing ground surface.

The purpose of the investigation was to explore the subsurface conditions at this site and to provide anticipated geotechnical conditions influencing the design and construction of the proposed building.

McIntosh Perry Consulting Engineers Ltd (McIntosh Perry) carried out the investigation at the request of TC United.

2.0 SITE DESCRIPTION

The property under considerations for proposed development is located at 506 Gladstone Ave, west of the intersection with Lyon Street within the Centertown neighbourhood of Ottawa, Ontario. The existing property contains a two and a half story building divided into three units. Adjacent to the property is a commercial building to the west and a residential structure to the east. A shared driveway runs along the west of the property with the rear of the property being paved and containing a concrete pad. The topography of property is relativity flat lying.

It is understood the proposed structure will be a three-story mixed use building with a basement.

Location of the property is shown on Figure 1, included in Appendix B. As no topographic information was available, borehole and soil profile elevations provided, are referenced to the top of slab for the loading dock doors at the rear of 508 Gladstone Ave, which has been assumed to be El. 100.00 m.

3.0 FIELD PROCEDURES

Staff of McIntosh Perry Consulting Engineers (McIntosh Perry) visited the site before the drilling investigation to mark out the proposed borehole locations and evaluate drill rig access. Utility clearance was carried out by USL-1 on behalf of McIntosh Perry. Public and private utility authorities were informed and all utility clearance documents were obtained before the commencement of drilling work.

The equipment used for drilling was owned and operated by CCC Group Ltd. of Ottawa, Ontario. Boreholes were advanced using hollow stem augers aided by a truck-mounted CME 45 Drilling Rig. Boreholes were

advanced to a maximum depth of 7.4 m below the ground surface. Soil samples were obtained at 0.6 m intervals of depth in boreholes using a 50 mm outside diameter split spoon sampler in accordance with the Standard Penetration Test (SPT) procedure. Boreholes were backfilled with cuttings and bentonite and were restored to match the original surface. Borehole locations are shown on Figure 2, included in Appendix B.

4.0 LABORATORY TEST PROCEDURES

Laboratory testing on representative SPT samples was performed at McIntosh Perry geotechnical lab included moisture content. Atterberg Limit test, sieve analysis, hydrometer grain-size analysis, and moisture content was done on retrieved SPT samples, was tested by LRL Ltd. The laboratory tests to determine index properties were performed in accordance with Ministry of Transportation Ontario (MTO) test procedures, which follow American Society for Testing Materials (ASTM) test procedures.

Paracel Laboratories Ltd., in Ottawa carried out chemical tests on one representative soil sample and one surface water sample to determine the soil and water corrosivity characteristics.

The soil samples recovered will be stored in McIntosh Perry's storage facility for a period of one month after submission of the final report. Samples will be disposed after this period of time unless otherwise requested in writing by the Client.

Laboratory tests are included in Appendix D.

5.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

5.1 Site Geology

Based on published physiography maps of the area (Ontario Geological Survey) the site is located within the Ottawa Valley Clay Plains. Surficial geology maps of southern Ontario identify the property is on Till.

The Ottawa Valley between Pembroke and Hawkesbury, Ontario consists of clay plains interrupted by ridges of rock or sand. It is naturally divided into two parts, above and below Ottawa, Ontario. Within the valley, the bedrock is further faulted so that some of the uplifted blocks appear above the clay beds. The sediments themselves in the valley are deep silty clay. Although the clay deposits are grey in color like the limestones that underlies them in part, they are only mildly calcareous and likely derived from the more acidic rock of the Canadian Shield.

5.2 Subsurface Conditions

In general, the site stratigraphy consists of fill material underlain by a silty clay then till. The soils encountered at this site can be divided into three different zones.

a) Fill
b) Clay

c) Till

The soils encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole sheets included in Appendix C. Description of the strata encountered are given below.

5.2.1 Fill

A layer of asphalt was observed overtop of the fill layer in all boreholes ranging from 65 mm to 130 mm in thickness. Below the asphalt in boreholes BH18-1 and BH18-2 was a layer of concrete. This layer was 165 mm thick in borehole BH18-1 and 50 mm thick in borehole BH18-2. Below the concrete and asphalt was a fill material which began as sand and gravel, containing some silt and traces of clay. The material was described as brown, moist and loose to compact. Cobbles were observed within this layer in borehole BH18-1. A layer of black to light grey, moist to loose silty sand under-laid the sand and gravel in borehole BH18-2. The fill material than transitioned to sand and fines described as light brown to light grey, wet to moist and loose to compact. In borehole BH18-3 the fill layer further transitioned to a brown, moist to wet, dense sand and gravel with traces of silt. Cobbles and boulders were present in this layer. The total depth of this layer extended to 3.0 m below ground surface. SPT 'N' values within this layer ranged from 50 – 4 blows/300 mm. A representative sample of fill underwent sieve grain size analysis and was found to contain 0% gravel, 50% sand and 50% fines. Moisture content within the layer was observed to be an average of 17%. Test results are shown on Figure 3, included in Appendix B.

5.2.2 Clay

Underlying the fill material was a layer of silty clay described as grey, wet and soft to very soft. Further into this layer traces of sand and gravel could be observed and the layer was described as stiff. The layer extended to a maximum depth of 6.1 m below ground surface. SPT samplers were advanced by weight of hammer, 'N' value of 0 blows/300 mm. MTO 'N-sized' vane tests conducted to estimate the in-situ shear strength of the layer ranged from 52 kPa to 74 kPa for an intact state and 14 kPa to 23 kPa for a remoulded state. Sensitivity values ranged from 2 to 5, indicating a sensitive to medium sensitive clay. Two Atterberg limit tests were conducted on representative samples and found the clay to be of high plasticity (CH). Results showed the liquid limit values ranged from 67% to 82% and the plastic limit values ranged from 25% to 28%. Test results are shown in figure 4 in Appendix B. Moisture content tests indicated the natural moisture contents of the silty clay material was close to and over the liquid limit, indicating the layer is in a sensitive state. Moisture content observed to be an average of 71%.

5.2.1 Till

Prior to encountering probable bedrock a layer of till was observed as sandy silt with some clay and gravel to silt and sand and some grave and trace clay. It was described as grey, wet and stiff to hard. SPT 'N' values within this layer ranged from 9 to 16 blows/300 mm excluding the SPT refusal blow counts. Two representative samples of the till underwent hydrometer grain size analysis and was found to contain between 13% and 24%

gravel, 19% and 39% sand, 30% and 58% silt and 7% to 10% silt. Test results are shown on Figure 5 included in Appendix B. Moisture contents within this layer were observed to be an average of 9%. This layer extended to a maximum depth of 7.4 m below surface.

5.3 Groundwater

Ground water was observed in boreholes BH18-2 and BH18-3 at a depth of 1.7 m. A well was installed in borehole BH18-3 in order to observe variations in water levels. Groundwater level may be expected to fluctuate due to seasonal changes.

5.4 Chemical Analysis

The chemical test results conducted by Paracel Laboratories in Ottawa, Ontario, to determine the resistivity, pH, sulphate and chloride content of representative soil sample are shown in Table 5-1 below:

Table 5-1: Soil Chemical Analysis Results

Borehole	Sample	Depth / El. (m)	pH	Sulphate (%)	Chloride (%)	Resistivity (Ohm-cm)
BH18-3	SS-03	1.52 – 2.13	7.48	0.0031	0.0158	2260

6.0 DISCUSSIONS AND RECOMMENDATIONS

6.1 General

This section of the report provides recommendations for the design of a residential low-rise mixed-use apartment building with residential units in the basement and top three floors, and commercial area on the main floor. The recommendations are based on interpretation of the factual information obtained from the boreholes advanced during the subsurface investigation. The discussions and recommendations presented are intended to provide sufficient information to the designer of the proposed building to select the suitable types of foundation to support the structure.

The comments made on the construction are intended to highlight aspects which could have impact or affect the detailed design of the building, for which special provisions may be required in the Contract Documents. Those who requiring information on construction aspects should make their own interpretation of the factual data presented in the report. Interpretation of the data presented may affect equipment selection, proposed construction methods, and scheduling of construction activities.

