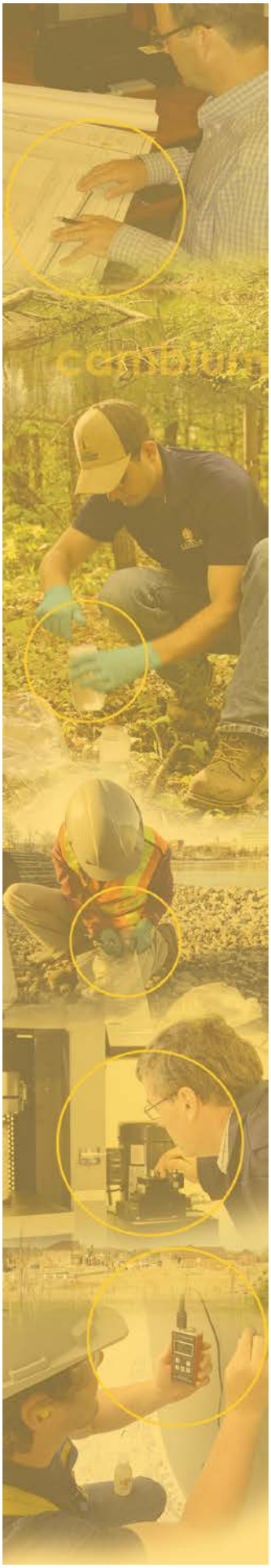

Geotechnical Investigation Report 156 Miller Drive, Barrie, Ontario

Cambium Reference No.: 9089-001

October 2, 2019

Prepared for: iVIVA Homes

Cambium Inc.

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cambium-inc.com

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1.0 INTRODUCTION

Cambium Inc. (Cambium) was retained by iVIVA Homes (Client) to complete a geotechnical investigation in support of the design and construction of a proposed residential subdivision at 156 Miller Drive in Barrie, Ontario (Site).

The property is currently a predominantly vacant “T” shaped site, with sloping topography, generally falling towards the north and south property extents, and is approximately 3.6 acres in size. At the time of the investigation the eastern extents of the property contained two (2) residential homes, the remainder of the site was undeveloped and consisted of a mixture of open field and medium mixed forest. Wet areas were noted at the northern and southern property extents with deposits of organic soils. Cambium understands that at the time of investigation the proposed residential development consists of approximately forty-three (43) slab on grade single lot homes with a stormwater retention tank at the southwest corner of the site.

The geotechnical investigation was required to confirm the subsurface conditions at the Site to provide geotechnical design parameters as input into the design and construction of the proposed residential development.

2.0 METHODOLOGY

2.1 BOREHOLE INVESTIGATION

A borehole investigation was performed at the site between May 21st and May 22nd, 2019. A total of seventeen (17) boreholes have been planned for the site, however due to access limitations fourteen (14) of the boreholes were completed during this initial investigation, with the remaining three (3) boreholes to be advanced during a subsequent investigation. The boreholes were designated as BH101-19 through BH114-19 and each borehole was terminated at a depth of 5.0 metres below ground surface.

The borehole positions and elevations were provided by a Topcon HiPer II Real Time Kinematic (RTK) GNSS receiver. Elevations were corrected relative to a Ministry of Natural Resources vertical control monument located on the west concrete foundation wall at 461 Edgehill Drive, the control monument has an elevation of 241.699 metres above sea level (mASL) The borehole UTMs are provided on the borehole logs. Borehole locations are shown on Figure 1.

Drilling and sampling were completed using a track mounted drill rig operating under the supervision of a Cambium technician. The boreholes were advanced to the sampling depths by means of continuous flight hollow 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 generally collected at 0.75 m intervals from 0 to 3 m and at 1.5 m intervals after 3 m. 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.

Two (2) boreholes, BH/MW110-19 and BH/MW114-19, were outfitted as monitoring wells in order to measure the static groundwater elevation at the Site. Another borehole at the north end of the site will be equipped with a monitoring well during the subsequent investigation.

Borehole logs are provided in Appendix A. Site soil, groundwater and geotechnical recommendations are discussed in the following sections of this report.

2.2 PHYSICAL LABORATORY TESTING

Physical laboratory testing, including three (3) sieve and hydrometer analyses (LS-702,705), was completed on selected soil samples to confirm textural classification and to assess geotechnical parameters. Natural moisture content testing (LS-701) was completed on all retrieved soil samples. Additional testing will be performed on select soil samples gathered during subsequent investigations. Testing results are presented in Appendix D and are discussed in Section 3.0.

3.0 SUBSURFACE CONDITIONS

The subsurface conditions at the site consist predominantly of topsoil or organic material overlying glaciolacustrine deposits or glaciofluvial ice contact deposits, generally consisting of sand to sand and gravel deposits. Each of the boreholes were terminated in native soils. Borehole locations are shown on Figure 1 and the individual soil units are described in detail below with individual borehole logs provided in Appendix A.

3.1 TOPSOIL

A layer of topsoil 150 mm to 450 mm in thickness was encountered at the surface of each borehole. The topsoil was generally dark brown to black and moist to saturated at the time of the investigation. The natural moisture content of the samples tested was generally between 10% and 71% based on laboratory analysis. The relative density of the topsoil was generally very loose to loose based on SPT results. Analysis of the organic content or the nutrients in the topsoil layer was beyond the scope of this investigation.

3.2 FILL SOILS

A layer of fill soils was encountered in two (2) of the boreholes advanced at the site, boreholes BH104-19 and BH111-19. The fill soils extended to depths between 1.7 mbgs to 2.1 mbgs and generally consisted of reworked native sand soils with traces of debris such as wood and bricks noted. Based on SPT N values ranging from 3 to 8 blows, the fill was generally very loose to loose in relative density. The natural moisture content of recovered samples of fill soils was between 8% and 13%.

3.3 SAND SOILS

Beneath the surficial topsoil, the native soils at the site generally consisted of sand deposits with trace amounts of gravel, silt, and clay. The sand soils were observed to be very loose to compact in relative density, with SPT N values ranging from 0 to 27 blows. The sand soils were generally moist to saturated at the time of investigation, with natural moisture content varying from 6% to 26% based on laboratory testing.

