Stantec Consulting Ltd.
300W – 675 Cochrane Drive, Markham, ON L3R 0B8

May 24, 2016
File: 160622334

Reference: Geotechnical Investigation
Rouge National Urban Park
19th Avenue at Ninth Line, Markham, ON

INTRODUCTION

Stantec Consulting Ltd. at the request of Parks Canada has carried out a Geotechnical Investigation to support the design for new temporary facility for Parks Canada to improve the accessibility and visitor experience within this new federal urban park.

The new temporary facilities will include washrooms, lookout platform, retaining walls and parking area, at the Northern Welcome Area of the Rouge National Urban Park which is located on 19th Avenue east of Ninth Line in Markham

This letter outlines the results and recommendations of the geotechnical investigation undertaken at the location of the Northern Welcome Area of the Rouge National Urban Park for the proposed facility. Limitations associated with this report and its contents are provided in the statement included in **Appendix A**.

SCOPE OF WORK

The scope of work for the Geotechnical Investigation at this site was as follows:

- Advance two (2) boreholes in the vicinity of the proposed structures and parking area to a depth of 3 m;
- Record the soil conditions encountered in the boreholes;
- Record the groundwater level (where present) in the open boreholes;
- Supplement the field information with a geotechnical laboratory testing program to provide geotechnical characterization of the soils encountered; and
- Provide geotechnical parameters and recommendations for the proposed development.

METHOD OF INVESTIGATION

FIELD INVESTIGATION

Prior to commencing the field investigation, the borehole locations were established in the field by Stantec personnel. The approximate locations of the boreholes are shown in the Landscape Plan in **Appendix B**.

Prior to commencing the field investigation, Stantec obtained public utility locates through the Ontario One Call system. Stantec also retained the services of a utility locate company, On-site

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locates, to provide private utility locate services to identify any traceable underground plants not identified by the public locates.

The geotechnical fieldwork component of the investigation was carried out on March 30, 2016. The boreholes were advanced using a Comacchio Geo 205 track mounted drill rig equipped with 200 mm hollow-stem augers. Stantec field personnel recorded the conditions encountered in the boreholes. Soil samples were recovered at regular intervals using 50-mm (outside diameter) split-tube sampler by conducting Standard Penetration Tests (SPTs) in accordance with the procedures outlined in ASTM specification D1586. All soil samples recovered from the boreholes were placed in moisture-proof bags and returned to our laboratory for geotechnical classification with a number of samples being selected for geotechnical laboratory testing.

The groundwater conditions were recorded in the open boreholes on completion of drilling.

Upon completion of drilling, the boreholes were backfilled with bentonite grout in accordance with the MOECC Regulation 903.

SURVEY

The ground surface elevation at the borehole locations was interpolated from topographic maps provided to Stantec. The ground surface elevation at the borehole location is shown on the Borehole Records Sheets Record provided in **Appendix C**.

LABORATORY TESTING

All soil samples returned to the laboratory were subjected to detailed visual examination and classification.

Grain size distribution and moisture content tests, were conducted on representative samples of the soils obtained from the investigation. Samples were selected for analysis that included the following:

- Grain size distribution with hydrometer 1
- Natural Moisture Content 5

The results of the laboratory tests are discussed in the text of this report and are provided on the Borehole Records in **Appendix C**. Figures illustrating the results of the grain size distribution tests and Atterberg Limits tests are included in **Appendix D**.

Unless specific instructions are received to the contrary, the samples will be discarded one month after issue of this report.

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RESULTS OF INVESTIGATION

SUBSURFACE CONDITIONS

The subsurface conditions encountered in the boreholes are provided on the Borehole Records in **Appendix C**. An explanation of the symbols and terms used in the Borehole Records is included in **Appendix C** for reference.

It should be noted that the stratigraphic boundaries shown on the borehole logs are inferred from non-continuous sampling and should be considered approximate only.

The subsurface stratigraphy in borehole BH1, generally consists of topsoil underlain by compact to very dense brown sand and in borehole BH2 the stratigraphy consists of a topsoil layer underlain by compact to dense silty sand till, over brown dense silty sand.

Bedrock was not encountered in the boreholes advanced to the maximum investigated depth of 3.7 m below existing grade.

Both boreholes remained dry and open upon competition of the drilling.

A summary of the soil and groundwater conditions encountered in the boreholes is provided below.

GROUND SURFACE COVER

The ground surface cover at the borehole locations consisted of grass with underlying topsoil. The thickness of the topsoil was approximately 0.3 m.