6.2 Project Design

6.2.1 Existing Site Condition

Detailed site condition is provided in Section 2. The property is predominately leveled and contains a two and a half story building divided into three units. Adjacent to the property is a commercial building to the west and a residential structure to the east. The location of the site is shown on Figure 1 included in Appendix B.

6.2.2 Proposed Development

It is understood that the proposed development will be a three-story mixed use apartment building with a basement and will likely be a conventional slab on grade with shallow footing foundation.

6.3 Frost Protection

Based on applicable building codes, a minimum earth cover of 1.8 m, or the thermal equivalent of insulation, should be provided for all exterior footings to reduce the effects of frost action.

6.4 Site Classification for Seismic Site Response

Selected spectral responses in the general vicinity of the site for 10% chance of exceedance in 50 years (475 years return period) are as indicated in Table 6-1, shown below and in Appendix D;

Table 6-1: Selected Seismic Spectral Responses (10% in 50 Yrs)

Sa(0.2)	Sa(0.5)	Sa(2.0)	PGA	PGV
0.161	0.088	0.020	0.101	0.068

The site can be classified as a Site Class “D” for soft rock for the purposes of site-specific seismic response to earthquakes based on Table 4.1.8.4.A OBC 2012.

6.5 Slabs-on-Grade

Free-floating Slabs-on-grade should be supported on minimum 200 mm of Granular A compacted to 100% SPMDD. In case the subgrade needs to be raised Granular B type II or Granular A needs to be compacted to minimum 96% SPMDD. If the slab-on-grade is designed to support internal columns, the fill used for the grade raise shall be compacted to minimum 100% SPMDD. The fill should be placed in horizontal lifts of uniform thickness of no more than 300 mm before compaction and it should be placed at appropriate moisture content. The requirements for fill material and compaction may be addressed with a note on the structural drawing for foundation or grading drawing and/or with a Non-Standard Special Provision (NSSP).

All slab-on-grade units shall float independently from all load-bearing structural elements. Subgrade should be proof rolled prior to placing any granular material.

6.6 Shallow Foundations

Considering the order of structural loads expected at the foundation level, provision of conventional strip footings will be adequate. Footings are expected to be buried to resist overturning and sliding and also to provide protection against frost action.

Due to the inconsistent nature of the fill material both in material type and density the excavation must extend at a minimum to the top of silty clay, any existing fill and any material from the existing building must be removed from the footprint of the proposed building. A geotechnical staff shall attend the site upon completion of excavation and approve the subgrade.

If adequate frost cover is not provided, the deficit of earth cover should be compensated by application of synthetic insulation material adequately projecting beyond foundation walls.

6.6.1 Bearing Capacity

Assuming the strip footings are constructed through excavating the fill and exposing the silty clay, the following bearing capacity values can be used for structural design;

Factored beading pressure at Ultimate Limit State (ULS): 110 kPa

Serviceability Limit State (SLS): 75 kPa

It is expected the strip footing will be between 0.6 m and 2.0 m, if strip footings outside these dimensions are required, the authors of this report should be informed to verify the compatibility of the design.

As the proposed building footprint is expect to extend beyond the existing building footprint, the clay under the existing footings is expected to have undergone consolidation. However, the material outside the footprint has not experienced, as a result the area of expended footprint may experience slightly higher settlement. The provided SLS bearing capacity is to keep the settlements within the range of 25 ± 10 mm. In order to reduce the risk of differential settlement, it is important that all footings are founded on the same stratum. Silty clay should be proof rolled prior to placing the footings. The existing fill as encountered in the geotechnical boreholes is very inconsistent and shall be removed from the influence zone of the footings. However it is acceptable to leave the exiting fill under the proposed slab on grade and proof roll.

6.7 Lateral Earth Pressure

Free draining material should be used as backfill material for foundation walls. If the proper drainage is provided “at rest” condition may be assumed for calculation of earth pressure on foundation walls. The following parameters are recommended for the granular backfill.

Table 6-1: Backfill Material Properties

Borehole	Granular "A"	Granular "B"
Effective Internal Friction Angle, ϕ'	35°	30°
Unit Weight, γ (kN/m^3)	22.8	22.8

7.0 CONSTRUCTION CONSIDERATIONS

Any organic material and existing fill material of any kind, shall be removed from the footprint of the footings and all structurally load bearing elements. If grade raise above the native subgrade is required suitable fill material to conform to specifications of OPSS Granular criteria shall be used. The Structural Fill should be free from any recycled or deleterious material, it should not be placed in lifts thicker than 300 mm and should be compacted as specified.

It is not clear is the founding level will be below groundwater at the time of construction. If water infiltrates into the excavation, a conventional sump and pump method can be applied. The excavated subgrade must be kept dry at all times to minimize the disturbance of the subgrade. Groundwater elevation is expected to fluctuate seasonally.

The excavations are expected to be advanced through the fill subgrade. The overburden excavation should be completed in accordance with Ontario Regulation (O.Reg.) 213/91 under the Occupational Health and Safety Act (OHSA) with specific reference to acceptable side slopes and stabilization requirements. The general stratigraphy outlined herein can be considered an OHSA Type 3 Soil. For excavations through multiple soil types, the side slope geometry is governed by the soil with the highest number designation. If excavation extends to below the groundwater table the soil shall be treated as Type 4 soil due high percentage of silt and sand.

Based on slope requirements of type 3 or 4 soil, and proximity of proposed construction to property limits, it is expected there will be inadequate space for sloped excavation. Stamped shop drawings for a protection system should be provided in accordance with OPSS 539, Construction Specification for Temporary Protection Systems, and OPSS 902, Construction Specifications for Excavation and Backfilling – Structures. Special provision should be provided for installation and decommission of the shoring system to ensure proposed construction does not impact existing neighbouring foundations.

No information on the neighbouring properties type or depth of foundation has been provided. Existing properties should be reviewed prior to construction by a structural engineer to assess per-construction condition.

A geotechnical engineer or technician should attend the site to confirm the type of the material and level of compaction.

Foundation walls should be backfilled with free-draining material such as OPSS Granular types A or B. The native till is not a suitable material for backfilling. Sub-drains with positive drainage to the City sewer should be provided at foundation level.

8.0 SITE SERVICES

At the subject site, the burial depth of water-bearing utility lines is typically 2.4 m below ground surface. If this depth is not achievable due to design restrictions, equivalent thermal insulation should be provided. The contractor should retain a professional engineer to provide detailed drawings for excavation and temporary support of the excavation walls during construction.

Utilities should be supported on minimum of 150 mm bedding of Granular A compacted to minimum 96% of SPMDD. Utility cover can be Granular A or Granular B type II compacted to 96% SPMDD. All covers are to be compacted to 100% SPMDD if intersecting structural elements. The engineer designing utilities shall ensure the proposed utility pipes can tolerate compaction loads.

Cut-off walls should be provided for utility trenches running below the groundwater level to mitigate the settlement risk due to groundwater lowering.

9.0 CEMENT TYPE AND CORROSION POTENTIAL

Samples from subgrade soil was submitted to Parcel laboratories for testing of chemical properties relevant to exposure of concrete elements to sulphate attacks as well as potential soil corrosivity effects on buried metallic structural element. Test results are presented in Tables 5-1.

The potential for sulphate attack on concrete structures is moderate to low. Type GU Portland cement is expected to be adequate to protect buried concrete elements in the subsurface conditions encountered.

The corrosion potential for buried steel elements was determined as ‘non-aggressive’.

10.0 CLOSURE

We trust this geotechnical investigation and foundation design report meets requirements of your project. The "Limitations of Report" presented in Appendix A are an integral part of this report. Please do not hesitate to contact the undersigned should you have any questions or concerns.

McIntosh Perry Consulting Engineers Ltd.

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Geotechnical Engineering Intern

N'eem Tavakkoli, M.Eng., P.Eng.
Senior Geotechnical Engineer

11.0 REFERENCES

Canadian Geotechnical Society, “Canadian Foundation Engineering Manual”, 4th Edition, 2006.

