Preliminary Geotechnical Investigation Report

103 & 107 Napier Street & 95 Cook Street, Barrie, Ontario

December 14, 2022

Prepared for:
2556055 Ontario Inc.

Cambium Reference: 14079-001

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1.0 Introduction

Cambium Inc. (Cambium) was retained by Innovative Planning Solutions Inc. (IPS) on behalf of 2556055 Ontario Inc. (Client) to complete a preliminary geotechnical investigation in support of a residential development at 103 & 107 Napier Street and 95 Cook Street, Barrie, Ontario (Site). Cambium understands that the proposed development consists of 35 townhouse units organized into six separate blocks with associated driveways, parking areas and utilities.

The purpose of the geotechnical investigation was to obtain information about the subsurface conditions to provide geotechnical design parameters as input into the design and construction of the proposed development. A Site Plan, including borehole locations, is included as Figure 1 of this report.

This report presents the methodology and findings of the geotechnical investigation to determine the subsurface soil and groundwater conditions and provide design recommendations. Based on the results of this investigation, the report provides geotechnical engineering recommendations pertaining to the proposed development including soil bearing capacity and foundation design, seismic site classification, excavation and dewatering, backfill and compaction, frost depth, sub-drainage, and pavement structure.

As part of Cambium's scope of work at the Site, a hydrogeological study report has been provided under a separate cover.

2.0 Site Description

The Site is located at the southeast of the corner of Cook Street and Napier Street in Barrie, Ontario. At the time of the investigation, the site was developed as two separate parcels which consisted of:

- *95 Cook Street:* an existing church, with associated parking areas on the west side of the property and a cleared area on the southeast side of the property.
- *103 Napier Street:* an existing dwelling with two sheds on the north side of the property and an open grassy area on the south side of the property.

Following completion of the investigation, an additional parcel was added to the development which consisted of:

- *107 Napier Street:* an existing dwelling with one shed on the south side of the property.

The ground elevation at the site was relatively flat, and the site is bordered by Cook Street to the west and by residential lots on all other sides. According to a Geological Survey of Ontario's Quaternary Geology the site contains deposits of till, which has a sandy silt to silt matrix, often high in total matrix carbonate content, and commonly rich in clasts.

3.0 Methodology

3.1 Borehole Investigation

A borehole investigation was conducted at the site on December 8, 2021, to assess subsurface conditions. Four boreholes were advanced at the predetermined locations agreed with IPS. Three of the boreholes were outfitted with monitoring wells and are designated as MW101-21, MW102-21, and MW104-21. The fourth borehole was designated as BH103-21. The boreholes were located within or in the immediate vicinity of the footprints of different townhouse blocks and are shown on Figure 1.

All boreholes were terminated at depths ranging from 6.2 to 6.6 meters below ground surface (mbgs) in native soils. The elevation of each borehole was determined relative to a site benchmark, the top of the northeast corner of the wooden retaining wall on the north side of the existing church, which was surveyed by Rudy Mak Surveying LTD. and was found to have an elevation of 270.13 metres above sea level (masl).

Drilling and sampling was completed using a track-mounted drill rig operating under the supervision of a Cambium geotechnical analyst. The boreholes were advanced to the sampling depths by means of continuous flight solid stem augers with 50 mm O.D. split spoon samplers. Standard Penetration Test (SPT) N values were recorded for the sampled intervals as the number of blows required to drive a split spoon sampler 305 mm into the soil, using a 63.5 kg drop hammer falling 750 mm, as per ASTM D1586 procedures. The SPT N values are used in this report to assess consistency of cohesive soils and relative density of non-cohesive materials. Soil samples were collected at approximately 0.75 m intervals up to a depth of 3.0 mbgs and at 1.5 m intervals thereafter. The encountered soil units were logged in the field using visual and tactile methods, and samples were placed in labelled plastic bags for transport, future reference, possible laboratory testing, and storage. Open boreholes were checked for groundwater and general stability prior to backfilling. The boreholes and monitoring wells were backfilled in accordance with O.Reg. 903, as amended and the Site was restored to pre-investigation conditions.

The prepared borehole logs are provided in Appendix A. Site soil and groundwater conditions and our geotechnical recommendations are presented in the following sections of this report.

3.2 Laboratory Testing

Laboratory soil testing included four Particle Size Distribution Analyses (LS 702) and twenty-nine Natural Moisture Content Analyses (LS 701). Results are presented in Appendix B, summarized on the borehole logs and described in the subsequent sections of this report.

4.0 Subsurface Conditions

The detailed soil profiles encountered in the boreholes are shown on the attached borehole logs in Appendix A. Conditions indicated on the borehole logs are for specific locations only and can vary between and beyond the borehole locations. The soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones and should not be interpreted as exact planes of geological change. In addition, the descriptions provided on the borehole logs are inferred from a variety of factors, including visual observations of the soil samples retrieved, laboratory testing, measurements prior to and after drilling, and the drilling process itself (drilling speed, shaking/grinding of the augers, etc.).

Based on the results of the borehole investigation, subsurface conditions at the Site generally consist of topsoil overlying a sand fill and transitioning native sand to silt soils, which extended to the termination depths. Bedrock was not encountered during this geotechnical investigation.

Assessments of organic matter content or other topsoil quality tests were beyond the scope of this study.

4.1 Topsoil

Topsoil with some organic content was encountered in three of the boreholes advanced throughout the site (MW101-21, MW102-21, and MW104-21). BH103-21 was advanced through the asphalt parking lot east of the existing church.

The topsoil consisted of a black silt with some sand and organics and was found to be up to 760 mm thick. At the time of the investigation the topsoil was found to be moist with a moisture content ranging from 21.8% to 22.9% based on laboratory analysis.

4.2 Fill Soils

Inferred fill soils were found underlying the topsoil in MW101-21 and beneath the asphalt in BH103-21. No soils identifiable as possible fill material were encountered within MW102-21 or MW104-21, which were advanced in grassy areas to the east and south of the parcel. Based

on a review of historic aerial imagery of the Site, no significant evidence of regrading or other development was found in the vicinity of MW102-21 and MW104-21.

The inferred fill soils consisted of a brown sand with some silt and trace organics in MW101-21 and a brown silt with some sand, and trace gravel in BH103-21. The fill soils ranged in thickness from 760 mm to 850 mm and extended to depths ranging from 0.9 mbgs to 1.5 mbgs. SPT N values for the fill ranged from 5 to 12 indicating a loose to compact relative density. The fill was found to be moist at the time of the investigation, with a natural moisture content ranging from 8.8% to 13.2%.

4.3 Sand to Silty Sand

Native sand to silty sand was encountered in all boreholes beginning at depths ranging from 0.8 mbgs to 1.5 mbgs. The sand to silty sand soils extended to the termination depths of all boreholes except MW102-21 and were found to contain varying amounts of gravel and clay. The sand to silty sand was found based on visual observations during drilling to range in moisture content from dry to wet at the time of the investigation, with a natural moisture content ranging from 1.3% to 14.2%.

SPT N values for the sand to silty sand soils ranged from 12 to 50 blows for 50 mm of penetration indicating a compact to very dense relative density. Below a depth of 1.5 mbgs, the SPT N values within this formation ranged from 33 to 50 blows, indicating a dense to very dense relative density below this depth.

A laboratory particle size distribution analysis was completed on two samples of this soil formation, taken from depths ranging from 1.5 mbgs to 3.5 mbgs in MW101-21 and MW104-21. The analysis results are provided in Appendix B and are summarized in Table 1 below based on the Unified Soil Classification System (USCS).

Table 1 Particle Size Distribution – Sand to Silty Sand

BH	Depth (mbgs)	Description	% Gravel	% Sand	% Silt	% Clay
MW101-21 SS3	1.5 – 2.0	Silty Sand trace Clay	0	70	27	3
MW104-21 SS5	3.0 – 3.5	Sand trace Silt trace Clay	0	88	9	3

4.4 Silt to Sandy Silt

A layer of silt was found underlying the native sand soils in MW102-21 and extended to the termination depth of 6.6 mbgs. The silt was found to contain some clay with traces of sand and gravel. The SPT N value for the silt was 50 indicating a dense relative density. The silt was found to be wet at the time of the investigation, with a natural moisture content of 17% based on laboratory testing.