Laboratory particle size distribution analyses were completed on three (3) samples of the sand soils taken from the boreholes at depths provided in Table 1 in order to identify the varying soil textures encountered throughout the overburden material. The testing results are provided in Appendix B and are summarized below in Table 1 based on the USCS.

Table 1 Particle Size Distribution Analysis – Silty Sand

Sample	Depth (mbgs)	Soil	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH101-19	1.5 – 2.0	Sand Trace Silt Trace Clay	0	93	4	3
BH108-19	2.3 – 2.7	Sand Trace Gravel Trace Silt, Trace Clay	4	88	5	3
BH114-19	0.6 – 1.2	Sand Some Silt Trace Clay	0	83	13	4

3.4 BEDROCK

Bedrock was not encountered within the investigation depths Boreholes were terminated in native soils at a depth of 5.0 mbgs. The borehole elevations and termination depths are summarized below in Table 2.

Table 2 Borehole and Test Pit Termination Depths

Borehole or Test Pit ID	Borehole Elevation (mASL)	Termination Depth (mbgs)	Termination Elevation (mASL)
BH101-19	236.416	5.0	231.42
BH102-19	237.514	5.0	232.51
BH103-19	237.776	5.0	232.78
BH104-19	238.664	5.0	233.66
BH105-19	238.707	5.0	233.71
BH106-19	237.527	5.0	232.53
BH107-19	237.118	5.0	232.12
BH108-19	238.47	5.0	233.47
BH109-19	236.183	5.0	231.18
BH110-19	235.726	5.0	230.73
BH111-19	239.95	5.0	234.95
BH112-19	240.125	5.0	235.12
BH113-19	239.603	5.0	234.60
BH114-19	240.942	5.0	235.94

3.5 GROUNDWATER

Groundwater was encountered at the time of the investigations within each of the boreholes advanced across the site at depths between 0.6 mbgs and 4.6 mbgs. Caving (sloughing) was encountered in twelve (12) of the boreholes. The groundwater level in monitoring wells BH110-19 and BH114-19 were recorded on May 28th, 2019. Groundwater and caving observations are summarized below in Table 3.

The moisture content of the inorganic soils generally ranged from 6% to 26%. It should be noted that soil moisture and groundwater levels at the Site may fluctuate seasonally and in response to climatic events.

Table 3 Groundwater and Caving Observations

Date	Borehole or Test Pit ID	Observed Groundwater Depth (mbgs)	Observed Sloughing Depth (mbgs)	Observed Groundwater Elevation (mASL)
May 21st. 2019	BH101-19	0.9	1.2	235.52
	BH102-19	1.95	1.95	235.56
	BH103-19	2.1	2.1	235.68
	BH104-19	3.0*	1.2	235.66
	BH105-19	4.6	4.6	234.11
	BH106-19	2.7	2.7	234.83
	BH107-19	2.55*	0.3	234.57
May 22nd, 2019	BH108-19	2.55	2.55	235.92
	BH109-19	0.6	1.8	235.58
	BH110-19	1.3*	-	234.43
	BH111-19	4.0	4.0	235.95
	BH112-19	3.65	3.65	236.48
	BH113-19	3.65	3.65	235.95
	BH114-19	4.0*	-	236.94
May 28th, 2019	BH/MW110-19	0.1	-	235.62
	BH/MW114-19	4.49	-	236.45

** Groundwater depth inferred based on moisture content of collected soil samples or observation of soil cuttings*

4.0 GEOTECHNICAL 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 and test pit 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.

4.1 SITE PREPARATION

Existing topsoil, any organic matter encountered, and existing fill shall be excavated and removed from 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 any building footprints. The exposed subgrade should be proof-rolled and inspected by a qualified geotechnical engineer prior to placement of granular fill. Any loose/soft soils identified at the time of proof-rolling that are unable to be uniformly 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 soils can be very 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.

4.2 EXCAVATIONS

All excavations must be carried out in accordance with the latest edition of the Occupational Health and Safety Act (OHSA). The generally compact to dense native sand soils may be classified as Type 3 soils above the groundwater table in accordance with OHSA. Type 3 soils may be excavated with side slopes no steeper than 1H:1V. Below the groundwater table, these soils may be classified as Type 4 soils and may be excavated with unsupported side slopes no steeper than 3H:1V.

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 excavations or if wet conditions are encountered, the side slopes should be flattened as required to maintain safe working conditions or excavation sidewalls must be fully supported (shored).

4.3 DEWATERING

The groundwater table was encountered across the site and appeared to vary in depth as measured in the monitoring wells and at the time of investigation. Groundwater was observed in each of the boreholes at depths

varying from 0.1 mbgs to 4.49 mbgs, or from an elevation of 234.11 mASL to 236.94 mASL as summarized in Table 3.

Additional seepage may occur across the Site if high groundwater conditions are present during construction due to seasonal fluctuations. If groundwater seepage is encountered it should be manageable with filtered sumps and pumps and depending on size of excavation, a Permit to Take Water (PTTW) or registry in the Environmental Activity and Sector Registry of the Ministry of the Environment Conservation and Parks (MOECP) may 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. In order to minimize predictable water issues and costs, it is recommended that excavation and in-ground construction be performed in drier seasons.

4.4 BACKFILL AND COMPACTION

Excavated topsoil or organic materials from the Site are not appropriate for use as fill below grading and parking areas. Excavated native soils not containing organics, may be appropriate for use as fill below grading and parking 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 on seasonal conditions. Geotechnical inspections and testing of engineered fill are required to confirm acceptable quality.

Any engineered fill below foundations should be placed in lifts appropriate to the type of compaction equipment used, and be compacted to a minimum of 100% of standard Proctor maximum dry density (SPMDD), as confirmed by nuclear densometer testing. 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. 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. Consideration could be given to using a material meeting the specifications of OPSS 1010 Granular B or an approved equivalent. Foundation wall and any buried utility backfill material should consist of free-draining imported granular material. Most of the native site soils are too fine-grained to provide proper drainage, and as such this should be accomplished using well graded Granular B Type 1 material complying with OPSS 1010.

The backfill material, if any, in the upper 300 mm below the pavement subgrade elevation should be compacted to 100 percent of SPMDD in all areas.