Ontario Ministry of Natural Resources (OMNR), Ontario Geological Survey, Special Volume 2, “The Physiography of Southern Ontario”, 3rd Edition, 1984.

Google Earth, Google, 2015.

506 GLADSTONE AVE.

APPENDIX A
LIMITATIONS OF REPORT

McINTOSH PERRY

LIMITATIONS OF REPORT

McIntosh Perry Consulting Engineers Ltd. (McIntosh Perry) carried out the field work and prepared the report. This document is an integral part of the Foundation Investigation and Design report presented.

The conclusions and recommendations provided in this report are based on the information obtained at the borehole locations where the tests were conducted. Subsurface and groundwater conditions between and beyond the boreholes may differ from those encountered at the specific locations where tests were conducted and conditions may become apparent during construction, which were not detected and could not be anticipated at the time of the site investigation. The benchmark level used and borehole elevations presented in this report are primarily to establish relative differenced in elevations between the borehole locations and should not be used for other purposes such as to establish elevations for grading, depth of excavations or for planning construction.

The recommendations presented in this report for design are applicable only to the intended structure and the project described in the scope of the work, and if constructed in accordance with the details outlined in the report. Unless otherwise noted, the information contained in this report does not reflect on any environmental aspects of either the site or the subsurface conditions.

The comments or recommendation provided in this report on potential construction problems and possible construction methods are intended only to guide the designer. The number of boreholes advanced at this site may not be sufficient or adequate to reveal all the subsurface information or factors that may affect the method and cost of construction. The contractors who are undertaking the construction shall make their own interpretation of the factual data presented in this report and make their conclusions, as to how the subsurface conditions of the site may affect their construction work.

The boundaries between soil strata presented in the report are based on information obtained at the borehole locations. The boundaries of the soil strata between borehole locations are assumed from geological evidences. If differing site conditions are encountered, or if the Client becomes aware of any additional information that differs from or is relevant to the McIntosh Perry findings, the Client agrees to immediately advise McIntosh Perry so that the conclusions presented in this report may be re-evaluated.

Under no circumstances shall the liability of McIntosh Perry for any claim in contract or in tort, related to the services provided and/or the content and recommendations in this report, exceed the extent that such liability is covered by such professional liability insurance from time to time in effect including the deductible therein, and which is available to indemnify McIntosh Perry. Such errors and omissions policies are available for inspection by the Client at all times upon request, and if the Client desires to obtain further insurance to protect it against any risks beyond the coverage provided by such policies, McIntosh Perry will co-operate with the Client to obtain such insurance.

McIntosh Perry prepared this report for the exclusive use of the Client. Any use which a third party makes of this report, or any reliance on or decision to be made based on it, are the responsibility of such third parties. McIntosh Perry accepts no responsibility and will not be liable for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

506 GLADSTONE AVE.

APPENDIX B
FIGURES

McINTOSH PERRY

LEGEND

- Site Location
- Local Road
- Major Road
- Watercourse
- Waterbody

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2018.

CLIENT: TC UNITED

PROJECT: GEOTECHNICAL INVESTIGATION
506 GLADSTONE AVENUE

TITLE: SITE LOCATION

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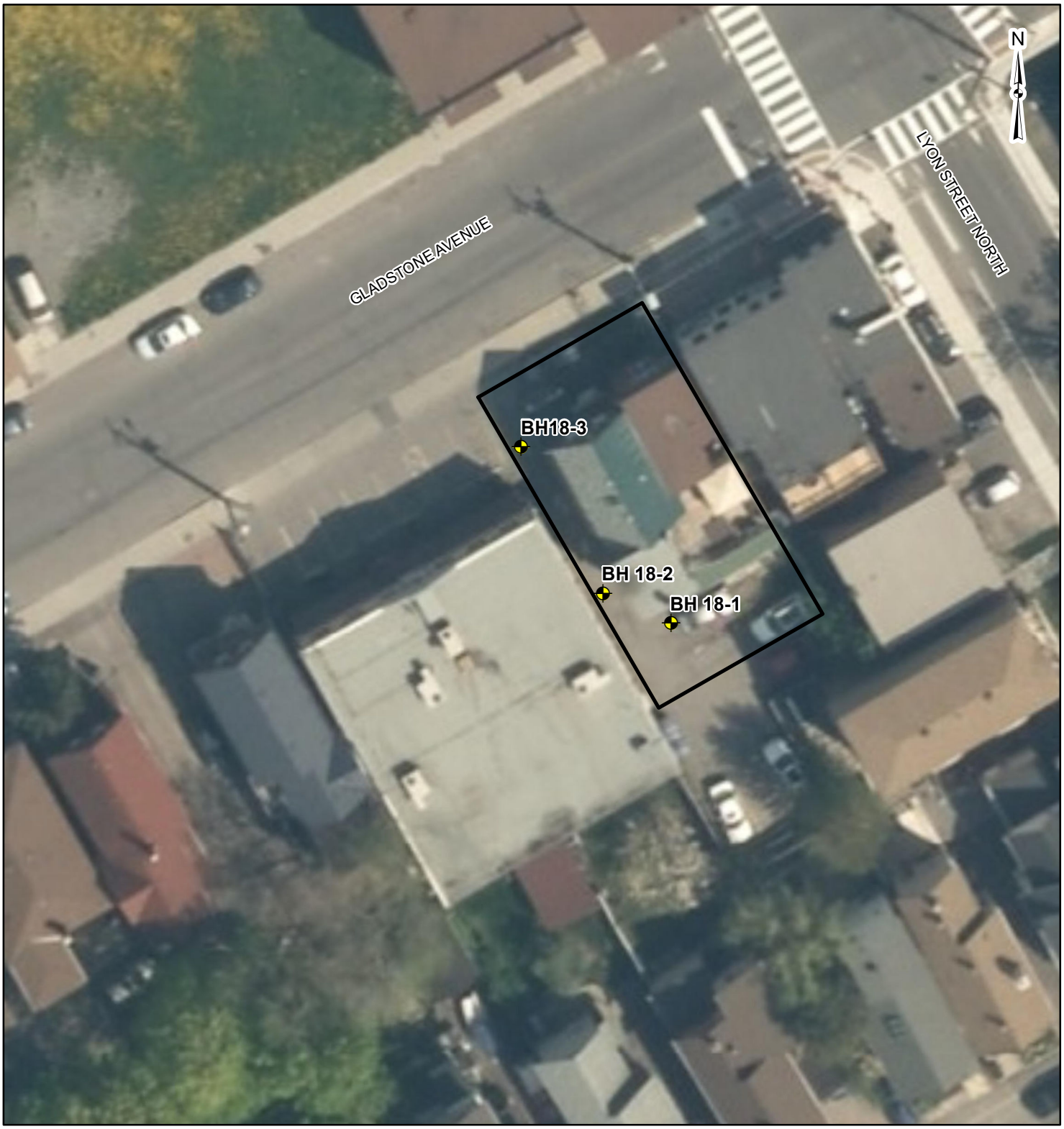
PROJECT NO:	CP-17-0605
Date	Mar., 22, 2018
GIS	JD
Checked By	JU

FIGURE: 1

H:\01 Project - Proposals\2017 Jobs\CP\0CP-17-0605 TCU_Mixed Use Building SPA_506 Gladstone Ave\Phase One ESA\05 GIS\mxd\CP-17-0605_Geotechnical\01_SiteLocation506Gladstone.mxd



10 5 0 10

Scale 1:400 Metres

LEGEND

- Borehole Location
- Approximate Property Boundary

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2018.