In BH104-21, a layer of sandy silt with trace amounts of gravel and clay was encountered below the topsoil, between depths of approximately 0.8 mbgs and 1.5 mbgs. An SPT N value of 9 was recorded, which indicates a loose relative density. Based on the laboratory testing, this deposit was found to have a natural moisture content of 12.9%.

A laboratory particle size distribution analysis was completed on one sample of the silt soils taken from a depth of 6.0 mbgs m to 6.6 mbgs in MW102-21. The analysis results are provided in Appendix B and are summarized in Table 2.

Table 2 Particle Size Distribution – Silt to Sandy Silt

BH	Depth (mbgs)	Description	% Gravel	% Sand	% Silt	% Clay
MW102-21 SS7	6.1 – 6.6	Silt some Clay trace Sand trace Gravel	1	4	77	18

4.5 Clayey Silt

A layer of clayey silt was found embedded within the sand soils in BH103-21 at a depth of 2.3 mbgs, extending to approximately 3.0 mbgs. The clayey silt was found to contain some sand and trace gravel components.

The SPT N value for the clayey silt was 30 indicating a very stiff consistency. The clayey silt soil was found to be moist at the time of the investigation, with a natural moisture content of 16.8%.

A laboratory particle size distribution analysis was completed on one sample of the clayey silt soil taken from a depth of 2.3 mbgs to 2.7 mbgs in BH103-21. The analysis results are provided in Appendix B and are summarized in Table 3.

Table 3 Particle Size Distribution – Clayey Silt

BH	Depth (mbgs)	Description	% Gravel	% Sand	% Silt	% Clay
BH103-21 SS4	2.3 – 2.7	Clayey Silt some Sand trace Gravel	1	13	63	23

4.6 Bedrock

Bedrock was not encountered within the investigation depths. The termination depths of the boreholes ranged from 6.2 mbgs to 6.6 mbgs.

4.7 Groundwater

On drilling completion, unstabilized groundwater (free water) was not observed in any of the boreholes. BH103-21 was found to be open (no caving) upon completion. Monitoring wells were outfitted in boreholes MW101-21, MW102-21, and MW104-21 to monitor the static groundwater level and any seepage/upsurge after installation. The groundwater was measured and recorded in each monitoring well on December 20, 2021. The groundwater observations are summarized in Table 4.

The moisture content of the soils generally ranged from 1.3% to 22.9%, however, high moisture content readings in MW101-21, MW102-21, and MW104-21 are likely a result of organic material present in the topsoil layer. It should be noted that soil moisture and groundwater levels at the Site may fluctuate seasonally and in response to climatic events.

Table 4 Groundwater Observations

Well		MW101-21	MW102-21	MW104-21
Top of Pipe Elevation[2]		271.34	270.03	269.13
Ground Surface Elevation[2]		270.36	269.08	268.17
Stick-up (m)		0.98	0.95	0.96
December 20, 2021	Water Level[1]	Dry	5.40	5.19
	Groundwater Elevation[2]	-	263.68	262.98
January 27, 2022	Water Level[1]	Dry	5.75	5.27
	Groundwater Elevation[2]	-	263.33	262.93
February 18, 2022	Water Level[1]	Dry	5.93	5.24
	Groundwater Elevation[2]	-	263.15	262.93
March 21, 2022	Water Level[1]	Dry	5.77	5.22
	Groundwater Elevation[2]	-	263.15	262.95
April 21, 2022	Water Level[1]	Dry	5.58	5.19
	Groundwater Elevation[2]	-	263.50	262.98
May 16, 2022	Water Level[1]	Dry	5.63	5.12
	Groundwater Elevation[2]	-	263.45	263.05
June 17, 2022	Water Level[1]	Dry	5.85	5.21
	Groundwater Elevation[2]	-	263.22	262.96
August 8, 2022	Water Level[1]	Dry	5.95	5.26
	Groundwater Elevation[2]	-	263.13	262.91
September 14, 2022	Water Level[1]	Dry	6.04	5.35
	Groundwater Elevation[2]	-	263.04	262.82
October 19, 2022	Water Level[1]	Dry	Dry	5.43
	Groundwater Elevation[2]	-	-	262.74

Notes
[1] Water Levels recorded in m below ground surface (mbgs)
[2] Elevations provided in m above sea level (masl)

4.8 Percolation Time and Hydraulic Conductivity

The particle distribution tests (hydrometer analyses) results were used to identify the percolation time T (min/cm) and hydraulic conductivity k_{fs} (m/sec). To determine the percolation time, the soil was classified according to the USCS, and the T Time was

interpolated based on the USCS gradation charts for the particle size distribution tests as shown in Appendix B. Where applicable, the hydraulic conductivity values were calculated with Puckett's method for fine grained soil and Hazen's formular for granular soil. The estimated percolation time and hydraulic conductivity rates are provided in Table 5.

Table 5 Percolation Times and Hydraulic Conductivity

Borehole/Sample	Sample Depth (mbgs)	Percolation Time (min/cm)	Hydraulic Conductivity (m/s)
MW101-21-SS3	1.5 – 2.0	18	7.8×10^{-4}
MW102-21-SS7	6.1 – 6.6	40	1.2×10^{-6}
BH103-21-SS4	2.3 – 2.7	45	4.6×10^{-7}
MW104-21-SS5	3.0 – 3.5	10	2.0×10^{-3}

5.0 Geotechnical Design Considerations

The following recommendations are based on borehole information and are intended to assist designers. Recommendations should not be construed as providing instructions to contractors, who should form their own opinions about site conditions. It is possible that subsurface conditions beyond the borehole locations may vary from those observed. If significant variations are found before or during construction, Cambium should be contacted so that we can reassess our findings, if necessary.

5.1 Site Preparation

Any topsoil and other disturbed material encountered should be excavated and removed beneath any areas of the Site to be developed; additionally, this material should be excavated and removed to a minimum distance of 3 m around building footprints. Any topsoil and materials with significant quantities of organics and deleterious materials (i.e., construction debris, etc.) are not appropriate for use as fill.

The exposed subgrades should be proof-rolled and inspected by a qualified geotechnical engineer prior to placement of any granular fill. Any loose/soft soils identified at the time of proof-rolling that are unable to uniformly be compacted should be sub-excavated and removed. The excavations created through the removal of these materials should be backfilled with approved engineered fill consistent with the recommendations provided below.

The near surface sand to sandy silt soils can become unstable if they are wet or saturated. Such conditions are common in the spring and late fall. Under these conditions, temporary use of granular fill, and possible reinforcing geotextiles, may be required to prevent severe rutting on construction access routes.

5.2 Frost Penetration

Based on climate data and design charts, the maximum frost penetration depth below the surface at the site is estimated at 1.5 mbgs.

Exterior footings for the proposed structures should be situated at or below this depth for frost penetration or should be appropriately protected.

It is assumed that the pavement structure thickness will be less than 1.5 m, so grading and drainage are important for good pavement performance and life expectancy. Any services should be located below this depth or be appropriately insulated.

5.3 Excavations

The following recommendations for required excavations apply to subgrade elevation depths from 1.5 mbgs (frost penetration depth) to 3.0 mbgs (approximate excavation depth where basements are constructed or for public utility tie ins).

If greater excavation depths are planned, Cambium should be contacted to review and adjust these recommendations, if necessary.

All excavations must be carried out in accordance with the latest edition of the Occupational Health and Safety Act (OHSA). The soils encountered throughout the borehole investigation may generally be classified as Type 3 soils above the groundwater table. Below the groundwater table, the native soils found at site should be classified as Type 4 soils. Type 3 soils may be excavated with side slopes no steeper than 1H:1V, and Type 4 soils may be excavated with side slopes no steeper than 3H:1V.

The groundwater levels measured in the monitoring wells are provided in Table 4. Based on these observations, it is unlikely that free groundwater will be encountered to the excavation depths stated above. Seepage of perched groundwater or any precipitation, run-off or meltwater contained within upper soil layers into the excavation is possible.

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.

The planning of excavation works, and related design should consider existing residential developments surrounding the site. In areas bordering neighbouring properties with structures

sensitive to settlement (houses, pools, etc.), for example along the east side of the parcel, the use of vertical shoring methods should be considered (for example, soldier piles and lagging) to reduce settlements. The shoring including any necessary bracing must be designed by a qualified geotechnical engineer.