4.4.1 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 1:1 slope to the competent 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 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. Any frost penetration into the fill material must be removed prior to placement of subsequent lifts of fill and reviewed by Cambium;

V. 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.

4.5 FROST PENETRATION

Based on climate data and design charts, the maximum frost penetration depth at the Site is estimated at 1.5 m.

Exterior footings of structures should be situated at or below this depth for frost penetration or should be appropriately protected. If structures include heated basements, footings sited on compact native soils may have a minimum of 1.2 m of cover fill to protect against frost heave per the Ontario Building Code.

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 utilities should be located below this depth or be appropriately insulated.

4.6 FOUNDATION DESIGN

Design and construction recommendations for these 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.

The quality of the subgrade should be inspected by Cambium during construction, prior to constructing the footings, to confirm bearing capacity estimates. Settlement potential at the noted at serviceability limit state (SLS) loadings is less than 25 mm and differential settlement should be less than 10 mm.

4.6.1 FOUNDATIONS ON NATIVE SOIL

Based on the undisturbed very loose to compact sand encountered throughout the site, footings situated throughout the development area, at a minimum depth of 1.5 metres below existing grade may be designed for an allowable bearing capacity of 75 kPa at SLS and 95 kPa at ultimate limit state (ULS).

4.6.2 FOUNDATIONS ON ENGINEERED FILL

If engineered fill is prepared per the requirements outlined in Section 4.4.1, footings may be sited on engineered fill.

Footings placed on a minimum of 1.0 metre of approved engineered fill can be designed for an allowable bearing capacity of 75 kPa at SLS and 135 kPa at ULS. Where OPSS 1010 Granular 'B' Type I granular material is utilized as an engineered fill up to underside of proposed footing elevation, the footings may be designed for an allowable bearing capacity of 115 kPa at SLS and 160 kPa at ULS. To account for the footings being constructed on differing soils, two rows of reinforcing steel is recommended in both the footings and the top of the foundation wall.

4.7 TEMPORARY SHORING

Consideration should be given to open cut excavations using OHSA requirements. If temporary shoring is required near loaded sidewall or restricted excavations, a soldier pile and lagging system with either a cantilever design or strut bracing to support lateral loads can be used. Sheet piles would also be suitable for use as temporary shoring. Soil properties for use in temporary shoring design are provided in Section 4.8.

4.8 SOIL PROPERTIES FOR LATERAL EARTH PRESSURE

Lateral earth pressure coefficients (K) for foundation and retaining wall design are provided below for the case of a horizontal backfill surface (i.e. the ground surface is not inclined). It is assumed that potential lateral loads will result from cohesionless, frictional materials, such as granular backfill. An angle of internal friction of 35° can be assumed for compacted granular backfill and 30° for the native silty sand. Unfactored lateral earth pressure coefficients (K) are provided in Table 4.

Table 4 Lateral Earth Pressure Coefficients

Soil Property	Granular Backfill	Native Sand
Friction Angle, Φ (º)	35	30
Cohesion, c_u (kPa)	0	0
Unit Weight, γ (kN/m^3)	21	18
Earth pressure coefficient, at rest, K_o	0.43	0.5
Active Earth pressure coefficient, K_a	0.27	0.33
Passive Earth pressure coefficient, K_p	3.7	3.0

The following formula may be used to calculate active lateral thrust (Pa) on yielding retaining structures;

$Pa= (H/2)(Ka)(\gamma H+2q)$

where,

H = Height of retaining structure (m)

γ= unit weight of retained soil (kN/m^3)

q = surcharge (kPa)

4.9 SLAB ON GRADE

To create a stable working surface, to distribute loadings, and for drainage purposes, the floor slabs should be constructed on a minimum of 200 mm of OPSS 1010 Granular A compacted to 100% of SPMDD.

4.10 SUBDRAINAGE

Given the potential for shallow groundwater elevations, Cambium recommends installation of geotextile wrapped subdrains set in a trench of clear stone and connected to a sump or other frost-free positive outlet below the floor slab and around the perimeter of any building foundations. It is noted that the slab and foundation walls should be water proofed.

4.11 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". Based on the explored soil properties and in accordance with Table 4.1.8.4.A of the OBC (2006), it is recommended that Site Class "E" (soft soil and soft rock) be applied for structural design at the Site. If required, consideration could be given to completing Multi-Chanel Analysis of Surface Wave (MASW) testing as Site Class D might be possible. Peak ground acceleration and spectral acceleration (period of 0.2 seconds) for the site are calculated to be 0.077g and 0.130g 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.

4.12 BURIED UTILITIES

Trench excavations above the groundwater table should generally consider Type 3 soil conditions, which require side slopes no steeper than 1H:1V, otherwise shoring would be required. Any excavations below the water table should generally consider Type 4 soil conditions which require side slopes of 3H:1V or flatter.

Bedding and cover material for any services should consist of OPSS 1010 Granular A or B Type II, placed in accordance with pertinent Ontario Provincial Standard Drawings (OPSD 802.013). The bedding and cover material shall be placed in maximum 200 mm thick lifts and should be compacted to at least 98 percent of SPMDD. The cover material shall be a minimum of 300 mm over the top of the pipe and compacted to 98 percent of SPMDD, taking care not to damage the utility pipes during compaction. If bedding is being placed in wet conditions consideration should be given to using 19 mm crushed clear stone underlain by a geotextile (Terrafix 270R or similar).

4.13 PAVEMENT DESIGN

The performance of the pavement is dependent upon proper subgrade preparation and drainage. All topsoil and organic materials should be removed down to native material and backfilled with approved engineered fill or native material, compacted to 98 percent SPMDD. The subgrade should be proof rolled and inspected by a Geotechnical Engineer. Any areas where rutting or appreciable deflection is noted should be subexcavated and replaced with suitable fill. The fill should be compacted to at least 98 percent SPMDD.

The recommended minimum pavement structure design has been developed for two (2) traffic loading scenarios; light duty and heavy duty. The heavy duty design is appropriate for areas where truck traffic is anticipated while the light duty design is appropriate for areas where no truck traffic is anticipated.

The recommended minimum pavement structure is provided in Table 5.

