Hydrogeological Assessment - 189-197 Duckworth Street, Barrie

November 3, 2023

Prepared for:
Cyngus Developments

Cambium Reference: 18989-001

CAMBIUM INC.

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1.0 Introduction

Cyngus Developments (Client) retained Cambium Inc. (Cambium) to complete a hydrogeological assessment in support of a proposed re-development of the combined properties at 189, 191, 195 & 197 Duckworth Street in Barrie, Ontario (Site).

The Site is approximately 0.3 ha and currently consists of four (4) developed residential properties with dwellings (serviced with municipal water and wastewater services), and associated landscaping (mature tree coverage and existing property line fencing).

The townhouse development consists of re-developing the Site as a three-story townhouse block, with associated parking, and an outdoor amenity area. Anticipated depth of the basement is 3.30 meters below the finished floor elevation (FFE) of 275.80 metres above sea level (masl). The townhouse development plan is attached in Appendix A.

The hydrogeological assessment was required to characterize the hydrogeological setting of the Site and assess impact (if any) to sensitive receptors upon development. A geotechnical investigation was completed concurrently with the hydrogeological assessment and was titled as Geotechnical Investigation Report, 189-197 Duckworth Street, Barrie, Ontario (Cambium Inc., 2023).

2.0 Methodology

This section describes the methodology undertaken to complete the hydrogeological assessment.

2.1 Drilling Program

A borehole investigation was completed on October 2, 2020, to assess subsurface conditions at the Site. A total of three (3) boreholes, designated as BH101-20 through BH103-20, were advanced throughout the Site. All the boreholes were terminated at depths ranging from 3.1 m to 4.7 m below ground surface (mbgs). Boreholes BH101-20, BH102-20, and BH103-20 were advanced at the south, north-west and north-east side of the Site, respectively.

The borehole locations and elevations were surveyed using a Sokkia RTK GPS system. The elevations were adjusted based on the closest Control Survey Information Exchange benchmark to the Site (Station 03120080028) which has an elevation 269.47 masl. The borehole coordinates and elevations are provided on the borehole logs in Appendix B. Borehole locations are shown on Figure 1.

Drilling and sampling were completed using a track-mounted drill rig, under the supervision of a Cambium Geotechnical Analyst. The boreholes were advanced by means of continuous flight hollow stem augers with 50 mm O.D. split spoon samplers. It is noted that due to the difficult drilling conditions, practical refusal was encountered prior to the predetermined drilling depths. Standard Penetration Test (SPT) N values were recorded for the sampled intervals as the number of blows required to drive a split spoon (SS) sampler 305 mm into the soil using a 63.5 kg drop hammer falling 750 mm, as per ASTM D1586 procedures. Soil samples were collected at 0.75 m intervals from 0 to 3 m depth and at 1.5 m intervals after 3 m depth. 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, laboratory testing, and storage. Open boreholes were checked for groundwater and general stability prior to backfilling.

Three (3) boreholes, BH101-20, BH102-20, and BH103-20 were outfitted as monitoring wells in order to determine the static groundwater elevation at the Site.

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

2.2 Physical Laboratory Testing

Physical laboratory testing (sieve and hydrometer analyses (LS-702, 705)) was completed on four soil samples to confirm textural classification and to assess geotechnical parameters. Results are presented in Appendix C and are discussed in Section 3.1.1.

2.3 Hydrogeological Field Tasks

On October 15, 2020, Cambium staff visited the Site to attempt in-situ infiltration testing with a Guelph Permeameter. In-situ infiltration testing of the native mineral soils could not be completed since the depth of topsoil/organic soil ranged in depth from 0.6 metres below ground surface (mbgs) to 0.9 mbgs. The depth of these organic soils precluded practical testing capabilities of the Guelph Permeameter from ground surface with the use of hand tools.

In addition, each of the three monitoring wells were reported as dry on October 15, 2022.

On October 13, 2023, Cambium staff visited the Site to confirm groundwater conditions. Monitoring wells MW101-20 and MW103-20 were reported to be dry, but well MW102-20 had a measurable water level (see Section 3.3).

Single Well Hydraulic Tests were not completed on any of the wells due to dry/insufficient groundwater conditions.