5.4 Dewatering

Based on the assumed excavation depths described in Section 5.3, the excavations may not encounter groundwater. However, some groundwater seepage may generally be expected due to climatic conditions (precipitation, runoff, etc.).

Groundwater seepage into the excavation, if encountered, should be controllable with filtered sumps and pumps and a Permit to Take Water (PTTW) from the Ministry of the Environment, Conservation and Parks (MECP) will not be required.

It is noted that the elevation of the groundwater table will vary due to seasonal conditions and in response to heavy precipitation events. Consideration should be given to measuring the monitoring wells over the spring months to estimate the seasonal high groundwater elevations.

5.5 Foundation Design

Design and construction recommendations for potential foundation systems are outlined below. It is understood that the site may be regraded, and our foundation recommendations may change depending upon the final grades. Cambium should be contacted to review the final grading plan and provide any necessary changes to our foundation recommendations.

It is noted that the foundation recommendations have been developed based on the proposed design and construction of residential development. If additional structures are to be constructed at the site in different locations, Cambium should be contacted for further foundation recommendations. Two foundation options are recommended for this site, including:

- Shallow foundations on undisturbed native cohesionless soils; or
- Shallow foundations on engineered fill

All footings must be provided with at least 1.5 m of earth cover or equivalent insulation for frost protection. Footings stepped from one level to another must be at a slope not exceeding 10H:7V.

5.5.1 Foundations on Native Soil

The structures may be supported on standard strip and spread footings placed at or below frost depth (1.5 m or below). Foundations constructed on undisturbed native soil may be designed using the allowable bearing capacity at serviceability limit state (SLS) and ultimate limit state (ULS) summarized in Table 6.

Table 6 Bearing Capacities – Shallow Foundations on Native Soils

Borehole	Depth (mbgs)	Elevation (masl)	Maximum Geotechnical Reaction SLS (kPa)	Maximum Geotechnical Reaction ULS (kPa)
BH101-21	Below 1.5	Below 268.8	200	250
BH102-21	Below 0.8	Below 268.2	200	250
BH103-21	0.8 – 1.5 Below 1.5	268.4 – 267.6 Below 267.6	100 200	140 250
BH104-21	0.8 – 1.5 Below 1.5	267.4 – 266.6 Below 266.6	100 200	140 250
Note: The bearing capacities given in this Table assume that foundations are embedded to the frost penetration depth in native soils. If the foundation overburden is increased using imported fill, Cambium may be contacted to adjust these bearing capacities according to actual regrading plans.				

Settlement potential at the above-noted SLS loadings is less than 25 mm and differential settlement should be less than 10 mm.

The quality of the subgrade should be inspected by Cambium during construction, prior to constructing the footings, to confirm bearing capacity estimates.

The bearing capacities provided in Table 6 are applicable for foundations constructed on undisturbed native soils, which were encountered between 0.8 and 1.5 mbgs. If the grade is raised prior to foundation construction, the foundations must extend to the native soils and be designed per the estimated bearing capacity values provided in Table 6.

Fill was encountered in some boreholes and the depth was found to range between 0.8 to 1.5 mbgs. It is noted that due to the variation in thickness of the earth fill across the site, there may be other areas where the earth fill is deeper than 1.5 mbgs.

5.5.2 Foundations on Engineered Fill

Engineered fill should be placed and constructed as outlined in Section 5.6.1.

Foundations placed on approved engineered fill at a depth at least 1.5 m below final grade, with a minimum fill thickness of 1 m between subgrade/base of foundation and subgrade of imported fill, may be designed using a bearing capacity of 150 kPa at SLS and 200 kPa ULS.

Post-construction settlement will occur following the placement of engineered fill and is estimated to be in the order of 1% of the height of the placed fill. Generally, if granular soil is placed as engineered fill, the settlement will occur within ± 4 weeks. Foundations for structures should not be constructed until post-construction settlement has been completed.

5.6 Backfill and Compaction

Excavated topsoil from the Site is not appropriate for use as fill below grading areas. Excavated sand soils not containing organics or significant deposits of clay may be appropriate for use as fill below grading areas, provided that the actual or adjusted moisture content at the time of construction is within a range that permits compaction to required densities. Some moisture content adjustments may be required depending upon seasonal conditions.

Foundation wall and any buried utility backfill material should consist of free-draining imported granular material. Typically, backfill should be placed in maximum 300 mm thick lifts and should be compacted to a minimum of 98% of Standard Proctor Maximum Dry Density (SPMDD). Backfill adjacent to the structural elements (i.e., foundation walls) should be compacted to 95% of SPMDD taking care not to damage the adjacent structures. The backfill material in the upper 300 mm below the pavement subgrade elevation should be compacted to 100% of SPMDD in all areas.

All existing vegetation, topsoil, organic and non-organic fills, and any loose soils shall be removed down to a competent base. Backfill areas must be approved by a qualified geotechnical engineer prior to placement of any new fill, to ensure the suitability of subgrade conditions.

5.6.1 Engineered Fill

When the fill is treated as an engineered fill to support structural elements such as foundations and / or floor slabs the following is recommended for the construction of engineered fill:

I. Remove any and all existing vegetation, surficial topsoil / organics, organic fills or fills and any loose soils to a competent subgrade for a suitable envelope.

II. The area of the engineered fill should extend horizontally 1 m beyond the outside edge of the foundations then extend downward at a 1H:1V slope to the competent approved native soil.

III. The subgrade or base of the engineered fill area must be approved by Cambium prior to placement of any new fill, to ensure that suitability of subgrade condition.

IV. Place approved OPSS 1010.MUNI SSM or Granular ‘B’ Type I material at a moisture content at or near optimum moisture in suitable maximum 200 mm thick lifts, compacted to 100% of SPMDD. If native soils from the site are not used as engineered fill, imported material for engineered fill should consist of clean, non-organic soils, free of chemical contamination or deleterious material. Any frost penetration into the fill material must be removed prior to placement of subsequent lifts of fill and reviewed by Cambium.

V. The moisture content of the engineered fill will need to be close enough to optimum at the time of placement to allow for adequate compaction.

VI. Full time testing and inspection of the engineered fill will be required for it to be used as a founding material, as outlined in Section 4.2.2.2 of the Ontario Building Code.

VII. To account for varying founding soils, the footings and foundation walls should be suitably reinforced to mitigate potential settlement cracking.

5.7 Subdrains

Provisions should be made for draining the basement wall backfill to prevent buildup of hydrostatic pressures; this could consist of geotextile-wrapped perforated plastic sub-drains covered on all sides by 19 mm crushed clear stone around the perimeter of the foundation appropriately sloped and drained to the stormwater management system or other suitable positive frost-free outlet. It is recommended the basement floor slab is constructed at least 500 mm above the seasonal high groundwater table.

5.8 Seismic Site Classification

The Ontario Building Code (OBC) specifies that the structures should be designed to withstand forces due to earthquakes. For the purpose of earthquake design, geotechnical information shall be used to determine the “Site Class”. The parameters for determination of Site Classification for Seismic Site Response are set out in Table 4.1.8.4A of the OBC (2012). The classification is based on the determination of the average shear wave velocity in the top 30 metres of the site stratigraphy, where shear wave velocity (v_s) measurements have been taken. Alternatively, the classification is estimated on the basis of rational analysis of undrained shear strength (s_u) or penetration resistances (N_{60} values). Based on the explored soil properties and in accordance with Table 4.1.8.4.A, it is recommended that Site Class “D” (stiff soil) be applied for structural design at the Site.

Peak ground acceleration and spectral acceleration (period of 0.2 seconds) for the site are calculated to be 0.063g and 0.108g respectively using the 2015 National Building Code Seismic Hazard Calculation. A detailed report of the calculation and its results can be found in Appendix C.

5.9 Lateral Earth Pressure

Lateral earth pressure coefficients (K) are shown along with soil mechanical parameters that may be used for the geotechnical design of temporary and permanent structures in Table 7. The coefficients provided assume that the surface of the granular backfill is horizontal against any proposed building, and the wall is vertical and smooth. Cambium should be contacted to

provide updated lateral earth pressure coefficients should the assumptions differ to those noted and if the soil is to be sloped at an angle behind the retaining wall.