Table 5 Recommended Minimum Pavement Structure

Pavement Layer	Light Duty (residential roads)	Heavy Duty (access roads or heavy truck traffic)
Surface Course Asphalt	40 mm HL3 or HL4	40 mm HL3 or HL4
Binder Course Asphalt	50 mm HL8	90 mm HL8
Granular Base	150 mm OPSS 1010 Granular A	150 mm OPSS 1010 Granular A
Granular Subbase	300 mm OPSS 1010 Granular B	400 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 98% of SPMDD (ASTM D698) standard. 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 percent to shed runoff. Abutting pavements should be sawcut to provide clean vertical joints with new pavement areas.

4.14 DESIGN REVIEW AND INSPECTIONS

Testing and inspections should be carried out during construction operations to examine and approve subgrade conditions, fill material, compaction of bedding, trench backfill, and granular base courses.

We 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.

5.0 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 ext. 405.

Respectfully submitted,

CAMBIUM INC.

Rob Gethin, P.Eng.
Senior Project Manager

RLG/jsb

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Appended Figures

GEOTECHICAL INVESTIGATION

IVIVA HOMES
Miller Drive,
Barrie, ON

LEGEND

- Borehole Location
- Monitoring Well Location

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.

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BOREHOLE/MONITORING WELL LOCATION PLAN

Project No.:	9089-001	Date:	June 2019
		Rev.:	
Scale:	1:1,000	Projection:	NAD 1983 UTM Zone 17N
Created by:	MAT	Checked by:	RG
Figure:	1		

O:\GIS\project_MXDs\9000-9099\9089-001 IViva Homes - Geotechnical - Miller Drive, Barrie ON\2019-06-03 FIG 1 Borehole-Monitoring Well Location Plan.mxd

Appendix A
Borehole Logs

Peterborough
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Kingston
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Log of Borehole: BH101-19

Client:	iViva Homes	**Project Name:**	Geotechnical Investigation - Miller Drive	**Project No.:**	9089-001
Contractor:	Walker Drilling	**Method:**	Hollow Stem Augers	**Date Completed:**	May 21, 2019
Location:	156 Miller Drive, Barrie, ON	**UTM:**	17T, 4914192.74, 600358.14	**Elevation:**	236.42 mASL

SUBSURFACE PROFILE			SAMPLE							
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
236 / 0		Topsoil: Dark brown topsoil, moist, loose	1A	SS	100	4				
		Fine Sand: Brown fine sand, trace silt, moist, loose	1B							
			2	SS	70	9				
235 / 1		Wet								
			3	SS	50	14				GSA SS3: 0% Gravel 93% Sand 4% Silt 3% Clay
234 / 2		Compact								
			4	SS	65	8				
233 / 3										
			5	SS	90	9				
232 / 4										
			6	SS	75	9				
231 / 5		Borehole terminated at 5.0 mbgs								Groundwater and caving at 0.9 mbgs upon completion.
6										

Logged By: JSB **Input By:** CM

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Log of Borehole: BH102-19

Client:	iViva Homes	**Project Name:**	Geotechnical Investigation - Miller Drive	**Project No.:**	9089-001
Contractor:	Walker Drilling	**Method:**	Hollow Stem Augers	**Date Completed:**	May 21, 2019
Location:	156 Miller Drive, Barrie, ON	**UTM:**	17T, 4914216.82, 600348.92	**Elevation:**	237.51 mASL

SUBSURFACE PROFILE			SAMPLE							
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
0 / 237		Topsoil: Dark brown topsoil, moist, loose	1A							
		Fine Sand: Brown fine sand, trace silt, moist, loose	1B	SS	70	3				
1 / 236			2	SS	90	7				
			3	SS	80	7				
2 / 235		Wet								
		Saturated, compact	4	SS	60	12				
3 / 234			5	SS	65	12				
4 / 233			6	SS	60	13				
5 / 232		Borehole terminated at 5.0 mbgs								Groundwater and caving at 1.95 mbgs upon completion.
6										

Logged By: JSB **Input By:** CM

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Log of Borehole: BH103-19

Client:	iViva Homes	**Project Name:**	Geotechnical Investigation - Miller Drive	**Project No.:**	9089-001
Contractor:	Walker Drilling	**Method:**	Hollow Stem Augers	**Date Completed:**	May 21, 2019
Location:	156 Miller Drive, Barrie, ON	**UTM:**	17T, 4914219.47, 600311.75	**Elevation:**	237.78 mASL

SUBSURFACE PROFILE			SAMPLE							
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
0 / 237		Topsoil: Dark brown topsoil, moist, loose	1A	SS	30	3				
		Fine Sand: Brown fine sand, trace silt, moist, loose	1B							
1			2	SS	90	3				
236										
2			3	SS	10	7				
235			4	SS	75	9				
3										
		Compact	5	SS	40	12				
234										
4										
233			6	SS	90	21				
5										
		Borehole terminated at 5.0 mbgs								Groundwater and caving at 2.1 mbgs upon completion.
232										
6										

Logged By: JSB **Input By:** CM

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Log of Borehole: BH104-19

Client: iViva Homes
Project Name: Geotechnical Investigation - Miller Drive
Project No.: 9089-001
Contractor: Walker Drilling
Method: Hollow Stem Augers
Date Completed: May 21, 2019
Location: 156 Miller Drive, Barrie, ON
UTM: 17T, 4914235.46, 600318.20
Elevation: 238.66 mASL

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
238 / 0		Topsoil: Dark brown topsoil, moist, loose	1A							
		Sand: Brown sand, trace silt, brick fragments, moist, loose FILL	1B	SS	50	6				
238 / 1			2	SS	10	7				
237 / 2			3A							
		Fine Sand: Brown fine sand, trace silt, moist, compact	3B	SS	65	14				
		Wet	4	SS	55	16				
236 / 3										
			5	SS	70	13				
235 / 4										
234 / 5			6	SS	80	14				
		Borehole terminated at 5.0 mbgs								Groundwater first observed at 2.7 mbgs and caving at 1.2 mbgs upon completion.
233 / 6										