3.0 Geological and Hydrogeological Setting

The Site is located in the physiographic region known as the Simcoe Uplands. The Simcoe Uplands region is comprised of broad, rolling till plains which are separated by steep-sided, flat-floored valleys. These areas are encircled by a number of shorelines indicating they were once islands in Lake Algonquin. Within this physiographic region are broad uplands south of Barrie and high ground north of Alliston, which stand approximately 60 m above the adjoining lake plains. It is likely that the ridges and valleys follow bedrock topography. It is also possible that the ridges originated as moraines due to an ice lobe in the Georgian Bay depression. Regardless, their surfaces were planed by a glacier moving towards the southwest. The till in the Simcoe uplands is different than that found east of Lake Simcoe, as it consists mostly of Precambrian rock rather than limestone. In more southern areas it is a gritty loam, becoming sandier and bouldery towards the north. There are heavier and more calcareous tills near Lake Simcoe and Midland (Chapman, L.J. and D.F. Putnam, 1984).

According to the Ontario Geological Survey (OGS, 2019), the Site is within an area where till soil is present that consists of sandy silt to silty sand sediments.

According to the Bedrock Geology of Ontario, southern sheet; Ontario Geological Survey, Map 2544, scale 1:250 000 (OGS, 2019) the bedrock in the area of the Site is characterized as limestone and shale.

3.1 Subsurface Investigation

The surface topsoil and organic fill ranged in thickness from 0.60 mbgs to 0.90 m, with an average thickness of 0.75 mm. The underlying mineral soil consisted of glacial till deposits predominantly sand with gravel to silty sand. These soils were encountered throughout the boreholes to the termination depths ranging from 3.1 mbgs to 4.7 mbgs. The boreholes were terminated in native soils and bedrock was not encountered within the investigation depths.

3.1.1 Grain Size Analyses

Laboratory grain size distribution analyses were completed on samples collected from three boreholes.

A T-Time for each grain size analysis was estimated. In addition, the document titled *Supplementary Guidelines to the Ontario Building Code 1997* (Ontario Ministry of Municipal Affairs and Housing, 1997) was referenced to establish infiltration rates, based upon the previously established T-Times. The infiltration rates of the mineral soils ranged from 20 mm/hr to 100 mm/hr. As described in the document titled Low Impact Development Stormwater Management Planning and Design Guide (Credit Valley Conservation, 2010) infiltration rates used for design purposes of Low Impact Development (LID) features should be assigned a safety correction factor. The infiltration rates outlined herein have not been assigned a safety correction factor. Additional infiltration testing should be completed to confirm in-situ soil conditions and a safety corrected factor applied to the infiltration rates for LID feature design and placement if deemed necessary. The grain sizes, T-Times and infiltration rates are summarized in Table 1.

Table 1 Grain Size Analyses Results

Borehole	Depth (mbgs)	Material	%Gravel	%Sand	%Silt	% Clay	T-Time (min/cm)	Infiltration Rate (mm/hr)
BH101-20	0.9 – 1.2	Silty Sand some Clay trace Gravel	6	49	33	12	30	20
BH101-20	1.5 – 1.8	Silty Sand trace Gravel and Clay	5	43	41	11	25	24
BH102-20	0.9 – 1.1	Gravelly Sand trace Silt and Clay	25	65	8	2	6	100
BH102-20	3.0 – 3.5	Silty Sand trace Gravel and Clay	7	44	36	13	25	24

3.2 Water Well Records

The Ministry of Environment, Conservation and Park's (MECP's) Water Well Information System (WWIS) was accessed to review water well records located within 500m of the Site. Water well records located within 500 m of the Site boundaries are outlined on Figure 2.

Five water well records were identified within approximately 500m of the Site. One record outlined the installation of a dug well, two records outlined installation of drilled wells, one record had no information, and one record was for the installation of a monitoring well.

The overburden was reported as combinations of sand and clay. The dug well was advanced to a depth of 7.60 mbgs and encountered groundwater at a depth of 3.05. The flow rate of the dug well was 2 gallons per minute. One of the drilled well records reported that no water was encountered (this well was advanced to a depth of 128 mbgs). The second drilled well record indicated that the well was advanced to a depth of 30 mbgs, encountered groundwater at a depth of 27 mbgs (in overburden), and had a recommended flow rate of 7 gpm.

It is likely that all properties in the area of the Site are provided potable water servicing from the City of Barrie. It is assumed that the water supply wells identified herein are no longer in use/service or have been decommissioned.

3.3 Hydrogeological Conditions

Shallow surficial soils were identified as glacial till deposits predominantly sand with gravel to silty sand. Upon installation (on October 2, 2020) and during a follow-up Site visit (on October 15, 2020) the monitoring wells were reported as dry.

On October 19, 2023, Cambium re-visited Site to confirm groundwater conditions take water levels. Monitoring wells MW101-20 and MW103-20 were reported to be dry, and MW102-20 had a static water level of 4.33 mbgs (elevation of 270.63 masl). Cambium recommends that water levels are measured monthly to confirm dry conditions through the spring.

