208-214 PRINCE ALBERT – GEOTECHNICAL REPORT

Project No.: CP-17-0395

Prepared for:

Ottawa Community Housing
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January 2018

McINTOSH PERRY

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GEOTECHNICAL INVESTIGATION and
FOUNDATION DESIGN RECOMMENDATION REPORT
208-214 Prince Albert Street, 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 additions to two existing semidetached homes located in Ottawa, Ontario. The field work was carried out on November 27 and 28, 2017 and comprised of three boreholes advanced to a maximum depth of 4.3 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 Atelier 292 Architect on behalf of Ottawa Community Housing.

2.0 SITE DESCRIPTION

The property under considerations for proposed development is located at 208, 210, 212, 214 Prince Albert Street, near intersection with Edith Avenue in the south of Vanier in a neighbourhood called Castle Heights of Ottawa. The property is located in the middle of a residential development. The existing property contains two, two-story semi-detached homes. Properties are separated by paved driveways; the backyards of each individual home have been framed by chain-link fences. The backyards are relatively flat, some properties contain sheds and raised flower beds.

It is understood the proposed structure will be a 2-story addition, with a half depth basement.

Location of the property is shown on Figure 1, included in Appendix B.

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 assess access for 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 Geotechnical & Environmental Drilling Ltd. of Ottawa, Ontario. Based on the restricted access to the backyard as a result of existing chain-link fence and overhead utilities, the original drilling plan of using a truck mounted drill rig was altered to a portable drill rig

to avoid the removal of the existing fence. Boreholes were advanced to a maximum depth of 4.3 m below the ground level. 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 auger cuttings. All boreholes 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 LRL Limited Laboratories and included moisture content, Atterberg Limit, and hydrometer grainsize analysis. 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. Select samples were tested for moisture content by McIntosh Perry.

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

The rest of the soil samples recovered will be stored in McIntosh Perry 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 C.

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 as on fine-textured glaciomarine deposits.

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 lime stones 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 an inconsistent fill material, followed by a gravelly silty sand till. All boreholes were terminated at SPT sample refusal on probable bedrock. The soils encountered at this site can be divided into two different zones.

a) Topsoil/Fill
b) 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

At the top off all boreholes was a thin layer of topsoil approximately 0.2m in thickness. Below the topsoil was a fill layer which changed in consistency and depth depending on the borehole location. The material type and level of compactness varied from loose to dense, with SPT 'N' values range from 6 to 35 blows/300 mm, with an average of 13 blows/300mm. The material was observed to range from sandy gravelly silt, to silty clay. Moisture content was observed to be an average of 22%. The thickness of the fill, was observed to range from 1.4 m to 2.9 m. Borehole BH17-1 which was drilled closest to the existing structure observed the thickest fill layer which extended to the depth of 2.9 m (El. 59.0 m). It is assumed the fill will not extend below the depth of the footings for the existing house.

5.2.2 Till

Below the fill in all boreholes was a silty and gravelly sand till layer with some clay. The layer was observed to be dark grey to brown, moist and frim to stiff. SPT 'N' values ranged from 12 to 70 blows/300 mm, all boreholes were terminated at SPT sampler refusal on probable bedrock, at a depth between 3.5 to 4.3 (El. 58.4 to 57.6 m). Moisture content within the weathered crust was an average of 11%. Three representative samples of the till from varying depths underwent hydrometer grain size analysis, distribution was found to range from 20% to 26% gravel, 35% to 40% sand, 26% to 32% silt, and 10% to 12% clay.

Test results are shown on Figure 3, included in Appendix B.

5.3 Groundwater

Groundwater was not observed in the open boreholes. 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	pH	Sulphate (%)	Chloride (%)	Resistivity (Ohm-cm)
BH17-2	SS-3B	1.5 – 1.7	7.66	0.0616	0.0010	1,480

6.0 DISCUSSIONS AND RECOMMENDATIONS

6.1 General

This section of the report provides recommendations for the design of the proposed additions to two semi-detached homes located on Price Albert Street in Ottawa, Ontario. 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 properties are predominately leveled, in the backyards where the proposed development is expected the land was relatively flat with grass, was divided by chain-link fence and contained a variety of yard features such as raised garden beds and sheds. The surrounding area consisted of residential homes. 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 two-story with a raised basement, and will likely be a conventional slab on grade with shallow footing foundation.

The existing buildings which have a full basement, have an expected footing depth around 2.4 to 2.7 m. It is understood the proposed addition will only be a half basement with expected footing depth around 1.5 to 1.8

m, based on the approximate average surface elevation of the backyard of El. 61.9 in the footprint of the proposed building, footings are expected around El. 60.3 +/- 0.3 m.

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 E;

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

Sa(0.2)	Sa(0.5)	Sa(2.0)	PGA	PGV
0.163	0.089	0.021	0.103	0.068

The above notes spectral responses are for reference only and it may not indicate the critical spectrum for the proposed structure. The structural engineer shall consider deriving design specific spectral responses. The PGA for 2% probability of exceedance in 50 years is 0.284 g.