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Log of Borehole: BH105-19

Client:	iViva Homes	**Project Name:**	Geotechnical Investigation - Miller Drive	**Project No.:**	9089-001
Contractor:	Walker Drilling	**Method:**	Hollow Stem Augers	**Date Completed:**	May 21, 2019
Location:	156 Miller Drive, Barrie, ON	**UTM:**	17T, 4914259.67, 600252.72	**Elevation:**	238.71 mASL

SUBSURFACE PROFILE			SAMPLE							
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
0 / 238		Topsoil: Dark brown topsoil, moist, loose	1A							
		Fine Sand: Brown fine sand, trace silt, trace organics, moist, compact	1B	SS	60	2				
1			2	SS	50	5				
237			3A							
		Fine Sand: Brown to grey fine sand, trace silt, wet, loose	3B	SS	70	8				
2										
		Compact, wet	4	SS	65	21				
236		Fine Sand: Grey fine sand, trace silt, trace clay, moist, compact								
3			5	SS	50	16				
235										
4										
234			6	SS	55	20				
5										
		Borehole terminated at 5.0 mbgs								Groundwater first observed at 2.3 mbgs and caving at 2.7 mbgs upon completion.
233										
6										

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Log of Borehole: BH106-19

Client:	iViva Homes	**Project Name:**	Geotechnical Investigation - Miller Drive	**Project No.:**	9089-001
Contractor:	Walker Drilling	**Method:**	Hollow Stem Augers	**Date Completed:**	May 21, 2019
Location:	156 Miller Drive, Barrie, ON	**UTM:**	17T, 4914296.41, 600235.82	**Elevation:**	237.53 mASL

Elevation (m) / Depth	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
237 / 0	Topsoil: Dark brown topsoil, moist, loose	1A							
	Sand: Brown sand, trace silt, moist, compact	1B	SS	60	11				
236 / 1	Fine Sand: Grey fine sand, trace silt, trace clay, saturated, compact	2	SS	70	11				
	loose	3	SS	100	3				
235 / 2									
		4	SS	100	17				
234 / 3									
		5	SS	60	18				
233 / 4									
		6	SS	90	21				
232 / 5	Borehole terminated at 5.0 mbgs								Groundwater at 0.6 mbgs and caving at 4.3 mbgs upon completion.
6									

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Log of Borehole: BH107-19

Client:	iViva Homes	**Project Name:**	Geotechnical Investigation - Miller Drive	**Project No.:**	9089-001
Contractor:	Walker Drilling	**Method:**	Hollow Stem Augers	**Date Completed:**	May 21, 2019
Location:	156 Miller Drive, Barrie, ON	**UTM:**	17T, 4914217.61, 600270.10	**Elevation:**	237.12 mASL

Elevation (m)	Depth	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
237	0	Topsoil: Dark brown topsoil, moist, loose	1A							
		Fine Sand: Brown fine sand, trace silt, moist, compact	1B	SS	40	4				
		Fine Sand: Brown to grey fine sand, trace silt, trace gravel, some cobbles, moist, compact	2	SS	70	11				
236	1									
		Wet	3	SS	60	27				
235	2									
		Fine Sand: Brown fine sand, trace silt, trace gravel, moist, compact	4	SS	70	21				
		Saturated								
234	3		5	SS	80	26				
233	4									
		Less gravel, grey	6	SS	70	18				
232	5									
		Borehole terminated at 5.0 mbgs								Groundwater first observed at 2.4 mbgs and caving at 0.3 mbgs upon completion.
	6									

Logged By: CM **Input By:** CM

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Log of Borehole: BH108-19

Client:	iViva Homes	**Project Name:**	Geotechnical Investigation - Miller Drive	**Project No.:**	9089-001
Contractor:	Walker Drilling	**Method:**	Hollow Stem Augers	**Date Completed:**	May 22, 2019
Location:	156 Miller Drive, Barrie, ON	**UTM:**	17T, 4914242.38, 600284.30	**Elevation:**	238.47 mASL

SUBSURFACE PROFILE			SAMPLE							
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
0 / 238		Topsoil: Dark brown topsoil, moist, loose	1A	SS	50	4				
		Fine Sand: Brown fine sand, trace silt, moist, loose	1B							
1 / 237			2	SS	65	5				
2 / 236			3	SS	10	9				
		Coarser sand, compact								GSA SS4: 4% Gravel 88% Sand 5% Silt 3% Clay
			4	SS	50	20				
3 / 235		Saturated								
			5	SS	65	19				
4 / 234										
5 / 233			6	SS	60	27				
		Borehole terminated at 5.0 mbgs								Groundwater and caving at 1.95 mbgs upon completion.
6										

Logged By: JSB **Input By:** CM

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Log of Borehole: BH109-19

Client:	iViva Homes	**Project Name:**	Geotechnical Investigation - Miller Drive	**Project No.:**	9089-001
Contractor:	Walker Drilling	**Method:**	Hollow Stem Augers	**Date Completed:**	May 22, 2019
Location:	156 Miller Drive, Barrie, ON	**UTM:**	17T, 4914194.77, 600301.85	**Elevation:**	236.18 mASL

SUBSURFACE PROFILE			SAMPLE							
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
236 / 0		Topsoil: Dark brown topsoil, wet, loose	1A	SS	50	3				
		Fine Sand: Brown fine sand, trace silt, wet, compact	1B							
235 / 1			2	SS	75	10				
			3	SS	60	15				
234 / 2										
			4	SS	70	12				
233 / 3										
			5	SS	70	11				
232 / 4										
			6	SS	90	17				
231 / 5		Borehole terminated at 5.0 mbgs								Groundwater at 1.83 mbgs and caving at 0.6 mbgs upon completion
6										

Logged By: JSB **Input By:** CM

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Log of Borehole: BH110-19

Client:	iViva Homes	**Project Name:**	Geotechnical Investigation - Miller Drive	**Project No.:**	9089-001
Contractor:	Walker Drilling	**Method:**	Hollow Stem Augers	**Date Completed:**	May 22, 2019
Location:	156 Miller Drive, Barrie, ON	**UTM:**	17T, 4914173.24, 600325.53	**Elevation:**	235.73 mASL