SILTY SAND TILL

A stratum of silty sand till was encountered underlying the topsoil in borehole BH2. The silty sand till typically contained trace to some clay and trace gravel. The silty sand till was interbedded with occasional sand and silt seams. This stratum extended to a depth of 2.9 m below existing grade.

Based on the SPT tests conducted (N-values ranged from 10 blows to 39), this soil was assessed as compact to dense.

Based on visual and textural examination, the silty sand till was assessed as moist. The results of the moisture content tests conducted on samples of the silty sand till ranged from 7% to 12%.

One grain size distribution test was completed on a sample of the silty sand till. The results of the test were as follows:

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Table 4.1: Grain Size Distribution – Silty Sand Till

Borehole	Sample	Depth (m)	Description	% Gravel	% Sand	% Silt	% Clay
BH2	SS3	1.8	Silty SAND (SM), TILL	2	61	37	

The results of the grain size distribution tests are shown on the Borehole Record sheet included in **Appendix C** and on Figure 1 in **Appendix D**.

In accordance with the Unified Soil Classification System, the sample tested can be classified as Silty Sand Till.

SILTY SAND TO SAND

A stratum of silty sand to sand was encountered in both boreholes. In borehole BH1, this stratum was found directly underlying the topsoil and in the borehole BH2 this stratum was found underlying the silty sand till layer. The silty sand contained trace to some clay and trace gravel.

The N-values obtained from the SPTs in the silty sand to sand ranged from 18 to 57. Based on these values, the soil was assessed as compact to very dense.

Based on visual and textural examination, the samples of the silty sand to sand were assessed as moist.

GROUNDWATER

Both boreholes remained dry and open upon competition of the drilling.

DISCUSSION AND RECOMMENDATIONS

The subsurface stratigraphy in borehole BH1, generally consists of topsoil underlain by compact to very dense brown sand and in borehole BH2 the stratigraphy consists of a topsoil layer underlain by compact to dense silty sand till, over brown dense silty sand.

Both boreholes remained dry and open upon competition of the drilling.

SITE PREPARATION / GRADING AND EARTHWORKS

It is anticipated that only minor site preparation activities may be required and cut and fill earthworks will be limited, as minimal infrastructure is to be constructed on the site for the

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proposed washroom, lookout platform and parking area. A retaining wall will be required for the proposed platform located at the northeast corner of the property.

Prior to grading and/or cut and fill earthworks operations, all vegetation and topsoil and other non-suitable material should be stripped from the ground surface, and removed to an approved off-site location. These materials are suitable only for reuse in general landscaping. The thickness of the topsoil recorded in the boreholes was approximately 0.3 m.

The exposed subgrade surface should be proof rolled with a tandem truck or equivalent and inspected by qualified geotechnical personnel. Any soft or loose areas encountered during this process should be sub-excavated and replaced with approved on-site soils or imported material such as OPSS Granular B – Type I or OPSS Select Subgrade Material compacted to a minimum of 98% of the material's Standard Proctor Maximum Dry Density (SPMDD).

All materials placed as engineered fill should be placed in 200 mm thick loose lifts. Each lift should be uniformly compacted to achieve a minimum of 98% of the material's Standard Proctor Maximum Dry Density (SPMDD).

FLOOR SLAB

A conventional slab-on-grade can be used for the proposed washroom facility, provided that the subgrade is prepared in accordance with the recommendations provided herein.

It is recommended that a moisture break be installed prior to construction of the floor slab. The moisture break should consist of a 300 mm thick layer of OPSS Granular A compacted to a minimum of 100% of the materials SPMDD.

A modulus of subgrade reaction, ks, of 25 MN/m3 can be used for design of the floor slab at this site, provided that the construction is in accordance with the recommendations provided herein.

A perimeter drainage system will not be required, provided that the proposed finished floor is a minimum of 150 mm above the exterior grade and the ground surface around the perimeter of the washroom facility slopes down away from the facility.

Under floor drains will not be required for the planned structure.

RETAINING WALL AND LATERAL EARTH PRESSURE PARAMETERS

Lateral earth pressure parameters are provided below in Table 5-1. These parameters can be used in the design of the retaining wall.

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The table includes parameters for the use of OPSS Granular B Type I fill which is recommended to be used behind the walls to provide drainage. In addition, we have included values for the native silty sand till and sand to silty sand soil. These values are provided for consideration in the overall external stability analysis of any walls.