The site can be classified as a Site Class “D” based on the clay consistency 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.

All subgrades should be approved and proof-rolled under the supervision of a geotechnical representative prior to placement of the Granular “A” and slab-on-grade.

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.

The excavation should extend at a minimum of the top of the native till. 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. The depth of fill is expected to vary across the site, the fill within the influence zone of the footing (1H:1V) needs to be removed, and backfilled with engineered fill. The fill should be placed in horizontal lifts of uniform thickness of no more than 300 mm before compaction. It should be placed at appropriate moisture content and compacted to a 100% standard Proctor density. 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).

6.6.1 Bearing Capacity

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

Factored beading pressure at Ultimate Limit State (ULS): 250 kPa

Serviceability Limit State (SLS): 160 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 shown in the borehole logs and previously discussed, the native till as its current state slopes down towards the existing footing, which can be the result of sloped excavation for the construction of the existing structure. In order to reduce the risk of differential settlement, it is important that all footings are founded on the same till.

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

It is expected the footings for the new structure will be adjacent to the foundation wall of the existing structure. An average vertical stress distribution factor of 0.9 can be used for the soil elements beneath the footing and a at rest earth pressure coefficient of 0.5 can be used for estimation of lateral loading on the existing foundation wall induced by the footing load. Care should be taken to not undermine the existing footings during excavation.

7.0 CONSTRUCTION CONSIDERATIONS

Any organic material and existing fill material of any kind, should be removed from the footprint of the footings and all structurally load bearing elements. If grade raise above the native till subgrade is required suitable fill material to conform to specifications of OPSS Granular criteria shall be used. The Structural Fill, if directly supporting the load of the structure, should be free from any recycled or deleterious material, it should not be placed in lifts thicker than 300 mm and should be compacted to 100% Standard Proctor Maximum Dry Density (SPMDD).

The founding level is expected above the groundwater level encountered at this site and no dewatering problems are anticipated. However, the excavated subgrade must be kept dry at all time to minimize the disturbance of the subgrade. Groundwater elevation is expected to fluctuate seasonally.

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 of 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. Since the native subgrade contains fine grain, it is recommended to separate the subgrade from the bedding material by a layer of geotextile to prevent cross migration of materials. 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

A soil sample 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. 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.

Mary-Ellen Gleeson, M.Eng., EIT.
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.

208-214 PRINCE ALBERT ST

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.

208-214 PRINCE ALBERT ST

APPENDIX B
FIGURES

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LEGEND

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

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2017.

CLIENT: OTTAWA COMMUNITY HOUSING CORP.

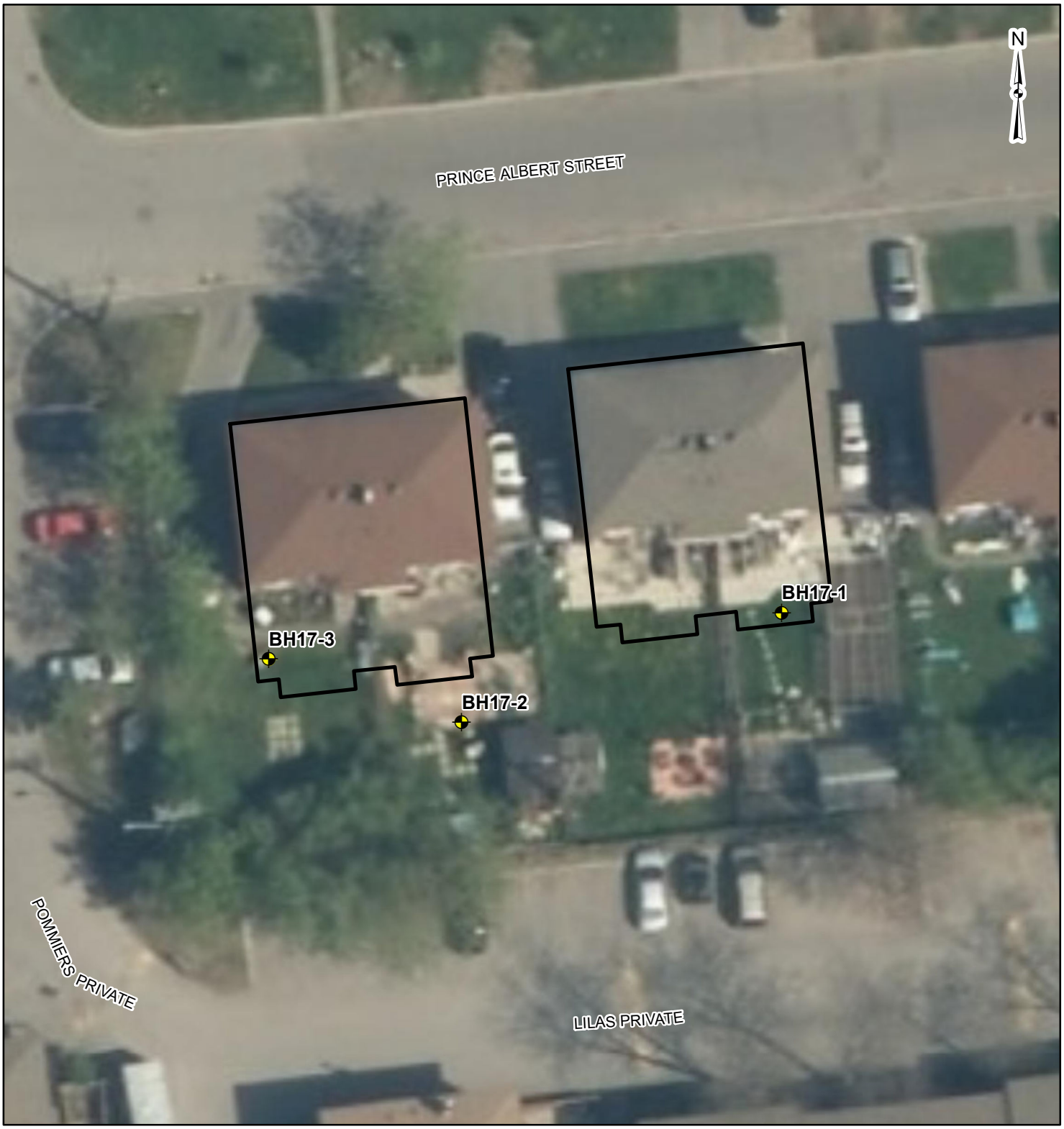
PROJECT: GEOTECHNICAL INVESTIGATION
208 AND 212 PRINCE ALBERT ST.