SUBSURFACE PROFILE			SAMPLE							
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
0 / 235		Peat: Dark brown to black fine fiberous organic material, wet, compact	1A	SS	70	11			Cap	Top of Standpipe Elevation = 236.80 mASL Stickup Height = 1.078 m
		Sand: Brown sand, trace silt, wet, compact	1B							
1 / 234			2	SS	80	11			Cuttings	
									PVC Standpipe	
2 / 233			3	SS	60	12				
			4	SS	100	21			Bentonite Plug	
3 / 232			5	SS	100	13			Sand Pack PVC Screen	
4 / 231			6	SS	100	12			Cap	
5 / 230		Borehole terminated at 5.0 mbgs								Groundwater measured at 0.10 mbgs (235.62 mASL) on May 28th, 2019
6										

Logged By: JSB **Input By:** CM

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Log of Borehole: BH111-19

Client: iViva Homes
Project Name: Geotechnical Investigation - Miller Drive
Project No.: 9089-001
Contractor: Walker Drilling
Method: Hollow Stem Augers
Date Completed: May 22, 2019
Location: 156 Miller Drive, Barrie, ON
UTM: 17T, 4914245.99, 600330.94
Elevation: 239.95 mASL

SUBSURFACE PROFILE			SAMPLE								
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
0 / 239		Topsoil: Dark brown sandy topsoil, moist, loose	1A							
		Sand: Brown sand, trace silt, moist, loose, FILL	1B	SS	100	3				
1			2	SS	70	3				
2 / 238			3	SS	45	8				
		Sand: Brown sand, trace silt, moist, loose								
			4	SS	0	6				Cobble in tip of split spoon
3 / 237										
		Compact	5	SS	60	12				
4 / 236										
5 / 235			6	SS	65	19				
		Borehole terminated at 5.0 mbgs								Groundwater and caving at 3.96 mbgs upon completion
6 / 234										

Logged By: JSB
Input By: CM

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Log of Borehole: BH112-19

Client: iViva Homes
Project Name: Geotechnical Investigation - Miller Drive
Project No.: 9089-001
Contractor: Walker Drilling
Method: Hollow Stem Augers
Date Completed: May 22, 2019
Location: 156 Miller Drive, Barrie, ON
UTM: 17T, 4914280.76, 600309.21
Elevation: 240.12 mASL

SUBSURFACE PROFILE			SAMPLE							
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
240 / 0		Topsoil: Dark brown topsoil, moist, loose	1A							
		Fine Sand: Brown fine sand, trace silt, moist, loose	1B	SS	50	2				
			2	SS	100	3				
239 / 1										
			3	SS	75	5				
238 / 2										
			4	SS	40	2				
237 / 3		Sandy Silt: Light brown sandy silt, some cobbles, saturated, compact	5	SS	50	11				
236 / 4		Silty Sand: Brown silty sand, saturated, compact								
			6	SS	65	15				
235 / 5		Borehole terminated at 5.0 mbgs								Groundwater and caving at 3.66 mbgs upon completion
6										

Logged By: JSB
Input By: CM

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Log of Borehole: BH113-19

Client:	iViva Homes	**Project Name:**	Geotechnical Investigation - Miller Drive	**Project No.:**	9089-001
Contractor:	Walker Drilling	**Method:**	Hollow Stem Augers	**Date Completed:**	May 22, 2019
Location:	156 Miller Drive, Barrie, ON	**UTM:**	17T, 4914285.09, 600287.07	**Elevation:**	239.60 mASL

SUBSURFACE PROFILE			SAMPLE							
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
0 / 239		Topsoil: Dark brown topsoil, moist, loose	1A	SS	50	2				
		Fine Sand: Brown fine sand, trace silt, moist, loose	1B							
1 / 238			2	SS	100	2				
2 / 237			3	SS	45	0				
		Compact								
3 / 236			4	SS	70	19				
		Wet, some clay								
4 / 235			5	SS	70	19				
5 / 234			6	SS	65	17				
6		Borehole terminated at 5.0 mbgs								Groundwater and caving at 3.66 mbgs upon completion

Logged By: JSB **Input By:** CM

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Log of Borehole: BH114-19

Client:	iViva Homes	**Project Name:**	Geotechnical Investigation - Miller Drive	**Project No.:**	9089-001
Contractor:	Walker Drilling	**Method:**	Hollow Stem Augers	**Date Completed:**	May 22, 2019
Location:	156 Miller Drive, Barrie, ON	**UTM:**	17T, 4914285.62, 600321.57	**Elevation:**	240.94 mASL

SUBSURFACE PROFILE			SAMPLE							
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
0 / 240		Topsoil: Dark brown topsoil, moist, loose	1A	SS	75	3			Cap	Top of Standpipe Elevation = 241.85 mASL Stickup Height = 0.907 m
		Fine Sand: Brown fine sand, trace silt, moist, loose	1B							
1			2	SS	100	4			Cuttings	GSA SS2: 0% Gravel 83% Sand 13% Silt 4% Clay
		Compact							PVC Standpipe	
2 / 239			3	SS	90	11				
			4	SS	70	17			Bentonite Plug	
3 / 238		Increased clay and silt content, wet	5	SS	90	11				
4 / 237									Sand Pack PVC Screen	
5 / 236			6	SS	75	10			Cap	
6 / 235		Borehole terminated at 5.0 mbgs								Groundwater measured at 4.49 mbgs (236.45 mASL) on May 28th, 2019