Table 5-1 Un-factored Lateral Earth Pressure Parameters

Parameters	Granular Fill (OPSS Granular B type I)	Granular Fill (OPSS Granular A)	Native Silty Sand Till	Compact to Dense native Sand to Silty Sand	Dense native Sand to Silty Sand
Bulk Unit Weight (kN/m3)	21	21	21	21	21
Angle of Internal Friction (degrees)	32	30	28	30	32
Coefficient of Active Earth Pressure, ka	0.31	0.33	0.36	0.33	0.31
Coefficient of Passive Earth Pressure, kp	3.3	3.0	2.8	3.0	3.3
Coefficient of Earth Pressure at Rest, ko	0.47	0.5	0.53	0.5	0.47

The backfill material behind the walls should consist of free draining granular materials such as OPSS Granular A or OPSS Granular B and be connected to a drainage system at the base of the wall (lowest elevation). The drainage system should be provided with a frost-free outlet with positive drainage.

The granular backfilling materials should be placed in 200 mm (8 inches) thick lift and compacted to 100% Standard Proctor Maximum Dry Density (SPMDD)

At the time of the investigation the type and design of the proposed platform associated with retaining wall had not been finalized.

The proposed retaining wall can be constructed with a recommended bearing resistance at Ultimate Limit State (ULS) and Serviceability Limit State (SLS) of 300 kPa and 200 kPa respectively to be founded on the compact to dense silty sand till or compact to very dense sand at depths of 1.5 m below existing grade.

It is recommended that 1.2 m of soil cover be provided for adequate frost protection.

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EXCAVATIONS

Temporary excavations for the proposed development must be carried out in accordance with the latest edition of the Occupational Health and Safety Act (OHSA).

The existing silty sand till should be considered a Type 2 soil. The maximum excavation side slope for a Type 2 soil is 1:1 (Horizontal: Vertical) in accordance with the OHSA regulation, with a maximum vertical cut of 1.2 m at the base of the excavation.

The compact sand and compact silty sand till should be considered a Type 3 soil. The maximum excavation side slope for a Type 3 soil is 1:1 (Horizontal: Vertical) from the base of the excavation in accordance with the OHSA.

Based on the information revealed during the investigation, it is considered that conventional sump pumping should be applicable to control localized seepage that may occur from precipitation, perched water in sand materials during the excavation for the proposed development.

Excavation side slopes should be protected from exposure to precipitation and associated ground surface runoff and should be inspected regularly for signs of instability. If localized instability is noted during excavation or if wet conditions are encountered, the side slopes should be flattened as required to maintain safe working conditions.

BACKFILL

The existing sand or approved imported soil can be used as backfill materials with moisture contents within 2% of their optimum moisture content based on the Standard Proctor moisture-density relationship tests

All backfill should be placed in 200 mm thick loose lifts and compacted to a minimum of 98% SPMDD.

All backfill and compaction operations should be monitored to verify that the specified degree of compaction is being achieved uniformly.

Backfill adjacent to the retaining walls should consist of free-draining, non-frost susceptible granular materials, such as OPSS Granular 'B'.

Where potential for adverse frost conditions exist, it is recommended that the implementation of supplementary drainage and frost protection be considered.

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ASPHALT PAVEMENTS

It is anticipated that asphalt pavement will be required for the driveway and parking area.

The asphalt pavement structures provided below can be considered for use at this site.

Table 5-2: Recommended Asphalt Pavement Structures

Material	Standard Duty	Heavy Duty	Compaction Requirements
HL3 (surface course asphalt)	60 mm	40 mm	95 % MTRD
HL8 (base course asphalt)	--	50 mm	95 % MTRD
OPSS Granular 'A' Base	150 mm	150 mm	100 % SPMDD
OPSS Granular 'B' Sub-base	200 mm	300 mm	100 % SPMDD

In preparation for construction of new pavements, the finished sub-grade surface should be proof-rolled and compacted to identify the presence of soft, wet, or deflecting areas; such areas should be removed and replaced with approved engineered fill compacted to a minimum of 98% SPMDD.

The base and sub-base materials should be compacted to a minimum of 100% SPMDD. The asphaltic concrete should be compacted to a minimum of 95% Bulk Relative Density (BRD).

SEISMIC

The seismic site class determination is based on the soil conditions in the upper 30 m of the stratigraphy as encountered in the boreholes for the Preliminary Geotechnical Investigation. For the purposes of this report, the weighted average N-value method has been used to assess the Seismic Site Classification for this project location, consistent with the second of three methods stated in the National Building Code (2005).