TITLE: SITE LOCATION

McINTOSH PERRY
115 Walgreen Road, RR3, Carp, ON K0A1L0
Tel: 613-836-2184 Fax: 613-836-3742
www.mcintoshperry.com

PROJECT NO:	CP-17-0395
Date	Dec., 06, 2017
GIS	JD
Checked By	JB

FIGURE: 1



10 5 0 10

Scale 1:300 Metres

LEGEND

- Borehole Location
- Proposed Building Footprint

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2017.

CLIENT: OTTAWA COMMUNITY HOUSING CORP.

PROJECT: GEOTECHNICAL INVESTIGATION
208 AND 212 PRINCE ALBERT ST.

TITLE: BOREHOLE LOCATIONS

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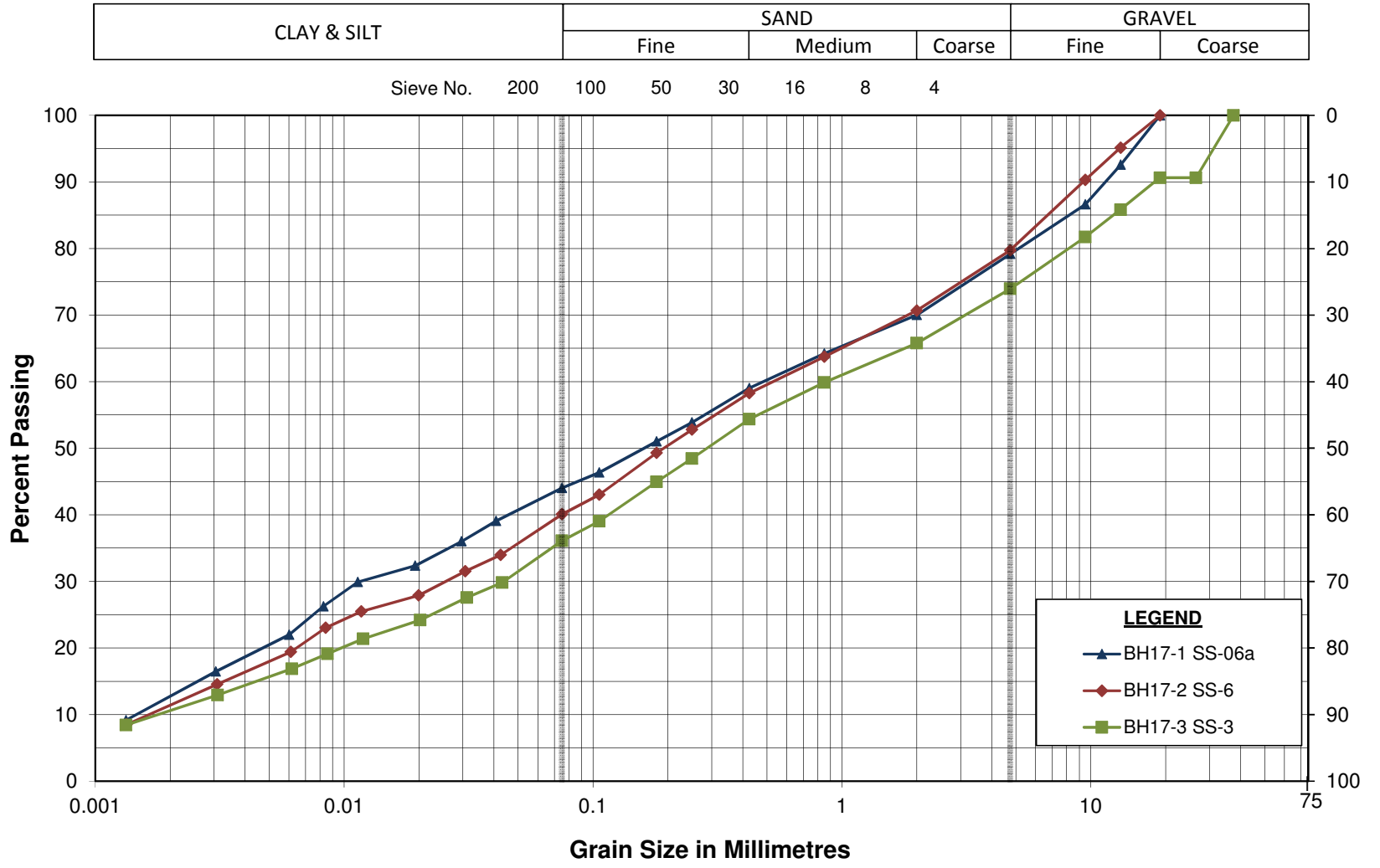
PROJECT NO:	CP-17-0395
Date	Dec., 14, 2017
GIS	JD
Checked By	MG