CLIENT: TC UNITED

PROJECT: GEOTECHNICAL INVESTIGATION
506 GLADSTONE AVENUE

TITLE: BOREHOLE LOCATIONS

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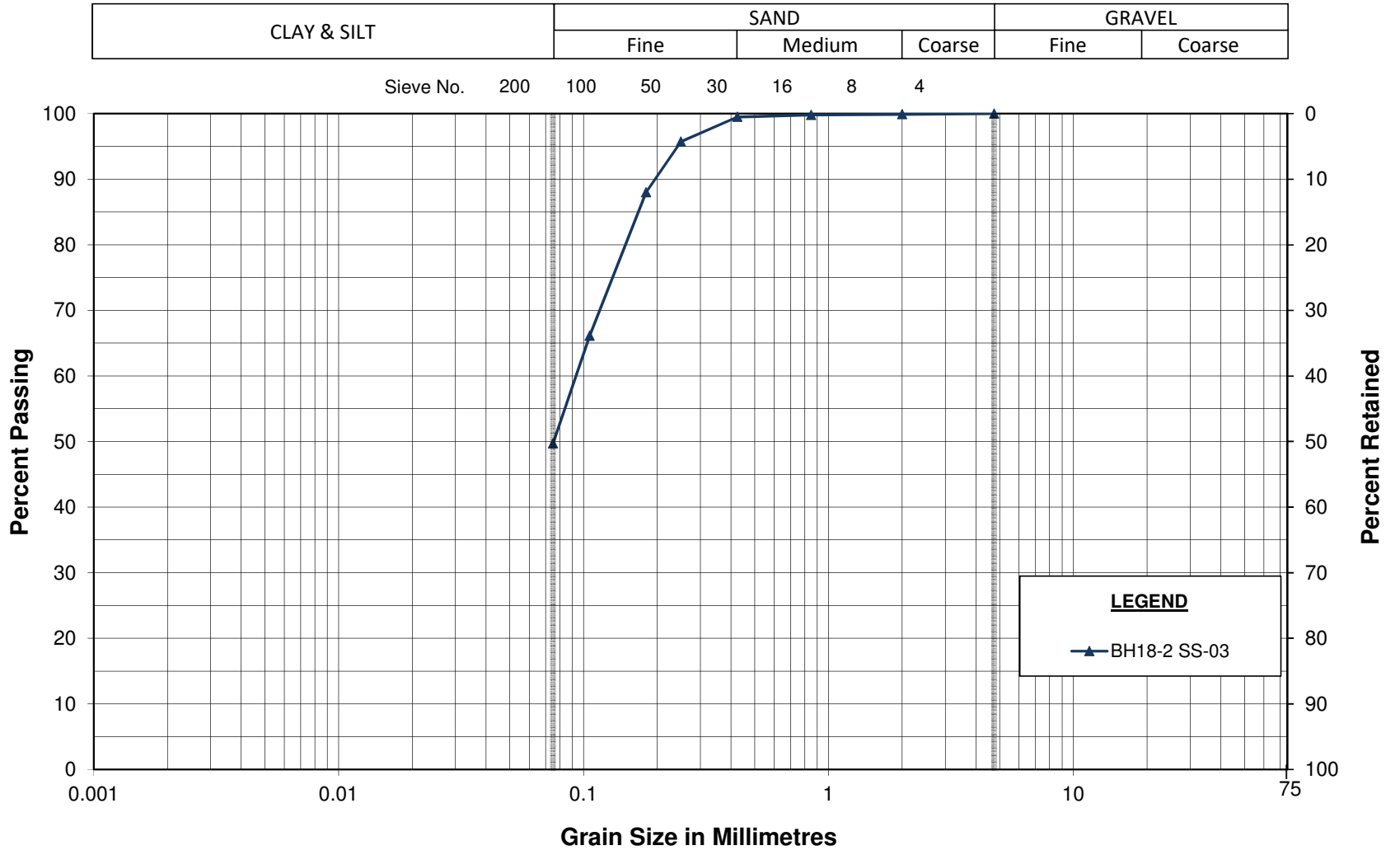
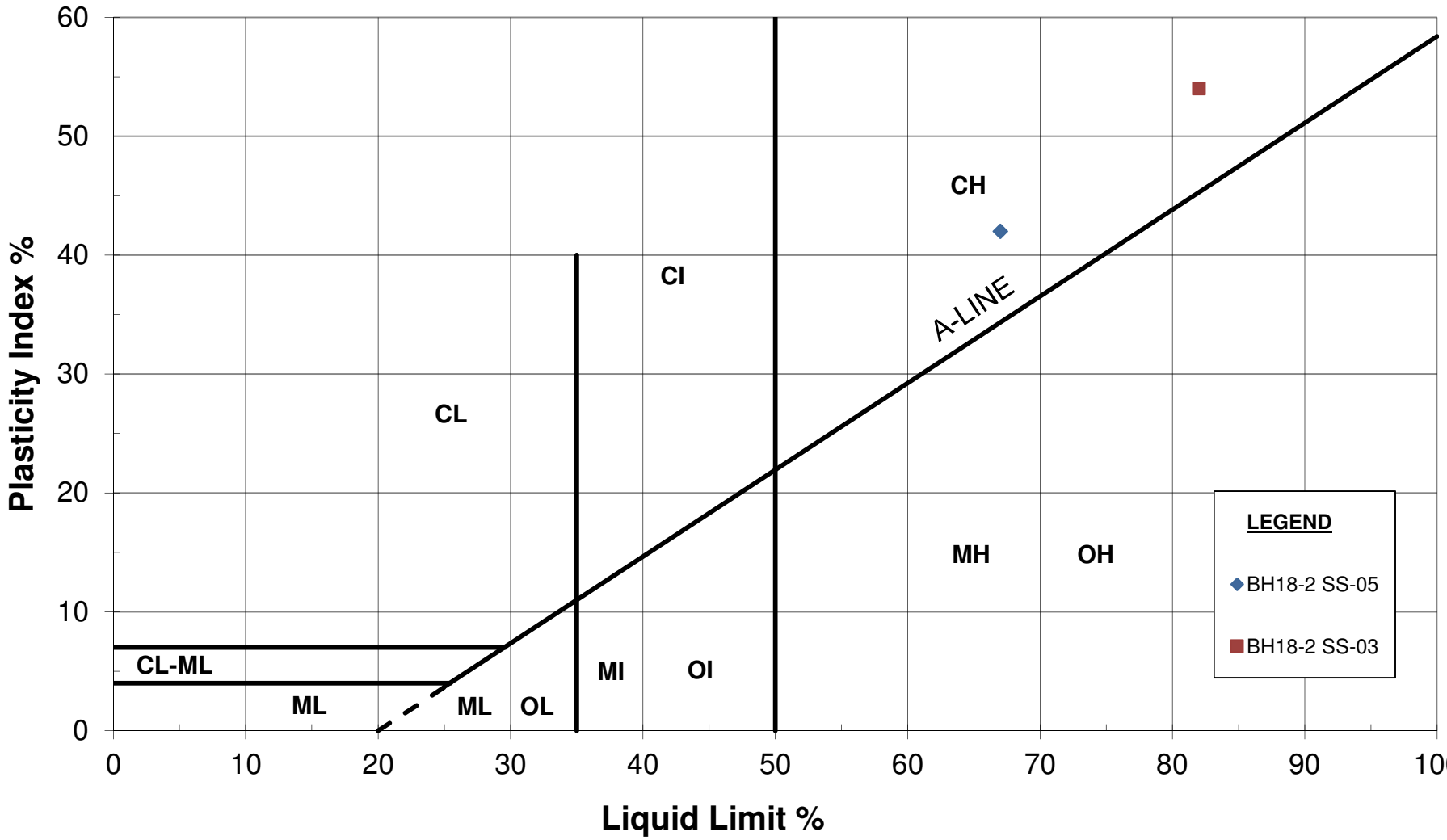
PROJECT NO:CP-17-0605		FIGURE:
Date	Mar., 22, 2018	2
GIS	JD	
Checked By	JU	

Unified Soil Classification System



McINTOSH PERRY	Grain Size Distribution FILL 506 Gladstone Ave	Figure No. 3 CP-17-0605