The following stratigraphic profile and respective N-values were considered for purposes of assessing the Seismic Site Classification:

- Layer 1 – Thickness of 1.2 m
  Average N = 17 (Silty Sand Till)

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- Layer 2 – Thickness of 1.8 m – 3.3 m (+)
  Average N = 40 (Sand to Silty Sand

Based on the profile described above, a weighted average N-value of 34 was calculated. Therefore, in accordance with the Ontario Building Code (2012), Seismic Site Class 'C' can be used for design.

A copy of the NBC Seismic Hazard Calculation Data sheet is provided in **Appendix E**.

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CLOSURE

Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of Parks Canada who is identified as "the Client" within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec Consulting Ltd. should any these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report;
- Basis of the report;
- Standard of care;
- Interpretation of site conditions;
- Varying or unexpected site conditions; and,
- Planning, design or construction.

Should you have any questions, please do not hesitate to contact the undersigned.

Respectfully Submitted,

STANTEC CONSULTING LTD.

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Attachment: Appendix A – Statement of General Conditions
Appendix B – Landscape Plan
Appendix C – Borehole Records
Appendix D – Geotechnical Laboratory Test Results
Appendix E – Seismic Hazard Calculation Sheet

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STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

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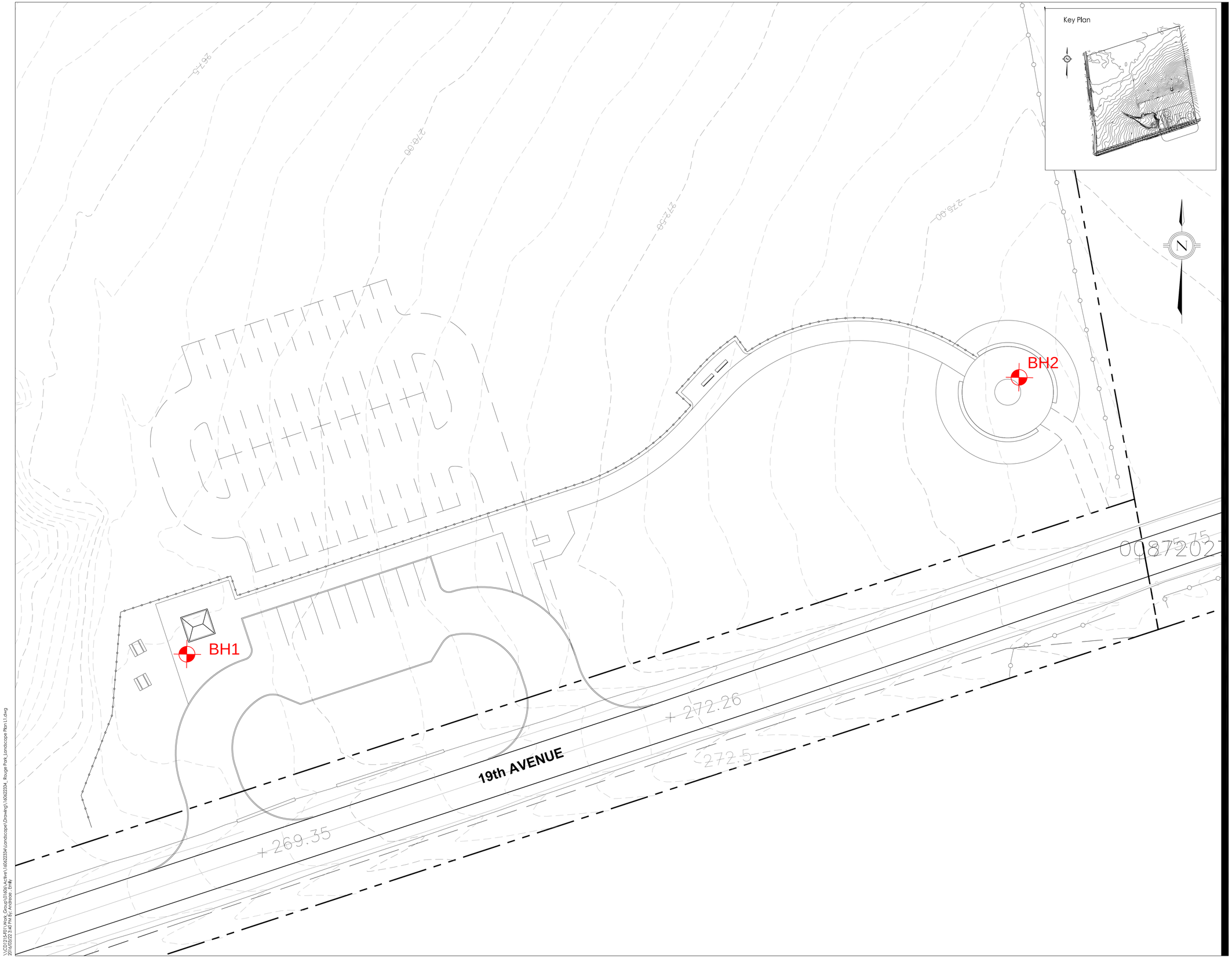
INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or sub-surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.