FIGURE: 2

Unified Soil Classification System

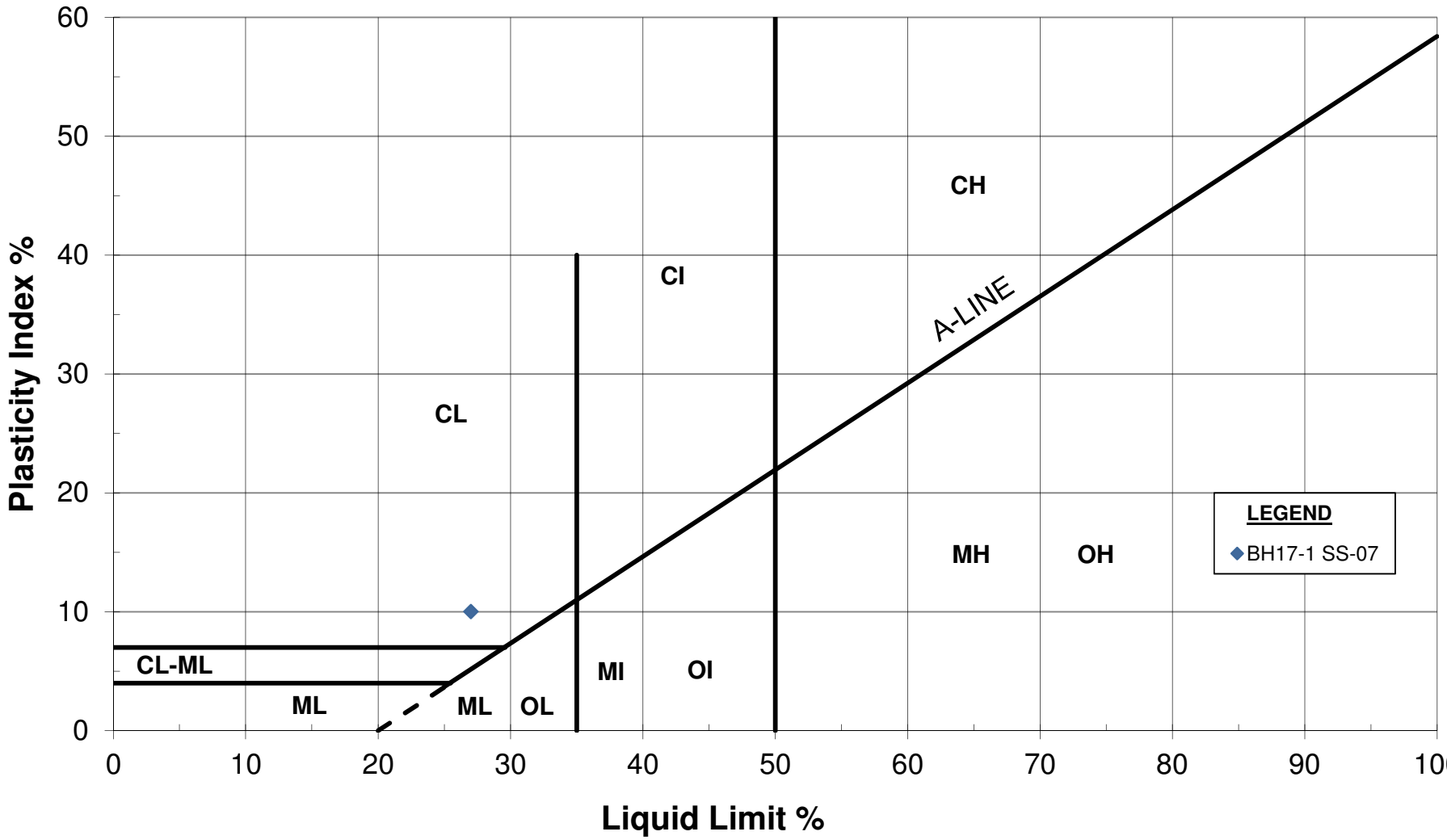


McINTOSH PERRY

Grain Size Distribution
SILTY and GRAVELLY SAND - TILL
208-214 Prince Albert St

Figure No. 3

CM-17-0395



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PLASTICITY CHART

TILL - Fines Content

208-212 Prince Albert St

Figure No. 4

0CP-17-0395

208-214 PRINCE ALBERT ST

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 17-1

DATE:	27/11/2017 -	**LOCATION:**	208 - 214 Prince Albert St ()	**ORIGINATED BY:**	Phil Hulan
ID:	CP-17-0395	**COORDINATES:**	Lat: 45.424161 , Lon: -75.65421	**COMPILED BY:**	Mary-Ellen Gleeson
CLIENT:	Ottawa Community Housing	**DATUM:**	Geodetic	**CHECKED BY:**	N'eem Tavakkoli
ELEVATION:	61.9 m	**REMARK:**	No water observed. Protable 1/3 weight hammer.	**REPORT DATE:**	12/12/2017

DEPTH - feet	DEPTH - meters	SOIL PROFILE: 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 (%) G S M C
		61.9	Natural ground surface									
		0.0 / 61.7	Topsoil. Black earth. Presence of organic matter.									
		0.2	Fill : Sandy and gravelly to some gravel, silt, traces of clay, brown, loose to compact.		SS-01		17	6				
					SS-02		4	10				
5	1				SS-03		17	35				
	2				SS-04		17	9				
					SS-05		50	14				
		59.0 / 2.9	Silty and gravelly sand, some clay, grey to brown, moist, firm to stiff (TILL).									
10	3		- sample wet		SS-06		83	14				21 35 32 12
					SS-07		67	59				
	4	57.6 / 4.3	**END OF BOREHOLE** **SPT sample refusal on probable bedrock.**		SS-08							
15	5											

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 17-2