Table 7 Unfactored Soil Parameters

Soil	Bulk Unit Weight γ [kN/m^3]	Internal Friction Angle Φ'[°]	Cohesion c' [kPa]	Active earth pressure coefficient K_a [-]	Passive earth pressure coefficient K_p [-]	At-rest earth pressure coefficient K_o [-]
Sand to Silty Sand *compact to very dense*	19.5	32.5	0	0.30	3.32	0.46
Silt, Sandy Silt, Clayey Silt *stiff to hard*	19	27.5	5	0.37	2.72	0.54
Engineered Fill (i.e. OPSS Granular B)	20	33	0	0.30	3.35	0.46

Walls subject to unbalanced earth pressures must be designed to resist a pressure that can be calculated based on the following equation:

$$\boldsymbol{P = K[\gamma(h - h_w) + \gamma' h_w + q] + \gamma_w h_w}$$

Where, P = the horizontal pressure at depth, h (m)

K = the earth pressure coefficient

h_w = the depth below the ground water level (m)

γ = the bulk unit weight of soil, (kN/m^3)

γ' = the submerged unit weight of the exterior soil, (γ_{sat} - γ_w, with γ_w = 10 kN/m^3)

q = the complete surcharge loading (kPa)

The wall backfill must be drained effectively to eliminate hydrostatic pressures on the wall that would otherwise act in conjunction with the earth pressure. In this case, the above equation is simplified to:

$$\boldsymbol{P = K[\gamma h + q]}$$

The factored geotechnical resistance to sliding of foundation elements is developed by friction between the base of the footing and the soil. This friction (R) depends on the normal load at the soil contact (N) and the frictional resistance of the soil (tan φ) expressed as $R_f = N\ tan\varphi$, which is the unfactored resistance. The factored geotechnical resistance at ULS is $R_f = 0.8\ N\ tan\varphi$.

5.10 Slabs-on-grade

Inorganic native soils at the Site are considered competent to support floor slab loads. To create a stable working surface and to distribute loadings, all slabs-on-grade should be constructed on a minimum of 200 mm of OPSS 1010 Granular A compacted to 98% of SPMDD. For basement floor slabs, consideration should be given to using a 200 mm thick layer of 19 mm diameter clear crushed stone connected to perimeter drains below the floor slab to assist with drainage.

5.11 Pavement Design

The performance of the pavement is dependent upon proper subgrade preparation. All topsoil and organic materials should be removed down to native material and backfilled with approved engineered fill or native material, compacted to 95% of SPMDD. The backfill material in the upper 300 mm below the pavement subgrade elevation should be compacted to 100% of SPMDD in all areas. The subgrade should be proof rolled and inspected by a geotechnical engineer. Any areas where rutting or appreciable deflection is noted should be sub-excavated and replaced with suitable fill. The fill should be compacted to at least 100% of SPMDD.

The recommended minimum pavement structure design has been developed for two traffic loading scenarios; light duty and heavy duty. The heavy-duty design is appropriate for areas where heavy traffic is anticipated and meets the City of Barrie's minimum pavement requirements for a residential local road, while the light duty design is appropriate for areas where light traffic is anticipated. The recommended minimum pavement structure is provided in Table 8.

Table 8 Recommended Minimum Pavement Structure

Pavement Layer	Light Duty	Heavy Duty
Surface Course Asphalt	40 mm HL3 or HL4	40 mm HL3 or HL4
Binder Course Asphalt	50 mm HL8	70 mm HL8
Granular Base	150 mm OPSS 1010 Granular A	150 mm OPSS 1010 Granular A
Granular Subbase	300 mm OPSS 1010 Granular B	450 mm OPSS 1010 Granular B

Material and thickness substitutions must be approved by the Design Engineer.

The thickness of the subbase layer could be increased at the discretion of the Engineer, to accommodate site conditions at the time of construction, including soft or weak subgrade soil replacement.

Compaction of the subgrade should be verified by the Engineer prior to placing the granular fill. Granular layers should be placed in 150 mm maximum loose lifts and compacted to at least 100% of SPMDD. The granular materials specified should conform to OPSS standards, as confirmed by appropriate materials testing.

The final asphalt surface should be sloped at a minimum of 2% to shed runoff. Abutting pavements should be sawcut to provide clean vertical joints with new pavement areas.

5.12 Buried Utilities

Trench excavations should generally consider Type 3 soil conditions which can be excavated with unsupported side slopes no steeper than 1H:1V.

Bedding and cover material for any services should consist of OPSS 1010-3 Granular A or B Type II, placed in accordance with pertinent Ontario Provincial Standard Drawings (OPSD 802.010). The bedding and cover material shall be placed in maximum 200 mm thick lifts and should be compacted to at least 95% of SPMDD.

The cover material shall be a minimum of 300 mm over the top of the pipe and compacted to 95% of SPMDD, taking care not to damage the utility pipes during compaction.

5.13 Design Review and Inspections

Testing and inspections should be carried out during construction operations to test concrete and to examine and approve subgrade conditions, placement and compaction of fill materials, granular base courses, and asphaltic concrete.

Cambium should be contacted to review and approve design drawings, prior to tendering or commencing construction, to ensure that all pertinent geotechnical-related factors have been addressed. It is important that onsite geotechnical supervision be provided at this site for excavation and backfill procedures, deleterious soil removal, subgrade inspections and compaction testing.

5.13.1 Inspections and Testing

Testing and inspections should be carried out during construction operations to examine and approve subgrade conditions and placement and compaction of fill materials. Cambium should be contacted to review and approve design drawings prior to commencing construction to ensure that all pertinent geotechnical-related factors have been addressed.

6.0 Closing

Please note that this work program and report are governed by the attached Qualifications and Limitations. If you have questions or comments regarding this document, please do not hesitate to contact the undersigned at (705) 719-0700.

Respectfully submitted,

Cambium Inc.

Josef Schweighofer, B.Sc., M.Sc.
Project Coordinator - Geotechnical

Rob Gethin, P.Eng.
Group Manager – Geotechnical

RG/js/bw

7.0 Standard Limitations

Limited Warranty

In performing work on behalf of a client, Cambium relies on its client to provide instructions on the scope of its retainer and, on that basis, Cambium determines the precise nature of the work to be performed. Cambium undertakes all work in accordance with applicable accepted industry practices and standards. Unless required under local laws, other than as expressly stated herein, no other warranties or conditions, either expressed or implied, are made regarding the services, work or reports provided.

Reliance on Materials and Information

The findings and results presented in reports prepared by Cambium are based on the materials and information provided by the client to Cambium and on the facts, conditions and circumstances encountered by Cambium during the performance of the work requested by the client. In formulating its findings and results into a report, Cambium assumes that the information and materials provided by the client or obtained by Cambium from the client or otherwise are factual, accurate and represent a true depiction of the circumstances that exist. Cambium relies on its client to inform Cambium if there are changes to any such information and materials. Cambium does not review, analyze or attempt to verify the accuracy or completeness of the information or materials provided, or circumstances encountered, other than in accordance with applicable accepted industry practice. Cambium will not be responsible for matters arising from incomplete, incorrect or misleading information or from facts or circumstances that are not fully disclosed to or that are concealed from Cambium during the provision of services, work or reports.

Facts, conditions, information and circumstances may vary with time and locations and Cambium's work is based on a review of such matters as they existed at the particular time and location indicated in its reports. No assurance is made by Cambium that the facts, conditions, information, circumstances or any underlying assumptions made by Cambium in connection with the work performed will not change after the work is completed and a report is submitted. If any such changes occur or additional information is obtained, Cambium should be advised and requested to consider if the changes or additional information affect its findings or results.

When preparing reports, Cambium considers applicable legislation, regulations, governmental guidelines and policies to the extent they are within its knowledge, but Cambium is not qualified to advise with respect to legal matters. The presentation of information regarding applicable legislation, regulations, governmental guidelines and policies is for information only and is not intended to and should not be interpreted as constituting a legal opinion concerning the work completed or conditions outlined in a report. All legal matters should be reviewed and considered by an appropriately qualified legal practitioner.

Site Assessments

A site assessment is created using data and information collected during the investigation of a site and based on conditions encountered at the time and particular locations at which fieldwork is conducted. The information, sample results and data collected represent the conditions only at the specific times at which and at those specific locations from which the information, samples and data were obtained and the information, sample results and data may vary at other locations and times. To the extent that Cambium's work or report considers any locations or times other than those from which information, sample results and data was specifically received, the work or report is based on a reasonable extrapolation from such information, sample results and data but the actual conditions encountered may vary from those extrapolations.