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Consultants

Legend

Revision	By	Appd.	YY.MM.DD

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File Name: Dwn. Chkd. Dsgn. YY.MM.DD

Permit-Seal

Client/Project

PARKS CANADA

ROUGE NATIONAL URBAN PARK
NORTHERN WELCOME AREA
Markham, Ontario

Title

LANDSCAPE PLAN

Project No. 160622334

Scale 1:250 0 2.5 7.5 12.5m

Drawing No. L1

Sheet of

Revision

Stantec

BOREHOLE RECORD

BH1

CLIENT PARKS CANADA PROJECT No. 160622334

LOCATION North Welcome Center, Markham, Ontario DATUM

DATES: BORING March 30, 2016 WATER LEVEL TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	269.2				0				
	268.9	300 mm TOPSOIL			1	SS	1	360/610	2
		Compact to very dense, brown SAND (SP-SM) - occasional sandy silt layers - trace clay and gravel - moist			2				
1					3	SS	2	530/610	18
					4				
					5				
2					6	SS	3	580/610	30
					7				
					8	SS	4	610/610	51
					9				
3					10				
					11	SS	5	610/610	57
	265.5				12				
		END OF BOREHOLE at approximately 3.7 m below grade. Borehole dry upon completion of drilling. Cave in noted at 2.6 m (8.5 ft).			13				
4					14				
					15				
					16				
5					17				
					18				
					19				
6					20				
					21				
					22				
7					23				
					24				
					25				
8					26				
					27				
					28				
9					29				
					30				
					31				
10					32				

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test, kPa

■ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

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BOREHOLE RECORD

BH2

CLIENT PARKS CANADA PROJECT No. 160622334

LOCATION North Welcome Center, Markham, Ontario DATUM

DATES: BORING March 30, 2016 WATER LEVEL TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	**275.8**				0				
	275.5	300 mm TOPSOIL			1	SS	1	560/610	6
		Compact to dense brown silty SAND (SM) TILL - trace to some clay - trace gravel - occasional sand and silt seams - moist			2				
1					3	SS	2	580/610	10
					4				
					5				
2					6	SS	3	510/610	24
					7				
					8	SS	4	580/610	39
	272.9				9				
3		Dense, brown silty SAND (SP) - trace to some clay - moist			10				
	272.1	- moist to dry			11	SS	5	610/610	47
		END OF BOREHOLE at approximately 3.7 m below ground surface Borehole dry and open upon completion of drilling.			12				
4					13				
					14				
					15				
5					16				
					17				
					18				
6					19				
					20				
					21				
					22				
7					23				
					24				
					25				
					26				
8					27				
					28				
					29				
9					30				
					31				
					32				
10									

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90 100

REMARKS & GRAIN SIZE DISTRIBUTION (%)