DATE:	28/11/2017 -	**LOCATION:**	208 - 214 Prince Albert St ()	**ORIGINATED BY:**	Phil Hulan
ID:	CP-17-0395	**COORDINATES:**	Lat: 45.424108 , Lon: -75.654436	**COMPILED BY:**	Mary-Ellen Gleeson
CLIENT:	Ottawa Community Housing	**DATUM:**	Geodetic	**CHECKED BY:**	N'eem Tavakkoli
ELEVATION:	61.7 m	**REMARK:**	No water observed. Portable tripod used.	**REPORT DATE:**	12/12/2017

DEPTH - feet	DEPTH - meters	SOIL PROFILE: 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 (%)
		61.7	Natural ground surface									
		0.0 / 61.5	Topsoil. Black earth.									
		0.2 / 61.2	Silty sand, some gravel, brown to light brown, moist, compact.		SS-01		28	10				
		0.5	Fill : Silty and sandy clay, some gravel, brown, moist, stiff. Presence of debris (wood/brick/glass).		SS-02		8	17				
5	1	60.2										
		1.5	Silty and gravelly sand, some clay, dark grey, moist, very stiff (TILL).		SS-03		67	15				
	2				SS-04		42	12				
					SS-05		54	15				
10	3				SS-06		79	70				20 40 29 11
		57.9			SS-07		2					
		3.8	**END OF BOREHOLE** **SPT sample refusal on probable bedrock.**									
15	4											
	5											

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

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

McINTOSH PERRY

RECORD OF BOREHOLE No 17-3

DATE:	28/11/2017 -	**LOCATION:**	208 - 214 Prince Albert St ()	**ORIGINATED BY:**	Phil Hulan
ID:	CP-17-0395	**COORDINATES:**	Lat: 45.424141 , Lon: -75.654572	**COMPILED BY:**	Mary-Ellen Gleeson
CLIENT:	Ottawa Community Housing	**DATUM:**	Geodetic	**CHECKED BY:**	N'eem Tavakkoli
ELEVATION:	61.9 m	**REMARK:**	No water observed. Portable tripod used.	**REPORT DATE:**	12/12/2017