The Site is located in a Wellhead Protection Area (WHPA) Q1 and Q2. A WHPA Q1 is an area where water withdrawal activities may be a threat to local municipal supply aquifers. The proposed townhouse development will be provided potable water by the City of Barrie, therefore WHPA Q1 policies do not apply to the Site. A WHPA Q2 is an area where activities that reduce recharge may be a threat. The townhouse development will increase runoff and decrease groundwater infiltration of the Site, as such WHPA Q2 policies apply to the townhouse development. A conceptual water balance is included in Section 5.0. The conceptual water balance characterizes the potential infiltration deficit upon development of the Site and includes a potential solution to mitigate the infiltration deficit.

The proposed townhouse development is not anticipated to influence local groundwater systems since dewatering efforts are anticipated to be minimal (see Section 4.0), and local residents are assumed to be provided potable water from the City of Barrie.

4.0 Results

In-situ infiltration testing of the mineral native soil could not be completed due to on-site topsoil conditions and instrument limitations. Infiltration rates were estimated based upon grain size analyses.

Additional in-situ infiltration testing should be completed during the detailed design stage of proposed LID features to confirm in-situ soil conditions.

There will be a one level basement for the townhouse development at a depth known to be 272.5 masl (i.e., 3.3 m below the FFE of 275.8 masl based on Drawing A 4.00 (Appendix A)) at the time this document was prepared. Presumably, construction excavations will be advanced around 1 m below the lowest floor elevation to approximately 271.5 masl.

Monitoring wells MW103-20 and MW101-20 were reported as dry upon monitoring on October 13, 2023. The water level of monitoring well MW102-20 was 4.33mbgs (270.62 masl) on October 13, 2023. The depth of groundwater in all the wells is below the maximum excavation depth of the structure. Therefore, it is likely that dewatering efforts during construction of the proposed townhouse development will be minimal. Water levels should be measured at the on-site monitoring wells on a regular basis for at least a 12-month period to confirm hydrogeological conditions.

5.0 Water Balance

Based on the Thornthwaite and Mather methodology (1957), the water balance is an accounting of water in the hydrologic cycle. Precipitation (P) falls as rain and snow. It can run off towards lakes and streams (R), infiltrate to the groundwater table (I), or evaporate from ground or evapotranspiration by vegetation (ET). When long-term average values of P, R, I, and ET are used, there is minimal or no net change to groundwater storage (ΔS).

The annual water budget can be expressed as:

$$P = ET + R + I + \Delta S$$

Where:

P = Precipitation (mm/year)

ET = Evapotranspiration (mm/year)

R = Run-off (mm/year)

I = Infiltration (mm/year)

ΔS = Change in groundwater storage (taken as zero) (mm/year)

It is noted that the water balance described herein does not account for catchment areas that extend off-site. The calculations compare the pre- and post-development water balance changes within the Site boundaries.

currently consists of four (4) developed residential properties with dwellings (serviced with municipal water and wastewater and natural gas), and associated landscaping (mature tree coverage and existing property line fencing). The proposed development consists of re-developing the residential properties to a townhouse development with a one level basement.

Based on the available design information, the development area at the Site can be generally categorized into three (3) types as paved area, roof area, and landscape areas. A summary of the surface areas of the development is listed in Table 2.

Table 2 Pre- and Post-Development Statistics

Type of Land Coverage	Pre-Developments Areas (m^2)	Post Development Areas (m^2)
Paved Area	223	1,457
Building Roof Area	648	792
Landscape Area	2,059	681
Total (m^2)	2,930	2,930

Supporting information referenced herein (including detailed water balance calculations) is attached in Appendix D.

5.1 Water Surplus

Water surplus is calculated by determining the difference between precipitation and evapotranspiration (changes in soil water storage was assumed to be negligible over the course of a year). The volume of water surplus is further sub-divided into portions that infiltrate the on-site soils and that are directed off-site as runoff.

The climatic data including monthly average temperature and precipitation were obtained from Environment Canada, for Barrie WPCP Weather Station (Climate ID: 6110557) located about 3 km distance from the Site. Accordingly, the average annual evapotranspiration was estimated to be about 531 mm/annum using the USGS Thornthwaite Monthly Water Balance methodology (Appendix D), and the average annual precipitation was recorded to be 933 mm/annum. The water surplus of the Site was calculated to be 402 mm/yr.

Evapotranspiration does not occur from structures, paved areas, or gravel surfaces. It was assumed that 10% of precipitation falling on these surfaces is lost directly to evaporation. The remaining depth (i.e., 90% of precipitation) was considered surplus and converted to infiltration and/or runoff.