Only conditions at the site and locations chosen for study by the client are evaluated; no adjacent or other properties are evaluated unless specifically requested by the client. Any physical or other aspects of the site chosen for study by the client, or any other matter not specifically addressed in a report prepared by Cambium, are beyond the scope of the work performed by Cambium and such matters have not been investigated or addressed.

Reliance

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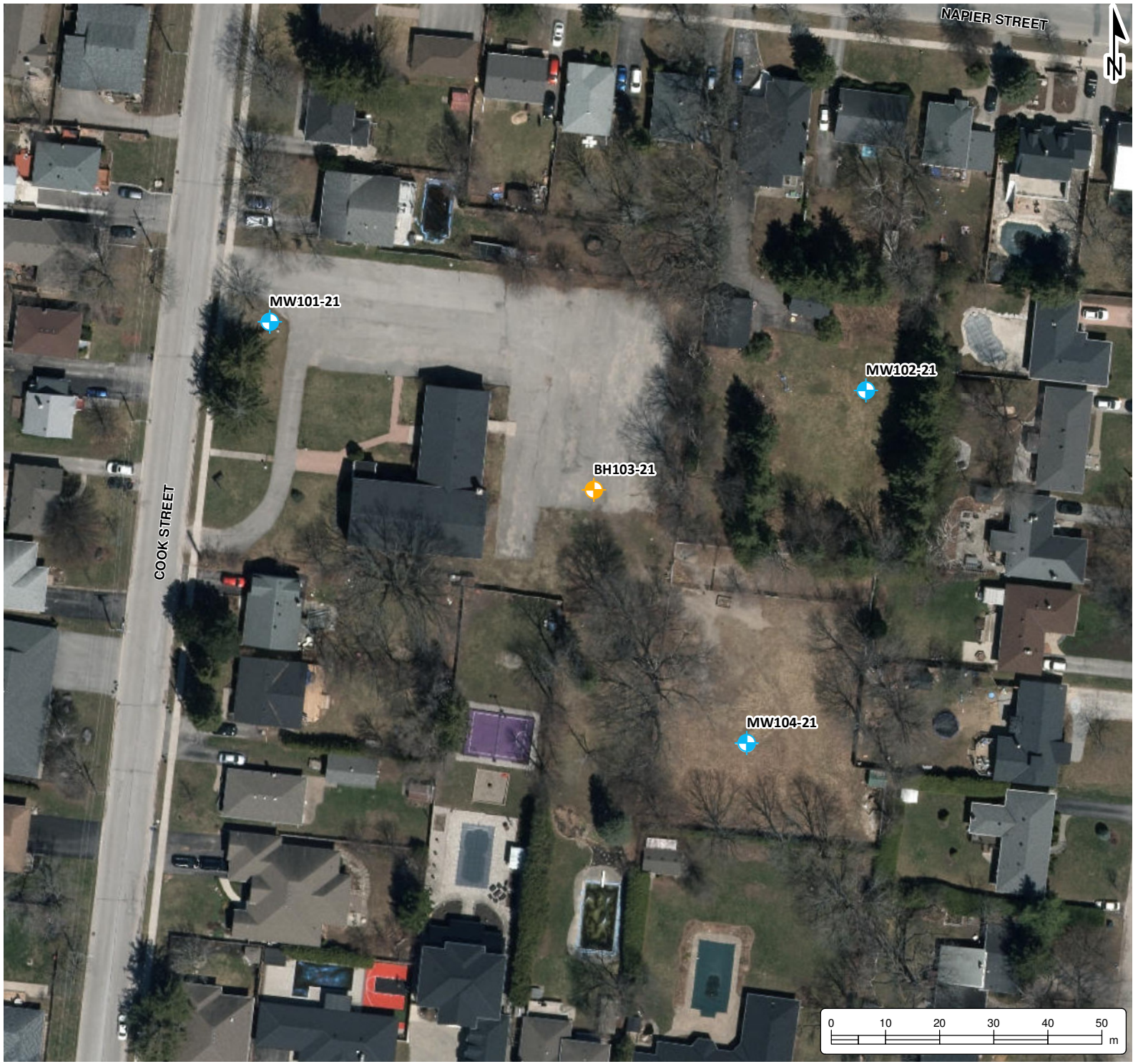
Limitation of Liability

Potential liability to the client arising out of the report is limited to the amount of Cambium's professional liability insurance coverage. Cambium shall only be liable for direct damages to the extent caused by Cambium's negligence and/or breach of contract. Cambium shall not be liable for consequential damages.

Personal Liability

The client expressly agrees that Cambium employees shall have no personal liability to the client with respect to a claim, whether in contract, tort and/or other cause of action in law. Furthermore, the client agrees that it will bring no proceedings nor take any action in any court of law against Cambium employees in their personal capacity.

Appended Figures



GEOTECHNICAL INVESTIGATION

INNOVATIVE PLANNING SOLUTIONS
103 Napier Street and 95 Cook Street
Barrie, Ontario

LEGEND

- Borehole
- Monitoring Well

Notes:
- Base mapping features are © Queen's Printer of Ontario, 2019 (this does not constitute an endorsement by the Ministry of Natural Resources or the Ontario Government).
- Distances on this plan are in metres and can be converted to feet by dividing by 0.3048.
- Cambium Inc. makes every effort to ensure this map is free from errors but cannot be held responsible for any damages due to error or omissions. This map should not be used for navigation or legal purposes. It is intended for general reference use only.

CAMBIUM
194 Sophia Street
Peterborough, Ontario, K9H 1E5
Tel: (705) 742.7900 Fax: (705) 742.7907
www.cambium-inc.com

SITE LOCATION MAP

Project No.: 14079-001		Date: December 2021	Rev.:
Scale: 1:1,000		Projection: NAD 1983 UTM Zone 17N	
Created by: TLC	Checked by: RG	Figure: 1	

O:\GIS\MXDs\1:4000-14079\14079-001 Innovative Planning Solution - Geo & Hydro\ - 103 Napier St. & 95 Cook St., Barrie\2021-12-16 FIG 1 - Borehole Location Plan.mxd

Appendix A

Borehole Logs

Peterborough
Barrie
Oshawa
Kingston
T: 866-217-7900
www.cambium-inc.com

Log of Borehole: MW101-21

Client: Innovative Planning Solutions
Project Name: 103 Napier Street and 95 Cook Street, Barrie, ON
Project No.: 14079-001
Contractor: Landshark Drilling
Method: Hollow Stem Auger
Date Completed: December 8, 2021
Location: 95 Cook Street, Barrie, Ontario
UTM: 17T: 4916983 m north, 605915 m east
Elevation: 270.36 mASL

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
270 / 0		Topsoil: Black silt, some sand, some organics, loose, moist [TOPSOIL]	1	SS	40	4			Monument; Cap	Top of Pipe (TOP) elevation: 271.34 mASL Well dry when measured on December 20, 2021
269 / 1		Sand: Brown sand, some silt, trace organics, loose, moist [FILL]	2	SS	80	7			Bentonite Plug; PVC Standpipe	
268 / 2		Silty Sand: Brown silty sand, trace clay, very dense, dry	3	SS	60	50/280 mm				GSA SS3: 0% Gravel 70% Sand 27% Silt 3% Clay
			4	SS	60	50/280 mm				
267 / 3			5	SS	60	50/230 mm				
266 / 4									Sand Pack; PVC Screen	
265 / 5			6	SS	70	50/280 mm				
264 / 6		-more silt, moist	7	SS	70	50/205 mm			Cap	
7		Borehole terminated at 6.5 mbgs in silty sand due to target depth								

Logged By: BW
Input By: BW

Peterborough
Barrie
Oshawa
Kingston
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Log of Borehole: MW102-21

Client: Innovative Planning Solutions
Project Name: 103 Napier Street and 95 Cook Street, Barrie, ON
Project No.: 14079-001
Contractor: Landshark Drilling
Method: Hollow Stem Auger
Date Completed: December 8, 2021
Location: 103 Napier Street, Barrie, Ontario
UTM: 17T: 4916970 m north, 606025 m east
Elevation: 269.08 mASL

Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
269	0		Topsoil: Black silt, some sand, some organics, trace gravel, loose, moist [TOPSOIL]	1	SS	20	6			Monument; Cap	Top of Pipe (TOP) elevation: 270.03 mASL Groundwater measured at 5.4 mbgs (263.68 mASL) on December 20, 2021
268	1		Silty Sand: Brown silty sand, some gravel, compact, moist	2	SS	60	27			Bentonite Plug; PVC Standpipe	
267	2		Sand: Brown sand, some gravel, trace silt, very dense, saturated	3	SS	50	50				
			-less gravel, wet	4	SS	50	50/280 mm				
266	3		-dense	5	SS	60	45				
265	4									Sand Pack; PVC Screen	
			-moist	6	SS	50	50				
264	5										
263	6		Silt: Brown, silt, some clay, trace sand, trace gravel, dense, wet	7	SS	80	50			Cap	GSA SS7: 1% Gravel 4% Sand 77% Silt 18% Clay
	7		Borehole terminated at 6.6 mbgs in silt due to target depth achieved.								