McINTOSH PERRY

PLASTICITY CHART

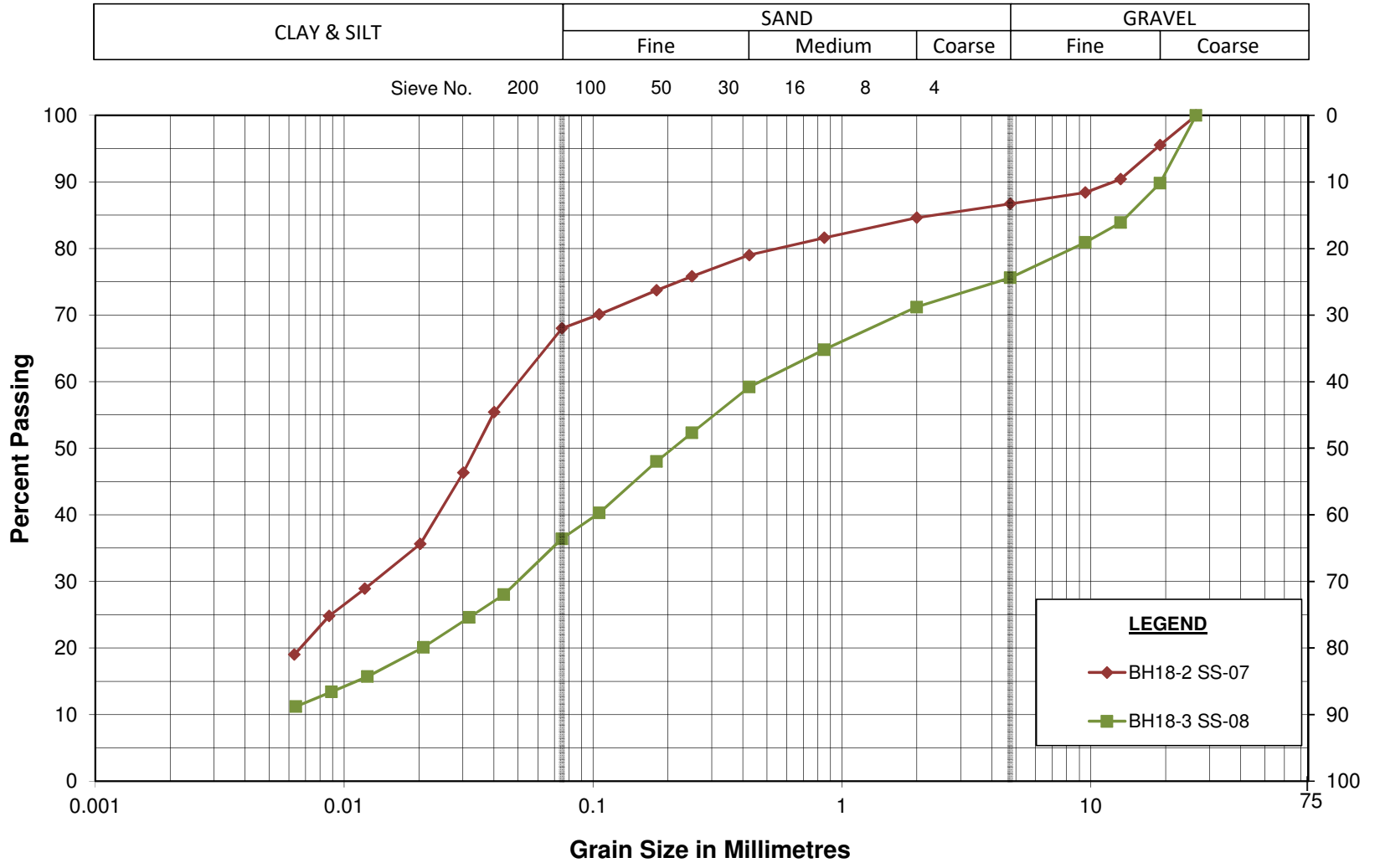
CLAY

506 Gladstone Ave

Figure No. 4

CP-17-0605

Unified Soil Classification System



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Grain Size Distribution
Till
506 Gladstone Ave

Figure No. 5

CP-17-0605

506 GLADSTONE AVE.

APPENDIX C
BOREHOLE LOGS

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EXPLANATION OF TERMS USED IN REPORT

N-VALUE: THE STANDARD PENETRATION TEST (SPT) N-VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5 kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N-VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N-VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

C_u (kPa)	0 – 12	12 – 25	25 – 50	50 – 100	100 – 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 – 5	5 – 10	10 – 30	30 – 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSION AND STRUCUTRAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY IS:

RQD (%)	0 – 25	25 – 50	50 – 75	75 – 90	90 – 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINT AND BEDDING:

SPACING	50mm	50 – 300mm	0.3m – 1m	1m – 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

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

MECHANICALL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
c_c	1	COMPRESSION INDEX
c_s	1	SWELLING INDEX
c_a	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
Φ'	$^{-o}$	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
Φ_u	$^{-o}$	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

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1,%	VOID RATIO	e_{min}	1,%	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1,%	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1,%	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	s_r	%	DEGREE OF SATURATION	D_n	mm	N PERCENT – DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_P	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_P	%	PLASTICITY INDEX = $(W_L - W_L)$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $(W - W_P)/ I_P$	i	1	HYDAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $(W_L - W) / 1_P$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERED SOIL	$e_{,max}$	1,%	VOID RATIO IN LOOSEST STATE	j	kN/m^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

McINTOSH PERRY

RECORD OF BOREHOLE No 18-1

DATE:	04/03/2018 -	**LOCATION:**	506 Gladstone Ave, Ottawa, ON ()	**ORIGINATED BY:**	PH
PROJECT:	CP-17-0605-GLADSTONE	**COORDINATES:**	Lat: 45.409978 , Lon: -75.69806	**COMPILED BY:**	JU
CLIENT:	TC United	**DATUM:**	Local	**CHECKED BY:**	NT
ELEVATION:	100.0 m	**REMARK:**	No water observed in open borehole.	**REPORT DATE:**	19/04/2018

DEPTH - feet	DEPTH - meters	SOIL PROFILE: ELEVATION - m / DEPTH - m	SOIL PROFILE: DESCRIPTION	SYMBOL	SAMPLES: TYPE AND NUMBER	SAMPLES: STATE	SAMPLES: RECOVERY	SAMPLES: "N" or RQD	GROUNDWATER CONDITIONS	DYNAMIC CONE PEN. RESISTANCE PLOT / SHEAR STRENGTH (kPa)	WATER CONTENT and LIMITS (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%)
		100.0 / 0.0	Natural ground surface									
		99.9 / 0.1	65 mm Asphalt									
		99.8 / 0.2	165 mm Concrete									
	1		Fill : Sand and gravel, some silt, traces of clay, brown, moist, loose. Presence of cobbles.		SS-01		12	7				
5	2	98.6 / 1.4	**END OF BOREHOLE**									Drilling terminated due to safety concerns with drilling angle.
10	3											
	4											
15	5											
	6											
20	7											
25	8											
30	9											

DYNAMIC CONE PEN. RESISTANCE PLOT: 20 40 60 80

SHEAR STRENGTH (kPa): Vane test (◇ Intact, ◆ Remolded); Lab vane (□ Intact, ■ Remolded); 20 40 60 80 100

WATER CONTENT and LIMITS (%): W_P W W_L; 25 50 75

REMARKS & GRAIN SIZE DISTRIBUTION (%): G S M C

McINTOSH PERRY

RECORD OF BOREHOLE No 18-2

DATE:	04/03/2018 -	**LOCATION:**	506 Gladstone Ave, Ottawa, ON ()	**ORIGINATED BY:**	PH
PROJECT:	CP-17-0605-GLADSTONE	**COORDINATES:**	Lat: 45.409997 , Lon: -75.698124	**COMPILED BY:**	JU
CLIENT:	TC United	**DATUM:**	Local	**CHECKED BY:**	NT
ELEVATION:	100.0 m	**REMARK:**		**REPORT DATE:**	19/04/2018