DEPTH - feet	DEPTH - meters	ELEVATION - m / DEPTH - m	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 (%)
		61.9	Natural ground surface									
		0.0 / 61.7	Topsoil. Black earth.									
		0.2 / 61.1	Fill : Sandy silt, some gravel, brown, moist, stiff.		SS-01		17	6				
		0.8 / 60.8	Fill : Sand, traces of clay and silt, grey, moist, loose.		SS-02		42	10				
	1	1.1 / 60.5	Fill : Silty clay, some sand, traces of gravel, black to light brown, moist, stiff.									
5		1.4	Silty and gravelly sand, some clay, dark grey, moist, dense (TILL).		SS-03		67	26				G 26 S 38 M 26 C 10
	2				SS-04		54	46				
					SS-05		67	32				
10	3				SS-06		94	74				
		58.4 / 3.5	**END OF BOREHOLE** **SPT sample refusal on probable bedrock.**									
15	4											
	5											

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

208-214 PRINCE ALBERT ST

APPENDIX D
LAB RESULTS

McINTOSH PERRY

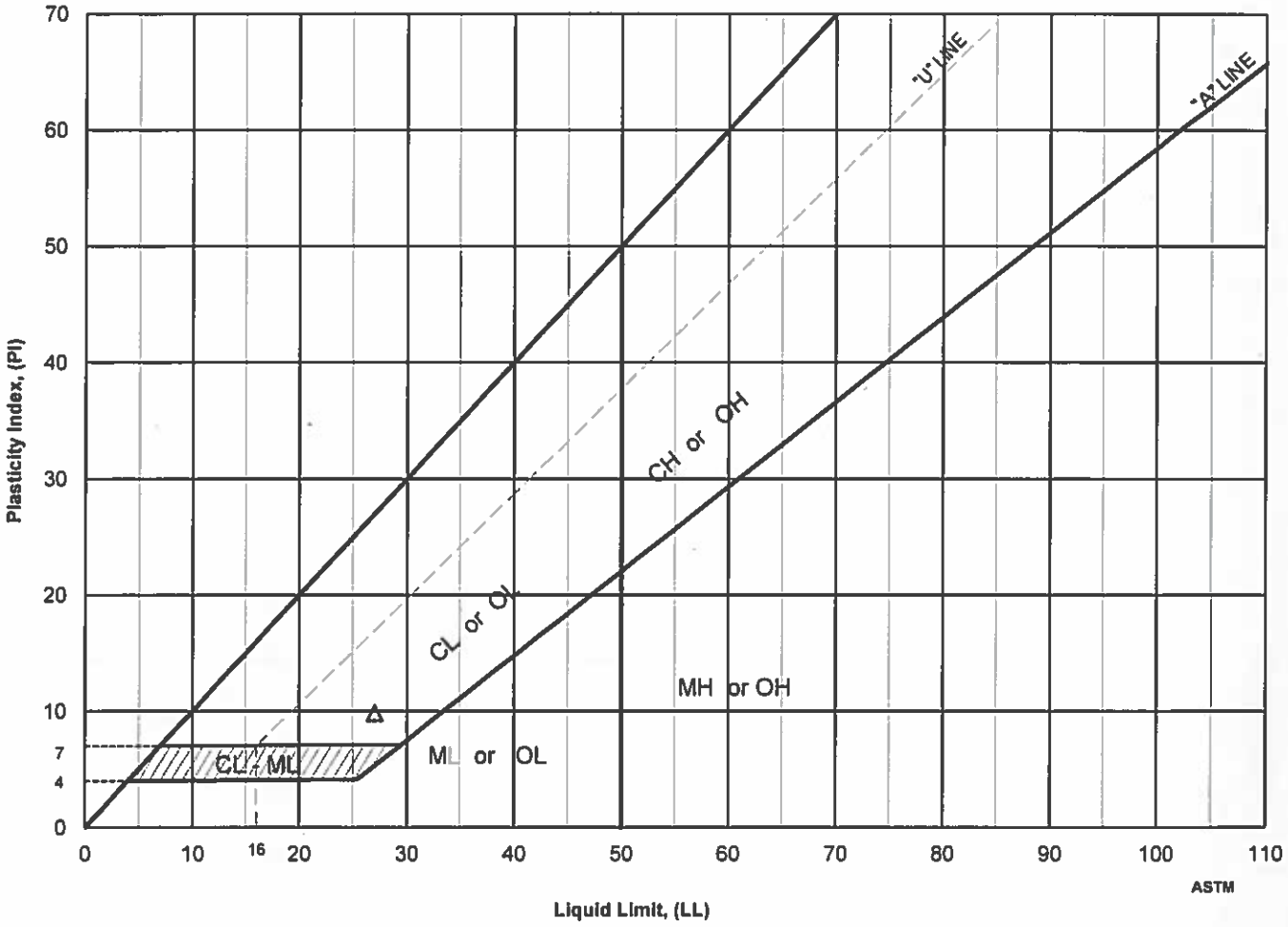
LRL Associates Ltd.