Logged By: JSB **Input By:** CM

Appendix B

Physical Laboratory Testing Results

Grain Size Distribution Chart

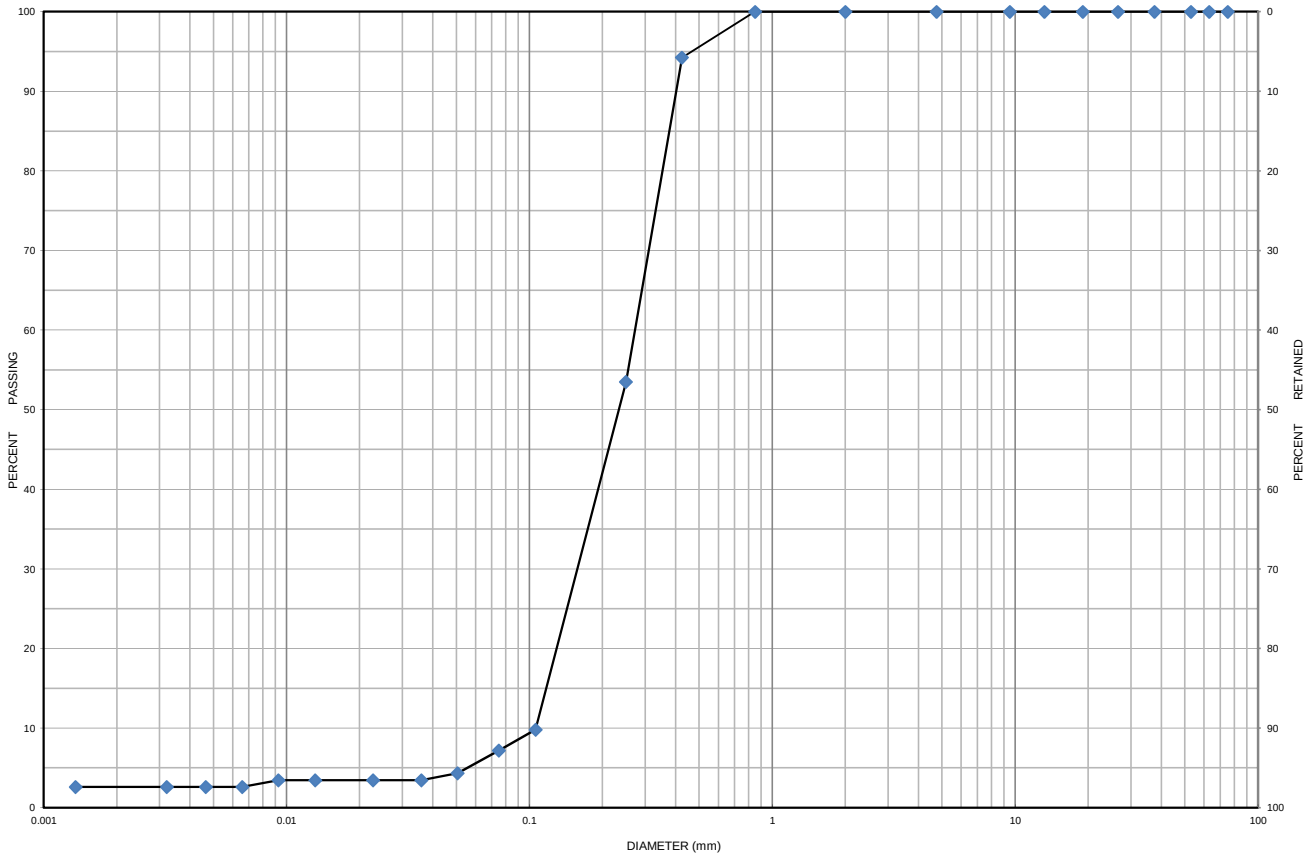
Project Number: *9089-001* **Client:** *iViva Homes*

Project Name: *Miller Drive Site*

Sample Date: *May 21, 2019* **Sampled By:** *Jacob Bell - Cambium Inc.*

Location: *BH 101-19 SS 3* **Depth:** *1.5 m to 2 m* **Lab Sample No:** *S-19-0334*

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 101-19	SS 3	1.5 m to 2 m	0	93	7		22.4

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Sand trace Silt trace Clay	SP	0.270	0.160	0.110	2.45	0.86

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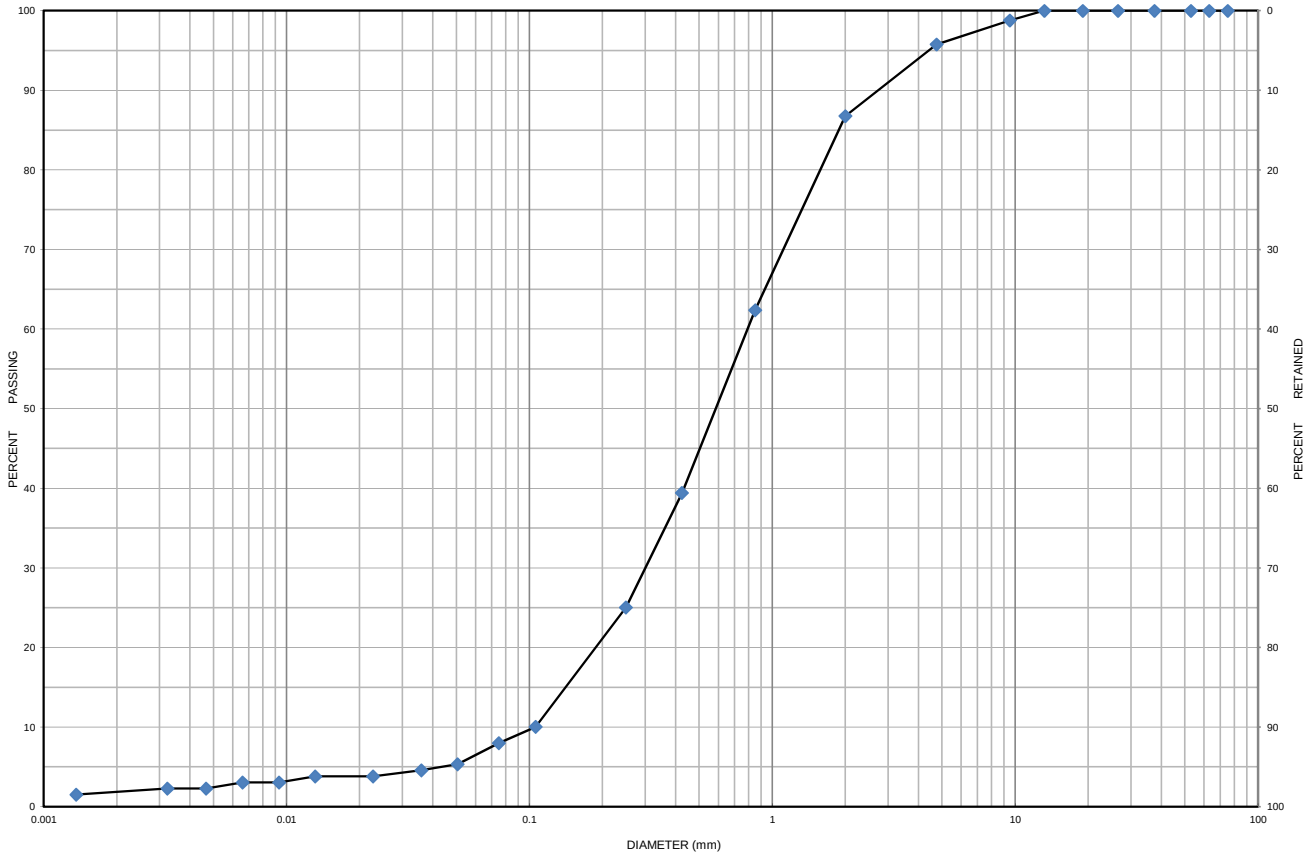
Grain Size Distribution Chart