DEPTH - feet	DEPTH - meters	SOIL PROFILE: ELEVATION - m / DEPTH - m	SOIL PROFILE: DESCRIPTION	SYMBOL	SAMPLES: TYPE AND NUMBER	SAMPLES: STATE	SAMPLES: RECOVERY	SAMPLES: "N" or RQD	GROUNDWATER CONDITIONS	DYNAMIC CONE PEN. RESISTANCE PLOT / SHEAR STRENGTH (kPa)	WATER CONTENT and LIMITS (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%)
		100.0	Natural ground surface							Vane test: ◇ Intact, ◆ Remolded; Lab vane: □ Intact, ■ Remolded; 20 40 60 80 / 20 40 60 80 100	W_P W W_L; 25 50 75	G S M C
		0.0 / 99.9	130 mm Asphalt.									
		0.1 / 99.8	50 mm Concrete.		GS-01							
		0.2 / 99.5	Fill : Sand and gravel, some silt, traces of clay, brown, moist, compact.									
		0.5 / 99.3	Fill : Silty sand, traces of clay, black to light grey, moist, loose.									
	1	0.7	Fill : Silt and sand, trace to some clay, light brown to light grey, moist to wet, loose to compact.		SS-02		25	5				
5												
	2				SS-03		54	10	1.7 m			0 50 50
					SS-04		42	4				
10	3	97.0 / 3.0	Clay, grey, wet, stiff.									
					SS-05		100	0		19.0 ◆ 74.0 ◇		
	4											
15										23.0 ◆ 52.0 ◇		
	5				ST-06		100					
		94.7 / 5.3	Sandy silt, some clay and gravel, grey, wet, stiff. (Till)							21.0 ◆ 52.0 ◇		
					SS-07		67	9				13 19 58 10
20	6	93.9 / 6.1	Silt and sand, some gravel, traces of clay, grey, very stiff. (Till)									
					SS-08		29	16				
	7				SS-09		35	50				
		92.6 / 7.4	**END OF BOREHOLE. BOREHOLE TERMINATED ON AUGER REFUSAL. WATER LEVEL READ AT END OF DAY WITH WATER LEVEL TAPE.**									Borehole backfilled with cuttings and bentonite.
25	8											
30	9											

\LICENSES7\Sobek\Geotec80\Style\Log_Borehole_v5.sty

McINTOSH PERRY

RECORD OF BOREHOLE No 18-3

DATE:	04/03/2018 -	**LOCATION:**	506 Gladstone Ave, Ottawa, ON ()	**ORIGINATED BY:**	PH
PROJECT:	CP-17-0605-GLADSTONE	**COORDINATES:**	Lat: 45.410094 , Lon: -75.698203	**COMPILED BY:**	JU
CLIENT:	TC United	**DATUM:**	Local	**CHECKED BY:**	NT
ELEVATION:	99.9 m	**REMARK:**		**REPORT DATE:**	19/04/2018

DEPTH - feet	DEPTH - meters	ELEVATION - m / DEPTH - m	DESCRIPTION	SYMBOL	SAMPLES: TYPE AND NUMBER	STATE	RECOVERY	"N" or RQD	GROUNDWATER CONDITIONS	DYNAMIC CONE PEN. RESISTANCE PLOT / SHEAR STRENGTH (kPa)	WATER CONTENT and LIMITS (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%)
		99.9	Natural ground surface									
		0.0	50 mm Asphalt.									
		99.9 / 0.1	Fill : Sand and gravel, some silt, traces of clay, brown, moist, loose.		GS-01							
	1	98.8 / 1.1	Fill : Sand and fines, light brown to light grey, moist, loose.		SS-02		33	7				
5					SS-03		17	7				
	2	97.6 / 2.3	Fill : Sand and gravel, traces of silt, brown, moist to wet, dense. Presence of cobbles and boulders.		SS-04		12	56				
		97.1 / 2.8	Clay, grey, wet, stiff.									
10	3				SS-05		71	0		14.0 / 69.0 / 20.0 / 69.0		
	4	95.3 / 4.6	Sandy silt, some clay and gravel, grey, wet, soft. (Till)		SS-06		50	2				
15	5	94.6 / 5.3	Silt and sand, some gravel, traces of clay, grey, wet, stiff. (Till)		SS-07		37	15				
20	6				SS-08		54	11				24 39 30 7
	7	92.8 / 7.2	**END OF BORHEOLE. BOREHOLE TERMINATED ON AUGER REFUSAL.**		SS-09		67	50				
25	8											
30	9											

DYNAMIC CONE PEN. RESISTANCE PLOT: 20 40 60 80

SHEAR STRENGTH (kPa): Vane test ◇ Intact ◆ Remolded; Lab vane □ Intact ■ Remolded; 20 40 60 80 100

WATER CONTENT and LIMITS (%): W_P W W_L; 25 50 75

REMARKS & GRAIN SIZE DISTRIBUTION (%): G S M C

506 GLADSTONE AVE.

APPENDIX D
LAB RESULTS

McINTOSH PERRY

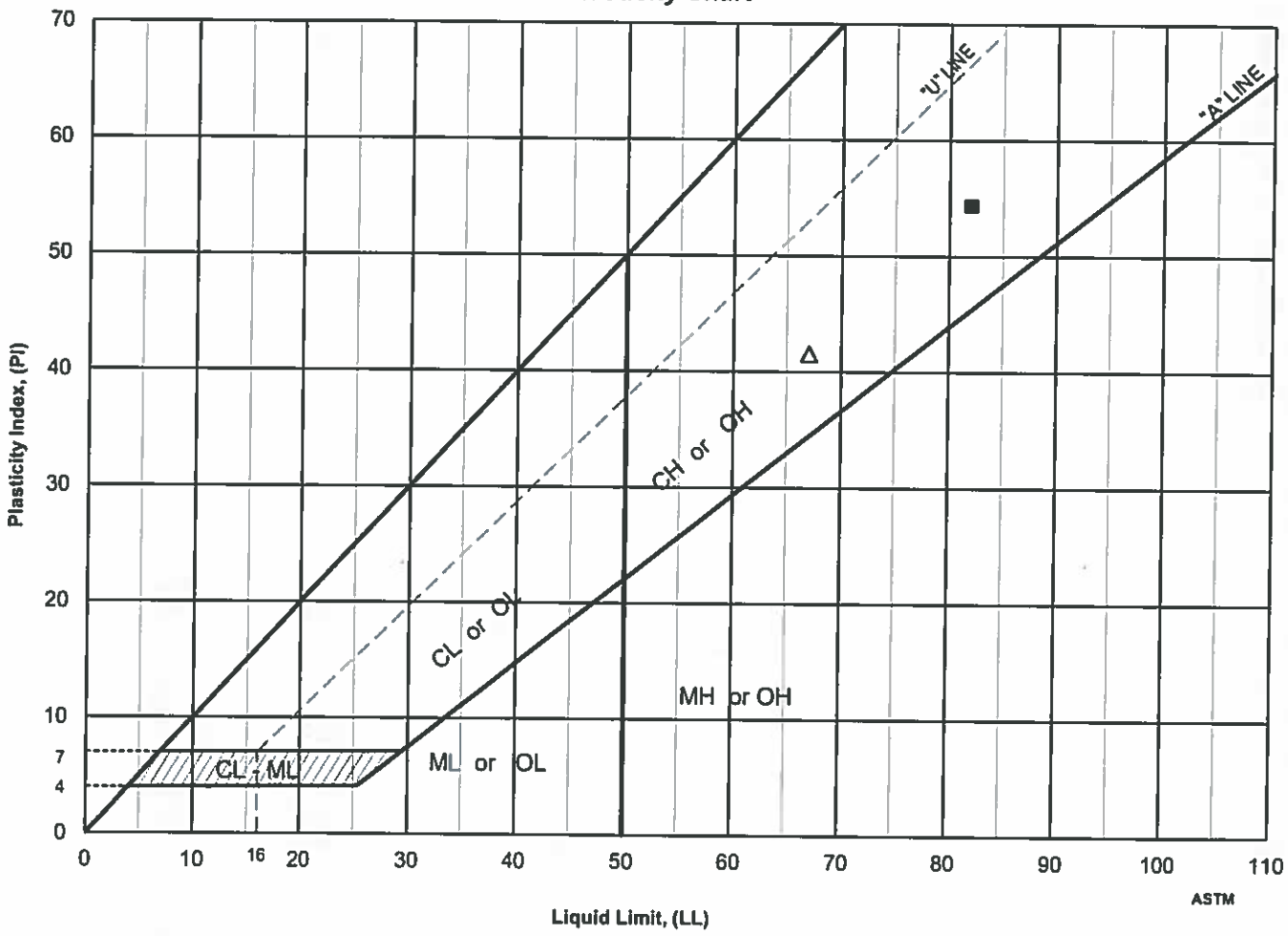
LRL Associates Ltd.