PLASTICITY INDEX

ASTM D 4318 / LS-703/704

Client:	McIntosh Perry Consulting Engineers	**Reference No.:**	CP-17-0395
Project:	Materials Testing	**File No.:**	170496-15
Location:	Prince Albert	**Report No.:**	1

Plasticity Chart



	Location	Sample	Depth, m	Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Activity Number	USCS
△	BH 17-1	SA-07	3.66 - 4.11	19	27	17	10	0.22	n/d	CL

Date Issued: December 7, 2017

Reviewed By: W.A.McLaughlin

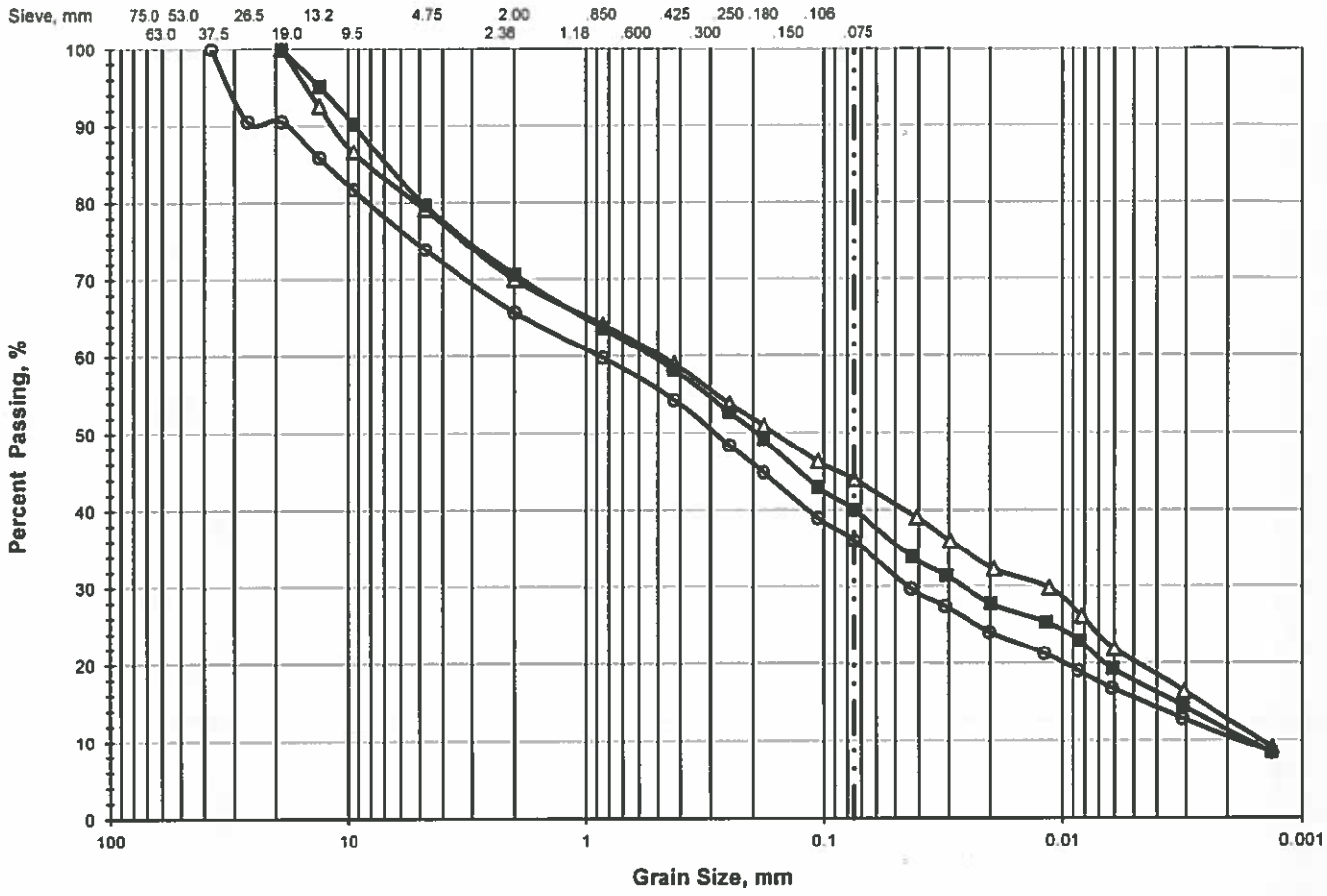
W.A.McLaughlin, Geo.Tech., C.Tech.

LRL Associates Ltd.