Project Number:	*9089-001*	**Client:**	*iViva Homes*		
Project Name:	*Miller Drive Site*				
Sample Date:	*May 21, 2019*	**Sampled By:**	*Jacob Bell - Cambium Inc.*		
Location:	*BH 108-19 SS 4*	**Depth:**	*2.3 m to 2.7 m*	**Lab Sample No:**	*S-19-0335*

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 108-19	SS 4	2.3 m to 2.7 m	4	88	8		10.7

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Sand trace Silt trace Gravel trace Clay	SP	0.790	0.300	0.110	7.18	1.04

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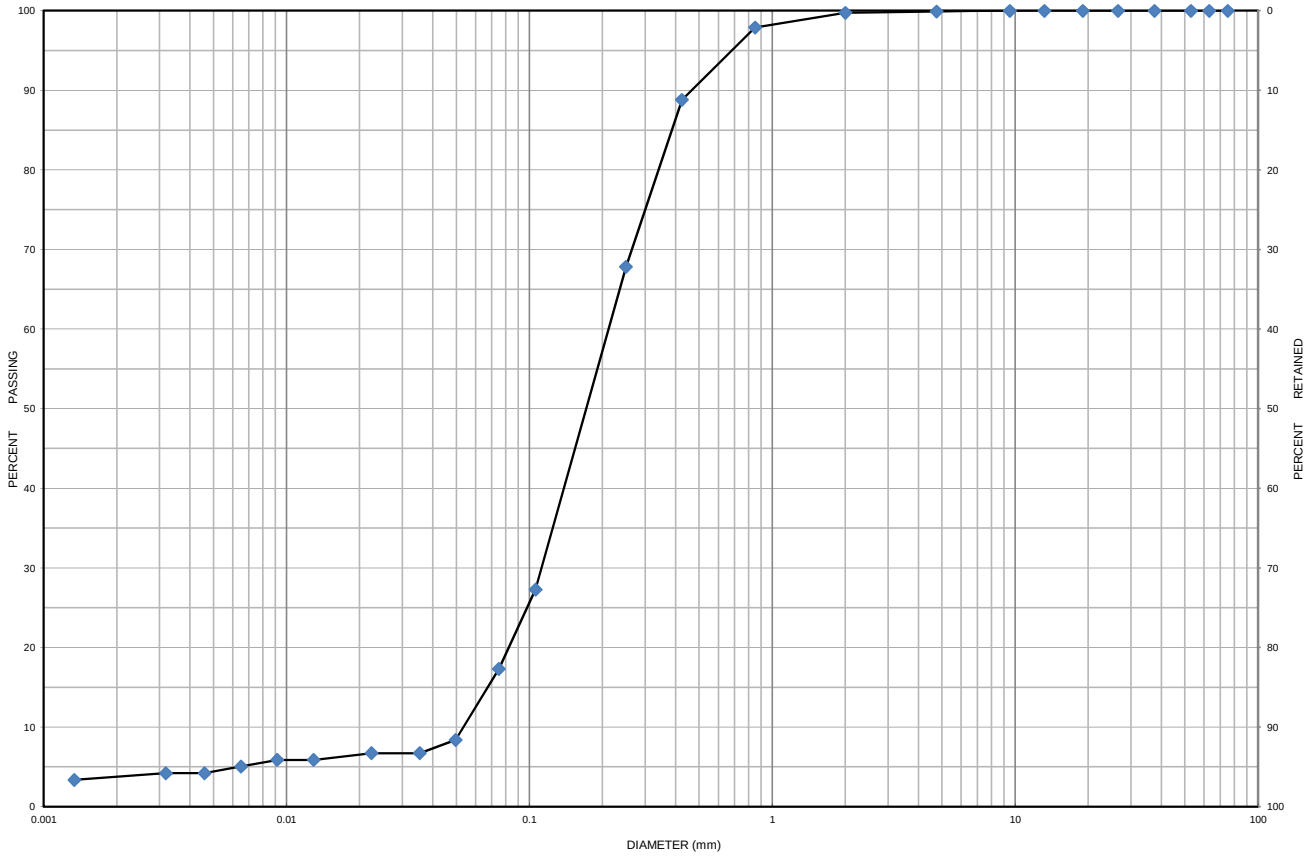
Grain Size Distribution Chart

Project Number:	*9089-001*	**Client:**	*iViva Homes*		
Project Name:	*Miller Drive Site*				
Sample Date:	*May 21, 2019*	**Sampled By:**	*Jacob Bell - Cambium Inc.*		
Location:	*BH 114-19 SS 2*	**Depth:**	*0.6 m to 1.2 m*	**Lab Sample No:**	*S-19-0336*

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 114-19	SS 2	0.6 m to 1.2 m	0	83	17		7.2

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Sand some Silt trace Clay	SP	0.220	0.120	0.053	4.15	1.23

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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: 44.374N 79.740W **User File Reference:** 156 Miller Drive 2019-05-29 16:46 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)	0.107	0.071	0.048	0.018
Sa (0.3)	0.092	0.062	0.043	0.016
Sa (0.5)	0.076	0.051	0.035	0.013
Sa (1.0)	0.047	0.031	0.021	0.006
Sa (2.0)	0.024	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	0.040	0.027	0.009
PGV (m/s)	0.063	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