PLASTICITY INDEX

ASTM D 4318 / LS-703/704

Client:	McIntosh Perry Consulting Engineers	**Reference No.:**	CP-17-0605
Project:	Materials Testing	**File No.:**	170496-26
Location:	506 Gladstone Avenue, Ottawa, ON.	**Report No.:**	1

Plasticity Chart



	Location	Sample	Depth, m	Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Activity Number	USCS
△	BH 18-2	SS-05	3.05 - 3.66	72	67	25	42	1.12	n/d	CH
■	BH 18-3	SS-05	3.05 - 3.66	70	82	28	54	0.78	n/d	CH

Date Issued: March 16, 2018

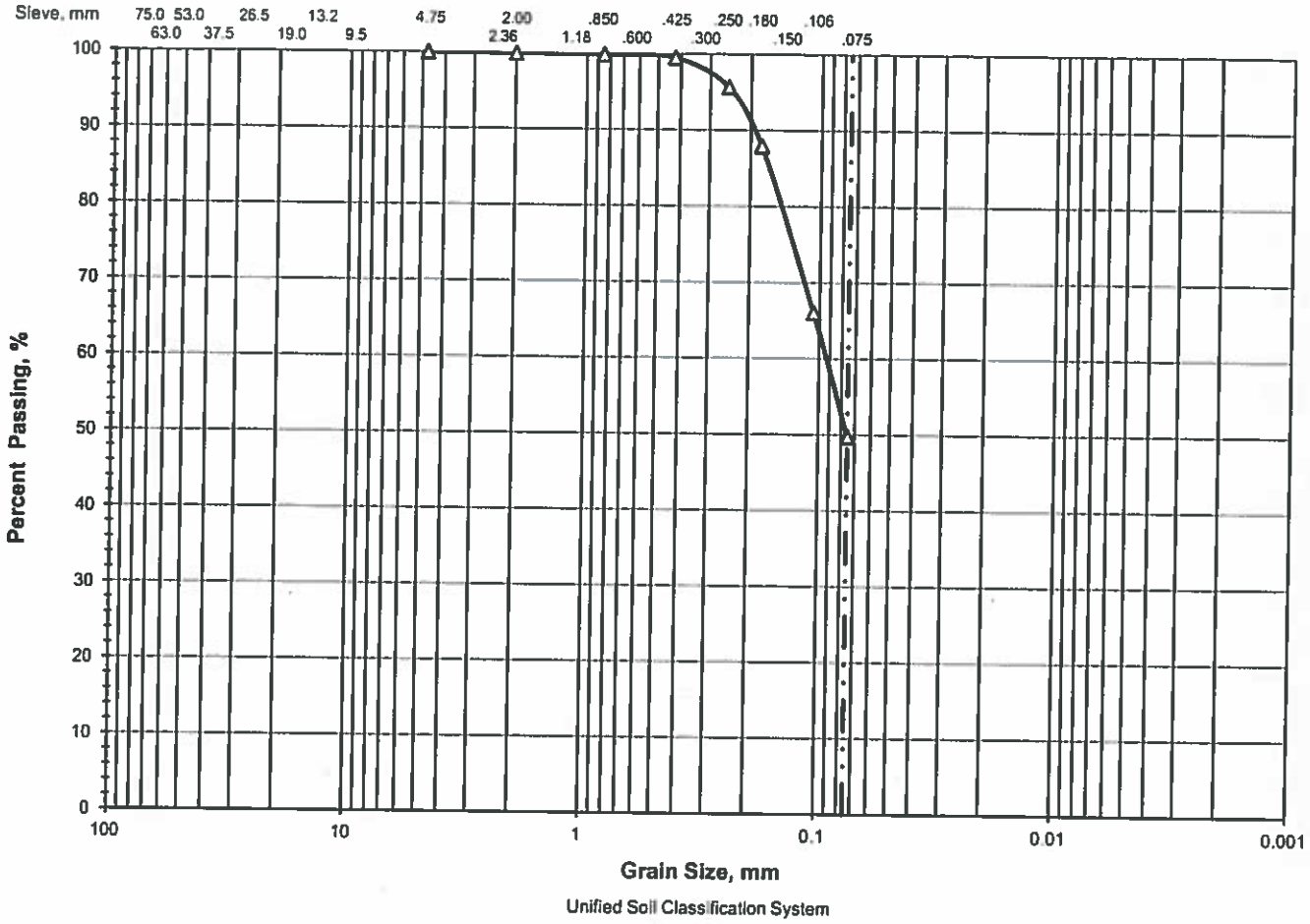
Reviewed By: W.A.M^cLaughlin, Geo.Tech., C.Tech.

LRL Associates Ltd.

PARTICLE SIZE ANALYSIS

ASTM D 422 / LS-702

Client:	McIntosh Perry Consulting Engineers	**Reference No.:**	CP-17-0605
Project:	Materials Testing	**File No.:**	170496-26
Location:	506 Gladstone Avenue, Ottawa, ON.	**Report No.:**	2



Unified Soil Classification System

	> 75 mm	% GRAVEL		% SAND			% FINES
		Coarse	Fine	Coarse	Medium	Fine	Silt & Clay
△	0.0	0.0	0.0	0.1	0.4	49.7	49.7

	Location	Sample	Depth, m	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
△	BH 18-2	SS-03	1.52 - 2.13	0.0944	0.0755					

Date Issued: March 16, 2018

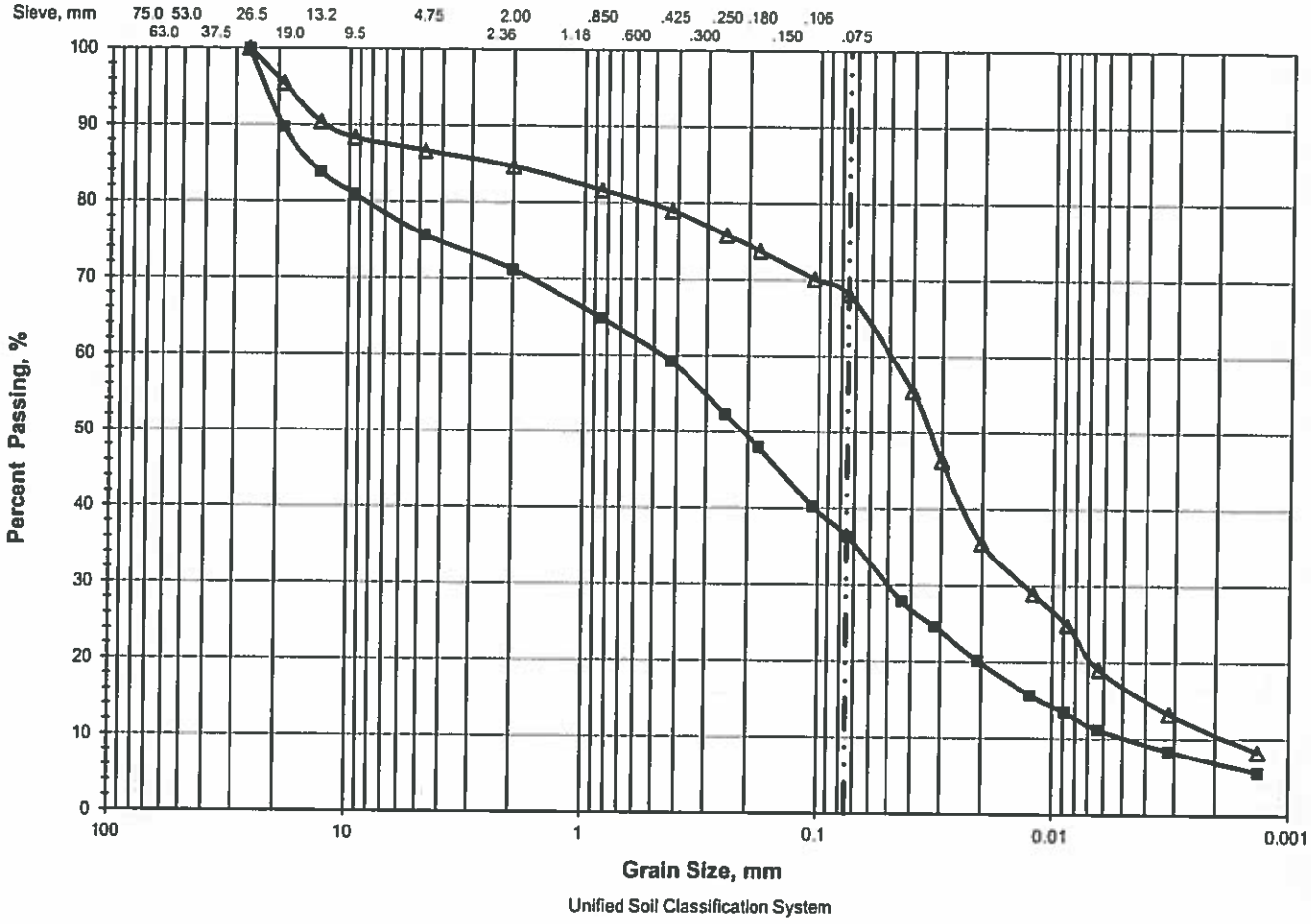
Reviewed By: W.A.M^cLaughlin, Geo.Tech, C.Tech.