Logged By: BW
Input By: BW

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Oshawa
Kingston
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Log of Borehole: BH103-21

Client: Innovative Planning Solutions
Project Name: 103 Napier Street and 95 Cook Street, Barrie, ON
Project No.: 14079-001
Contractor: Landshark Drilling
Method: Hollow Stem Auger
Date Completed: December 8, 2021
Location: 95 Cook Street, Barrie, Ontario
UTM: 17T: 4916952 m north, 605975 m east
Elevation: 269.30 mASL

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
269 / 0		Asphalt: Asphalt thickness: 50 mm								Borehole open and dry upon completion
		Silt: Brown silt, some sand, trace gravel, loose, moist [FILL]	1	SS	60	5				
		-compact	2A	SS	80	12				
268 / 1		Silty Sand: Brown silty sand, trace gravel, compact, moist	2B							
		Sand: Brown sand, some gravel, trace silt, dense, dry	3	SS	70	49				
267 / 2		Clayey Silt: Brown clayey silt, some sand, trace gravel, very stiff, moist	4	SS	90	30				GSA SS4: 1% Gravel 13% Sand 63% Silt 23% Clay
266 / 3		Sand: Brown sand, trace gravel, trace silt, very dense, dry	5	SS	70	50/205 mm				
265 / 4			6	SS	0	50/50 mm				
264 / 5										
263 / 6		-grey, more gravel	7	SS	20	50/100 mm				broken cobbles in spoon
263 / 7		Borehole terminated at 6.2 mbgs in sand due to target depth achieved.								

Logged By: BW
Input By: BW

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Kingston
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Log of Borehole: MW104-21

Client: Innovative Planning Solutions
Project Name: 103 Napier Street and 95 Cook Street, Barrie, ON
Project No.: 14079-001
Contractor: Landshark Drilling
Method: Hollow Stem Auger
Date Completed: December 8, 2021
Location: 95 Cook Street, Barrie, Ontario
UTM: 17T: 4916905 m north, 606003 m east
Elevation: 268.17 mASL

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
268 / 0		Topsoil: Black silt, some sand, some organics, loose, moist [TOPSOIL]	1	SS	20	7			Monument; Cap	Top of Pipe (TOP) elevation: 269.13 mASL Groundwater measured at 5.19 mbgs (262.98 mASL) on December 20, 2021
267 / 1		Sandy Silt: Brown sandy silt, trace organics, trace gravel, trace clay, loose, wet	2	SS	70	9			Bentonite Plug; PVC Standpipe	
266 / 2		Sand: Brown sand, trace silt, trace clay, dense, wet	3	SS	50	33				
			4	SS	60	37				
265 / 3			5	SS	70	50				GSA SS5: 0% Gravel 88% Sand 8% Silt 3% Clay
264 / 4		-very dense	6	SS	60	50/255 mm			Sand Pack; PVC Screen	
263 / 5										
262 / 6		-saturated	7	SS	90	50/180 mm			Cap	
7		Borehole terminated at 6.4 mbgs in sand due to target depth achieved.								

Logged By: BW
Input By: BW

Appendix B

Physical Laboratory Testing Results

Grain Size Distribution Chart

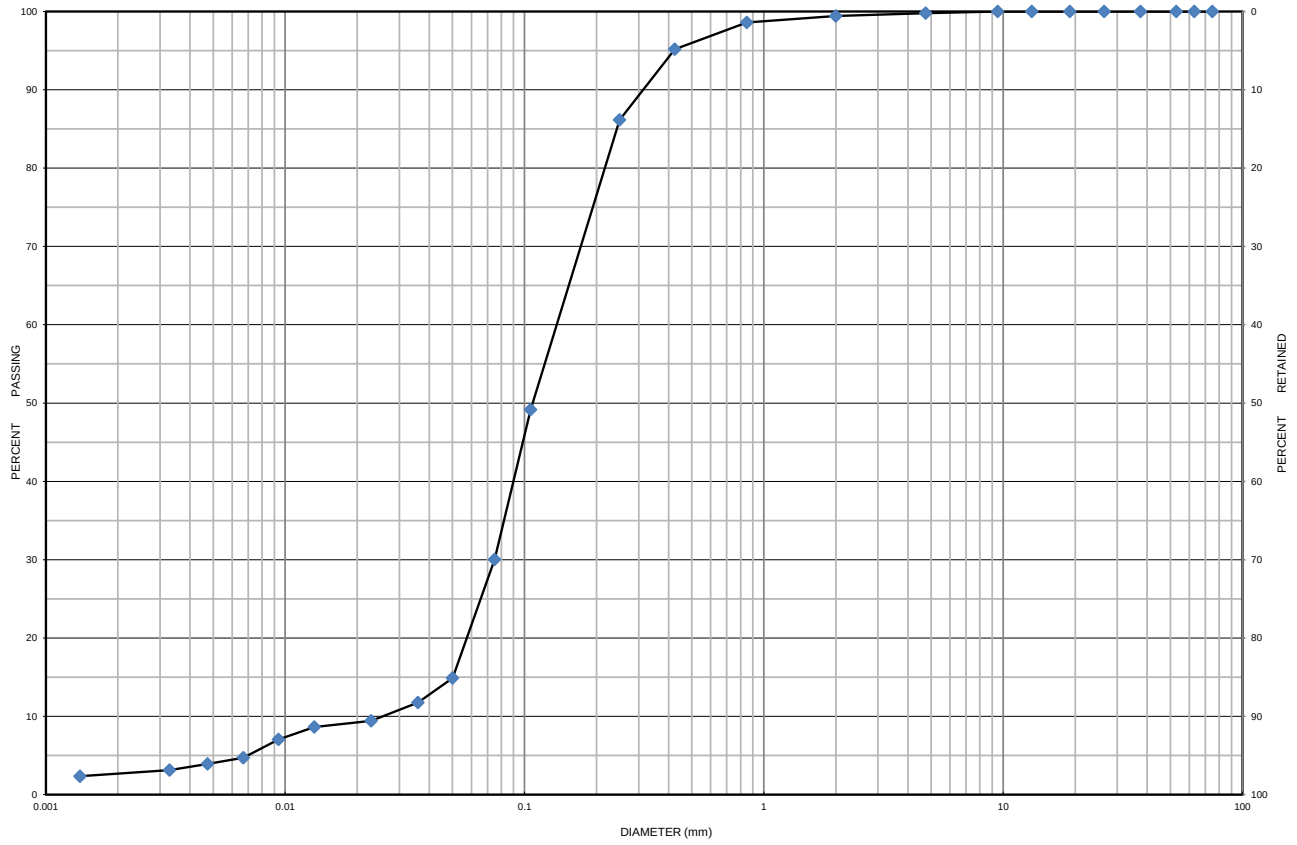
Project Number: *14079-001* **Client:** *Innovative Planning Solutions*

Project Name: *103 Napier St. & 95 Cook St., Barrie*

Sample Date: *December 8, 2021* **Sampled By:** *Ben White - Cambium Inc.*

Location: *BH 101-21 SS 3* **Depth:** *1.5 m to 2 m* **Lab Sample No:** *S-21-1686*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 101-21	SS 3	1.5 m to 2 m	0	70	27	3	6.6

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Silty Sand trace Clay	SM	0.145	0.075	0.026	5.58	1.49

Additional information available upon request

Issued By: _____ *Date Issued:* *December 16, 2021*

(Senior Project Manager)

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Grain Size Distribution Chart