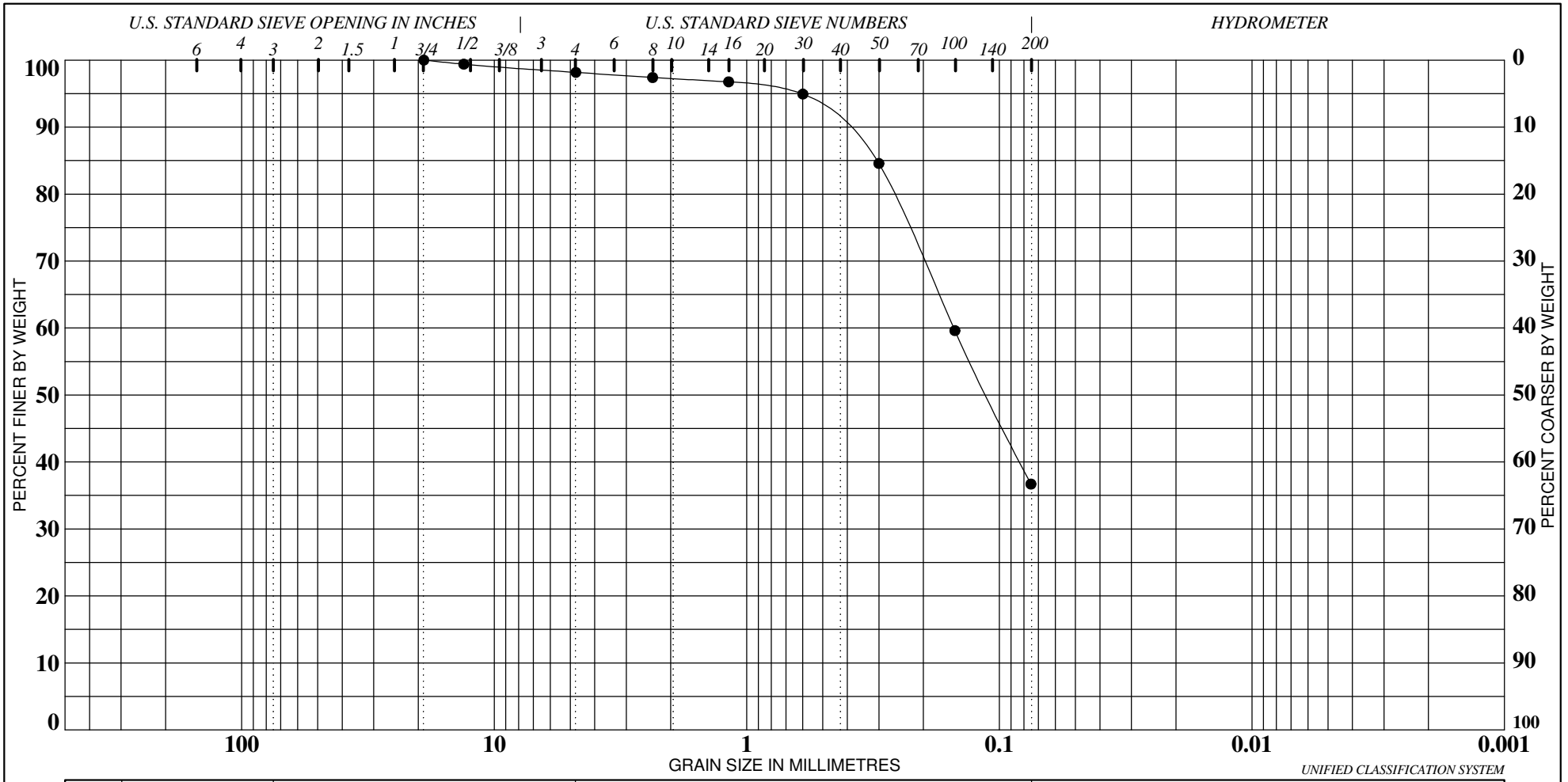
GR SA SI CL

2 61 37

□ Field Vane Test, kPa

■ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa



BLDs	COBBLES	GRAVEL		SAND			SILT & CLAY	
		coarse	fine	coarse	medium	fine	SILT	CLAY

Sample	Depth (m)	Description	W%	W_L	W_P	I_P	%Gravel	%Sand	%Silt	%Clay
● BH2	1.8	Silty SAND (SM) TILL	12				2	61	37	

Stantec

Project: Parks Canada - North Welcome Center
Location: Markham, Ontario
Project No.: 160622334

GRADATION CURVE (ASTM D422)

Figure: 1
Remarks:

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 29, 2016

Site: 43.7296 N, 79.2978 W User File Reference:

Requested by: ,

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)**
0.232	0.279	**0.232**	0.174	**0.121**	**0.061**	**0.029**	**0.0070**	**0.0029**	**0.149**	**0.096**

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)	0.012	0.058	0.112
Sa(0.1)	0.019	0.079	0.143
Sa(0.2)	0.021	0.071	0.123
Sa(0.3)	0.018	0.057	0.095
Sa(0.5)	0.015	0.044	0.069
Sa(1.0)	0.0072	0.024	0.037
Sa(2.0)	0.0031	0.011	0.018
Sa(5.0)	0.0006	0.0025	0.0041
Sa(10.0)	0.0004	0.0011	0.0017
PGA	0.011	0.042	0.077
PGV	0.0089	0.032	0.054

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