LRL Associates Ltd.

PARTICLE SIZE ANALYSIS

ASTM D 422 / LS-702

Client:	McIntosh Perry Consulting Engineers	**Reference No.:**	CP-17-0605
Project:	Materials Testing	**File No.:**	170496-26
Location:	506 Gladstone Avenue, Ottawa, ON.	**Report No.:**	3



Unified Soil Classification System

	> 75 mm	% GRAVEL		% SAND			% FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
△	0.0	3.9	9.4	2.1	5.7	10.9	58.0	10.0
■	0.0	8.9	15.5	4.5	11.9	22.9	29.8	6.6

	Location	Sample	Depth, m	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
△	BH 18-2	SS-07	5.33 - 5.94	0.0528	0.0341	0.0134	0.0041	0.0020	1.7	26.4
■	BH 18-3	SS-08	6.10 - 6.71	0.4827	0.2126	0.0513	0.0114	0.0050	1.1	96.5

Date Issued: March 16, 2018

Reviewed By: W.A.M^cLaughlin, Geo.Tech., C.Tech.

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Certificate of Analysis

McIntosh Perry Consulting Eng. (Carp)

115 Walgreen Road
RR#3 Carp, ON K0A 1L0
Attn: Mary Ellen Gleeson

Client PO: CP-17-0605- Gladstone
Project: CP-17-0605
Custody: 34165

Report Date: 16-Mar-2018
Order Date: 13-Mar-2018

Order #: 1811140

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

Paracel ID	Client ID
1811140-01	CP-17-0605 BH18-3 SS-03

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO: CP-17-0605- Gladstone

Report Date: 16-Mar-2018
Order Date: 13-Mar-2018
Project Description: CP-17-0605

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	14-Mar-18	14-Mar-18
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	13-Mar-18	13-Mar-18
Resistivity	EPA 120.1 - probe, water extraction	14-Mar-18	14-Mar-18
Solids, %	Gravimetric, calculation	14-Mar-18	14-Mar-18

Certificate of Analysis

Report Date: 16-Mar-2018

Client: McIntosh Perry Consulting Eng. (Carp)

Order Date: 13-Mar-2018

Client PO: CP-17-0605- Gladstone

Project Description: CP-17-0605

	Client ID:	CP-17-0605 BH18-3 SS-03	-	-	-
	Sample Date:	04-Mar-18	-	-	-
	Sample ID:	1811140-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	83.7	-	-	-
General Inorganics					
pH	0.05 pH Units	7.48	-	-	-
Resistivity	0.10 Ohm.m	22.6	-	-	-
Anions					
Chloride	5 ug/g dry	158	-	-	-
Sulphate	5 ug/g dry	31	-	-	-

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO: CP-17-0605- Gladstone

Report Date: 16-Mar-2018
Order Date: 13-Mar-2018
Project Description: CP-17-0605

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									
Resistivity	ND	0.10	Ohm.m						

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO: CP-17-0605- Gladstone

Report Date: 16-Mar-2018
Order Date: 13-Mar-2018
Project Description: CP-17-0605

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	14.4	5	ug/g dry	13.9			3.4	20	
Sulphate	39.5	5	ug/g dry	37.7			4.6	20	
General Inorganics									
pH	5.93	0.05	pH Units	5.93			0.0	10	
Resistivity	51.2	0.10	Ohm.m	53.7			4.8	20	
Physical Characteristics									
% Solids	87.3	0.1	% by Wt.	87.7			0.4	25	

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO: CP-17-0605- Gladstone

Report Date: 16-Mar-2018
Order Date: 13-Mar-2018
Project Description: CP-17-0605

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	110	5	ug/g	13.9	95.9	78-113			
Sulphate	136	5	ug/g	37.7	98.5	78-111			

Qualifier Notes:

None

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.

506 GLADSTONE AVE.

APPENDIX E
SEISMIC HAZARD CALCULATION

McINTOSH PERRY

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

April 04, 2018

Site: 45.4088 N, 75.7013 W User File Reference: 605 Glastone Ave

Requested by: , McIntosh Perry

National Building Code ground motions: 2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.05)	Sa(0.1)	**Sa(0.2)**	Sa(0.3)	**Sa(0.5)**	**Sa(1.0)**	**Sa(2.0)**	**Sa(5.0)**	**Sa(10.0)**	**PGA (g)**	**PGV (m/s)**
0.446	0.522	**0.439**	0.333	**0.237**	**0.118**	**0.056**	**0.015**	**0.0054**	**0.280**	**0.196**

Notes. Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC 2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are specified in **bold** font. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. ***These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.***

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.05)	0.044	0.148	0.247
Sa(0.1)	0.061	0.186	0.299
Sa(0.2)	0.055	0.161	0.254
Sa(0.3)	0.043	0.124	0.195
Sa(0.5)	0.031	0.088	0.138
Sa(1.0)	0.015	0.044	0.069
Sa(2.0)	0.0061	0.020	0.033
Sa(5.0)	0.0012	0.0047	0.0081
Sa(10.0)	0.0006	0.0019	0.0032
PGA	0.033	0.101	0.163
PGV	0.021	0.068	0.111

References

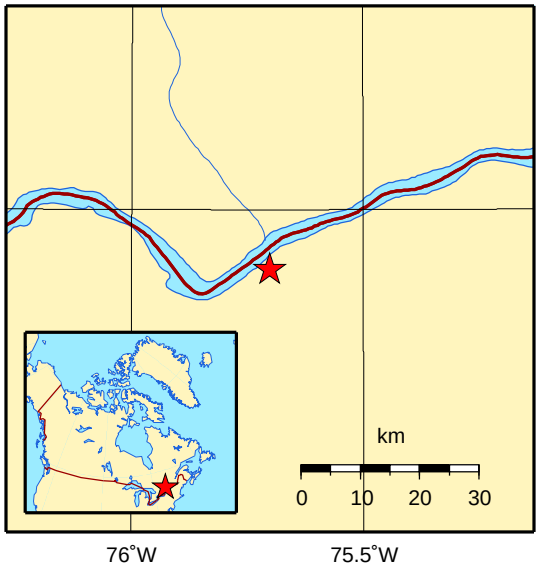
National Building Code of Canada 2015 NRCC no. 56190;
Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

User's Guide - NBC 2015, Structural Commentaries NRCC no. xxxxxx (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information

Aussi disponible en français



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