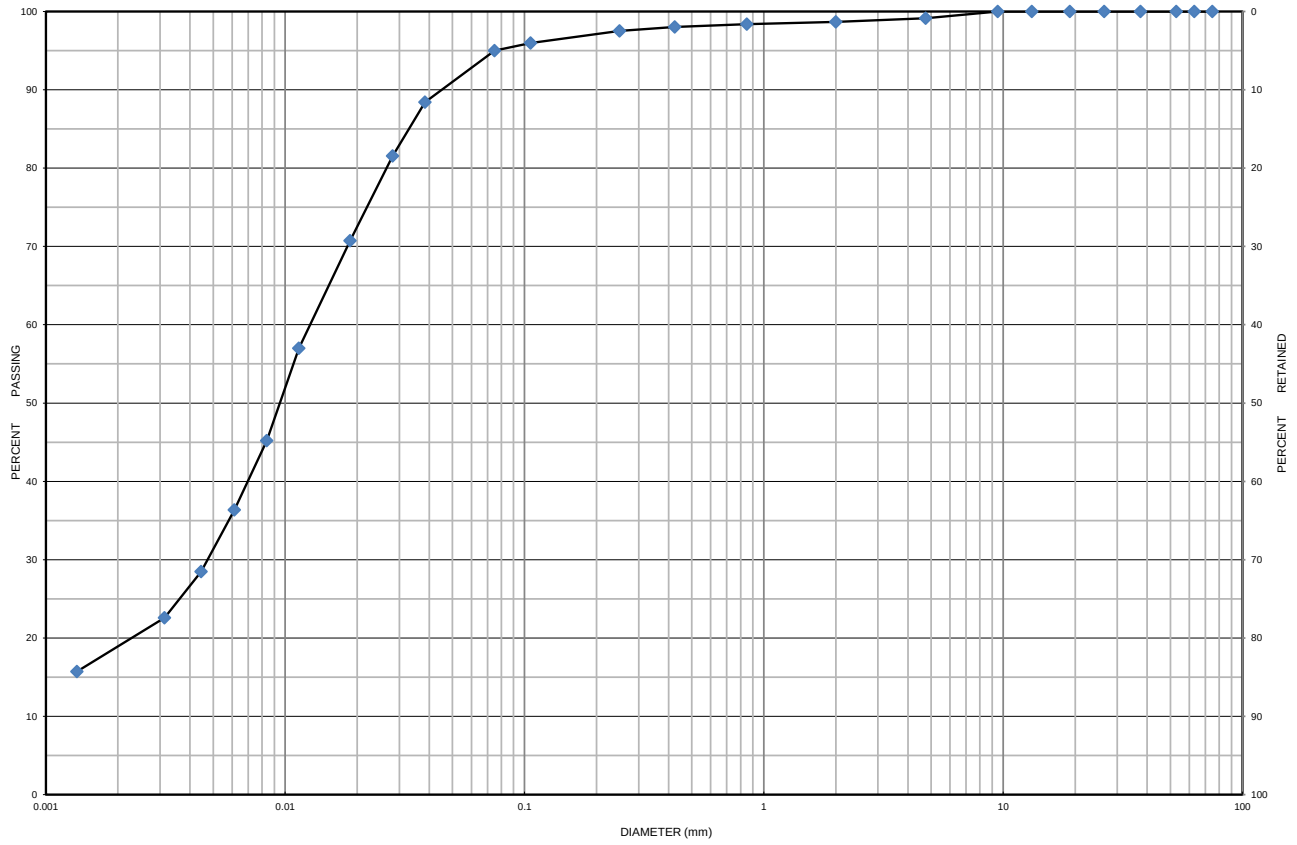
Project Number: *14079-001* **Client:** *Innovative Planning Solutions*

Project Name: *103 Napier St. & 95 Cook St., Barrie*

Sample Date: *December 8, 2021* **Sampled By:** *Ben White - Cambium Inc.*

Location: *BH 102-21 SS 7* **Depth:** *6.1 m to 6.6 m* **Lab Sample No:** *S-21-1687*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 102-21	SS 7	6.1 m to 6.6 m	1	4	77	18	17.0

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Silt some Clay trace Sand trace Gravel	ML	0.0140	0.0047	-	-	-

Additional information available upon request

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Grain Size Distribution Chart

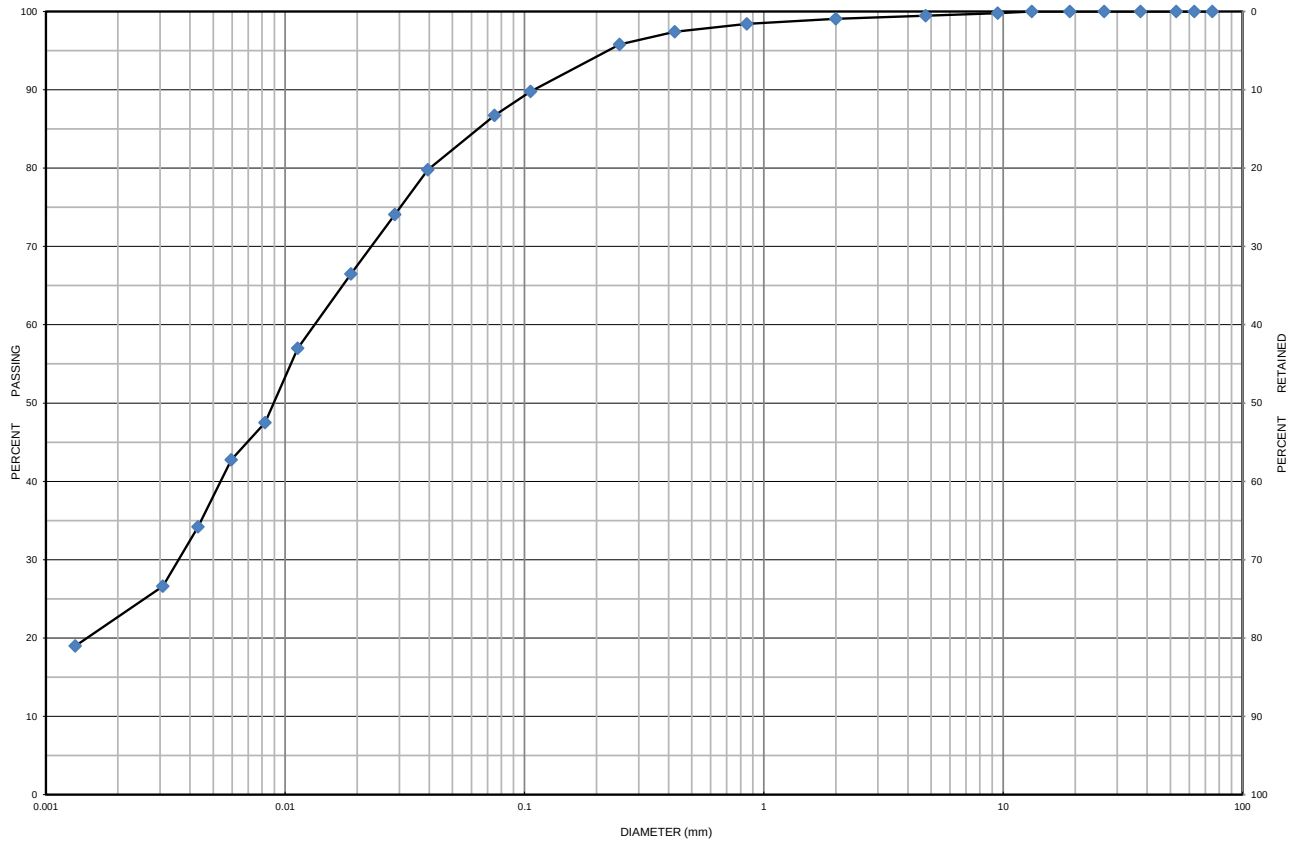
Project Number: *14079-001* **Client:** *Innovative Planning Solutions*

Project Name: *103 Napier St. & 95 Cook St., Barrie*

Sample Date: *December 8, 2021* **Sampled By:** *Ben White - Cambium Inc.*

Location: *BH 103-21 SS 4* **Depth:** *2.3 m to 2.7 m* **Lab Sample No:** *S-21-1688*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 103-21	SS 4	2.3 m to 2.7 m	1	13	63	23	16.8

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Clayey Silt some Sand trace Gravel	ML	0.0140	0.0036	-	-	-