PARTICLE SIZE ANALYSIS

ASTM D 422 / LS-702

Client:	McIntosh Perry Consulting Engineers	**Reference No.:**	CP-17-0395
Project:	Materials Testing	**File No.:**	170496-15
Location:	Prince Albert	**Report No.:**	2



Unified Soil Classification System

	> 75 mm	% GRAVEL		% SAND			% FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
△	0.0	0.0	20.8	9.2	11.0	15.0	32.0	12.0
■	0.0	0.0	20.3	9.1	12.4	18.2	29.3	10.8
O	0.0	9.4	16.7	8.2	11.4	18.3	26.0	10.2

	Location	Sample	Depth, m	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
△	BH 17-1	SS-06a	3.05 - 3.48	0.5056	0.1637	0.0116	0.0027	0.0015	0.2	337.1
■	BH 17-2	SS-6	3.05 - 3.66	0.5600	0.1944	0.0261	0.0034	0.0018	0.7	311.1
O	BH 17-3	SS-3	1.35 - 1.83	0.8777	0.2957	0.0440	0.0047	0.0019	1.2	461.9

Date Issued: December 7, 2017

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:
Project: CP-17-0395
Custody: 34141

Report Date: 11-Dec-2017
Order Date: 5-Dec-2017

Order #: 1749145

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

Paracel ID	Client ID
1749145-01	CP-17-0395-BH17-2/SS-3b

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO:

Report Date: 11-Dec-2017
Order Date: 5-Dec-2017
Project Description: CP-17-0395

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	6-Dec-17	6-Dec-17
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	6-Dec-17	6-Dec-17
Resistivity	EPA 120.1 - probe, water extraction	11-Dec-17	11-Dec-17
Solids, %	Gravimetric, calculation	7-Dec-17	7-Dec-17

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO:

Report Date: 11-Dec-2017
Order Date: 5-Dec-2017
Project Description: CP-17-0395

	Client ID:	CP-17-0395-BH17-2/SS-3b	-	-	-
	Sample Date:	28-Nov-17	-	-	-
	Sample ID:	1749145-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	89.2	-	-	-
General Inorganics					
pH	0.05 pH Units	7.66	-	-	-
Resistivity	0.10 Ohm.m	14.8	-	-	-
Anions					
Chloride	5 ug/g dry	10	-	-	-
Sulphate	5 ug/g dry	616	-	-	-

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO:

Report Date: 11-Dec-2017
Order Date: 5-Dec-2017
Project Description: CP-17-0395

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						

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	189	5	ug/g dry	194			2.8	20	
Sulphate	562	5	ug/g dry	578			2.8	20	
General Inorganics									
pH	7.66	0.05	pH Units	7.67			0.1	10	
Resistivity	8.02	0.10	Ohm.m	8.06			0.6	20	
Physical Characteristics									
% Solids	89.7	0.1	% by Wt.	87.7			2.3	25	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	298	5	ug/g	194	104	78-113			
Sulphate	670	5	ug/g	578	91.8	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.

208-214 PRINCE ALBERT ST

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

December 13, 2017

Site: 45.4241 N, 75.6543 W User File Reference: Prince Albert St

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)**
0.453	0.530	**0.444**	0.337	**0.239**	**0.119**	**0.056**	**0.015**	**0.0054**	**0.284**	**0.198**

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)	0.045	0.150	0.251
Sa(0.1)	0.061	0.189	0.304
Sa(0.2)	0.055	0.163	0.258
Sa(0.3)	0.044	0.125	0.197
Sa(0.5)	0.031	0.089	0.140
Sa(1.0)	0.015	0.045	0.070
Sa(2.0)	0.0061	0.021	0.033
Sa(5.0)	0.0012	0.0047	0.0081
Sa(10.0)	0.0006	0.0019	0.0032
PGA	0.033	0.103	0.165
PGV	0.021	0.068	0.112

References

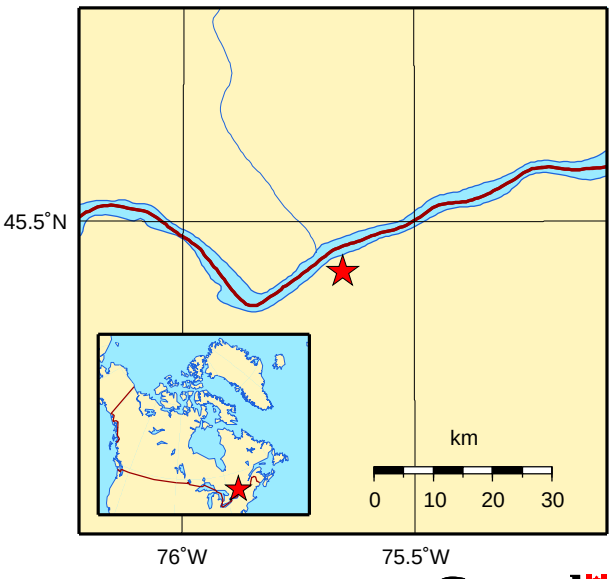
National Building Code of Canada 2015 NRCC no. 56190;
Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

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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