Additional information available upon request

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Grain Size Distribution Chart

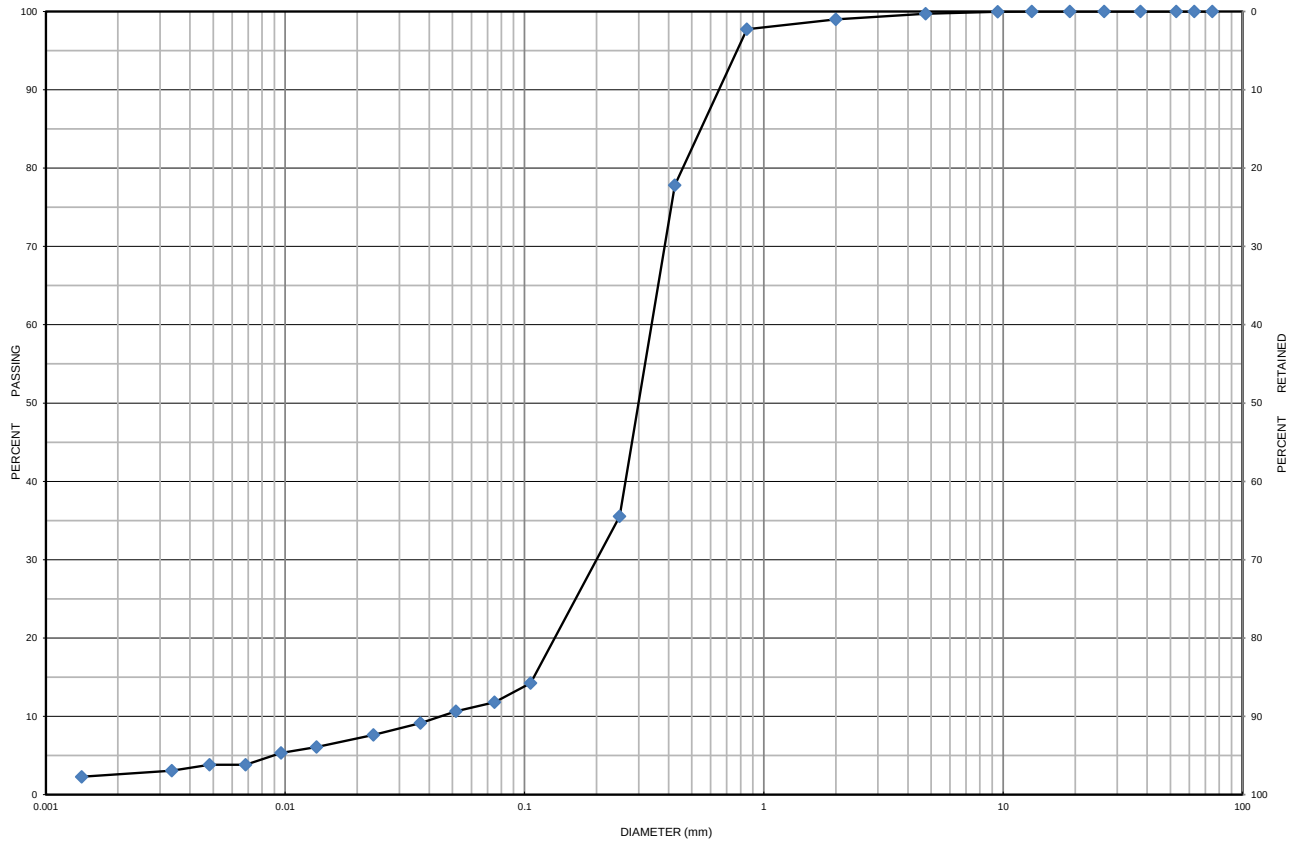
Project Number: *14079-001* **Client:** *Innovative Planning Solutions*

Project Name: *103 Napier St. & 95 Cook St., Barrie*

Sample Date: *December 8, 2021* **Sampled By:** *Ben White - Cambium Inc.*

Location: *BH 104-21 SS 5* **Depth:** *3 m to 3.5 m* **Lab Sample No:** *S-21-1689*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 104-21	SS 5	3 m to 3.5 m	0	88	9	3	6.4

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Sand trace Silt trace Clay	SW	0.345	0.200	0.045	7.67	2.58

Additional information available upon request

Issued By: _____ *Date Issued:* *December 16, 2021*

(Senior Project Manager)

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Moisture Content

Project Number: 14079-001
Project Name: 103 Napier St. & 95 Cook St., Barrie
Client: Innovative Planning Solutions
Date Taken: 2021-12-08

Lab Number: S-21-1685
Date Tested: 2021-12-13
Tested By: J. O'Brien

Borehole Number	Sample Number	Sample Depth (m)	Water Weight (g)	Water Content (%)	Additional Observations
101	1	0.00-0.61	33.4	21.8	1
101	2	0.76-1.37	27.6	13.2	1
101	3	1.52-1.98	43.3	6.6	NR
101	4	2.29-2.71	12.1	4.1	
101	5	3.05-3.43	5.5	2.4	
101	6	4.57-5.00	10.1	3.7	
101	7	6.10-6.64	22.0	7.4	
102	1	0.00-0.61	35.4	22.6	1
102	2	0.76-1.22	28.9	8.7	
102	3	1.52-1.98	20.1	7.3	
102	4	2.29-2.71	10.0	3.7	
102	5	3.05-3.51	11.9	4.0	
102	6	4.57-5.03	5.4	2.1	
102	7	6.10-6.55	137.9	17.0	NR
103	1	0.06-0.67	23.2	10.6	
103	2A	0.76-0.91	23.4	10.6	NR,1
103	2B	0.91-1.37	19.7	8.8	
103	3	1.52-1.98	17.1	5.3	
103	4	2.29-2.74	152.4	16.8	NR
103	5	3.05-3.41	16.7	6.1	
103	7	6.10-6.19	3.8	1.3	NR
104	1	0.00-0.61	31.5	22.9	NR,1
104	2	0.76-1.37	37.0	12.9	
104	3	1.52-1.98	12.5	6.2	
104	4	2.29-2.74	17.6	7.6	
104	5	3.05-3.51	42.3	6.4	NR
104	6	4.57-4.97	13.5	5.6	

1 – Contains organics
2 – Contains rubble
3 – Hydrocarbon Odour
4 – Unknown Chemical Odour
5 – Saturated – free water visible
6 – Very moist – near optimum moisture content
7 – Moist – below optimum moisture
8 – Dry – dry texture – powdery
9 – Very small – caution may not be representative
10 – Hold sample for gradation analysis

Moisture Content

Project Number: 14079-001
Project Name: 103 Napier St. & 95 Cook St., Barrie
Client: Innovative Planning Solutions
Date Taken: 2021-12-08

Lab Number: S-21-1685
Date Tested: 2021-12-13
Tested By: J. O'Brien

Borehole Number	Sample Number	Sample Depth (m)	Water Weight (g)	Water Content (%)	Additional Observations
104	7	6.10-6.55	44.2	14.2	

1 – Contains organics
2 – Contains rubble
3 – Hydrocarbon Odour
4 – Unknown Chemical Odour
5 – Saturated – free water visible
6 – Very moist – near optimum moisture content
7 – Moist – below optimum moisture
8 – Dry – dry texture – powdery
9 – Very small – caution may not be representative
10 – Hold sample for gradation analysis

Appendix C

2015 National Building Code Seismic Hazard Values

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

Site: 44.398N 79.669W **User File Reference:** 103 Napier St., 95 Cook St. 2022-01-24 13:32 UT

Requested by: Cambium Inc.

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.080	0.049	0.032	0.011
Sa (0.1)	0.110	0.071	0.047	0.017
Sa (0.2)	0.108	0.071	0.049	0.019
Sa (0.3)	0.092	0.062	0.043	0.017
Sa (0.5)	0.077	0.052	0.036	0.013
Sa (1.0)	0.047	0.031	0.021	0.006
Sa (2.0)	0.025	0.016	0.010	0.003
Sa (5.0)	0.006	0.004	0.002	0.001
Sa (10.0)	0.003	0.002	0.001	0.000
PGA (g)	0.063	0.041	0.027	0.009
PGV (m/s)	0.064	0.040	0.026	0.008

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" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. 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.**

References

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

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
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