5.2 Infiltration Factor

The volume of surplus water that infiltrates through pervious surfaces on-site was determined by applying an infiltration factor to the surplus depth. The surplus water that does not infiltrate into pervious surfaces will leave the Site as surface water runoff. The infiltration factor varies

from 0 to 1 and is estimated based on topography, soils, and vegetation cover as per the *Stormwater Management Planning and Design Manual* (Ministry of the Environment, 2003).

The rate of infiltration at a site is expected to vary, based on a number of factors to be considered in any infiltration model. To partition the available water surpluses into infiltration and surface run-off, the Ministry of Environment, Conservation and Parks (MECP) infiltration factor was used. The MECP Storm Water Management Planning and Design Manual (2003) methodology for calculating total infiltration based on topography, soil type and land cover was used, and a corresponding run-off component was calculated for the soil moisture storage conditions.

Prior to development, the topography of the Site exhibits a minor slope southward and the landscaped areas are vegetated with grass. The soils were determined to be glacial till deposits predominantly sand with gravel to silty sand. The infiltration factor of the pre-development landscaped areas was assumed to be 0.65 of available surplus. The infiltration factor of all landscaped included in the proposed development was also assumed to be 0.65. An infiltration factor of 0.65 corresponds to an infiltration rate of 261 mm/yr and a runoff rate of 141 mm/yr.

5.3 Pre-Development Water Balance

The water balance for existing conditions at the Site is summarized in Table 3. The pre-development infiltration rate and runoff rate was calculated to be 538 m³/yr and 1,021 m³/yr, respectively. The calculations assume no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

Table 3 Pre-Development Water Balance

Land Use		Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Impervious Areas	Paved Area	223	208	21	-	187
	Roof Area	648	605	60	-	544
Pervious Areas	Landscape Area	2,059	1,921	1,093	538	290
Total		**2,930**	**2,734**	**1,175**	**538**	**1,021**

5.4 Post Development Water Balance

The water balance for post-development conditions at the Site is summarized in Table 4. The pre-development infiltration rate and runoff rate was calculated to be 178 m^3/yr and 1,994 m^3/yr, respectively. The calculations assume no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

Table 4 Post-Development Water Balance

Land Use		Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Impervious Areas	Paved Area	1,457	1,360	136	-	1,224
	Roof Area	792	739	74	-	665
Pervious Areas	Landscape Area	681	635	362	178	96
Total		**2,930**	**2,734**	**571**	**178**	**1,984**

5.5 Water Balance Comparison

The water balances of the pre-development and post-development scenarios are summarized below in Table 5.

Table 5 Water Balance Comparison

	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Pre-Development	2,734	1,175	538	1,021
Post-Development	2,734	571	178	1,984
Change in Volume	0	**-603**	**-360**	**963**
Change in %	0	**-51**	**-67**	**94**

Based on the above, there is a net infiltration deficit of about 360 m^3/year compared to the pre-development infiltration, while the runoff rate upon development of the Site will increase by 963 m^3/year.

To compensate for the post-development infiltration deficit (and applicable WHPA Q2 policies), a portion of roof run-off water can be captured and directed towards infiltration. As the infiltration deficit volume is 360 m^3/yr and the total roof run-off volume is projected to be 665 m^3/yr, the percentage of roof run-off that is required to be redirected to maintain pre-development infiltration volumes is 54%. These details are summarized in Table 6.

Table 6 Requirement of Infiltration from Roof Runoff

Volume of Pre-Development Infiltration (m^3/yr)	538
Volume of Post-Development Infiltration (m^3/yr)	178
Deficit from Pre to Post Development Infiltration (m^3/yr)	360
Percentage of Roof Runoff required to match the pre-development infiltration (%)	54

A qualified stormwater management engineer should be retained to design re-infiltration features. Groundwater infiltration features should target the native soils underlying the fill. Additional infiltration in-situ testing should be completed (as needed) to support the detailed design of groundwater infiltration features.

6.0 Conclusions

Cambium was retained by Cyngus Developments, to complete a hydrogeological assessment in support of a proposed re-development of the property located at 189, 191, 195 & 197 Duckworth Street in Barrie, Ontario (Site).

The surface topsoil and organic fill extended up to a depth of 0.90 m, with an average thickness of 0.75 mm. The underlying mineral soil consisted of glacial till deposits predominantly sand with gravel to silty sand. The infiltration rates of native soil were estimated to range from 20 mm/hr to 100 mm/hr, based upon grain size analyses. The infiltration rates outlined herein have not been assigned a safety correction factor. Additional infiltration testing should be completed to confirm in-situ soil conditions and a safety corrected factor applied to the infiltration rates for LID feature design and placement if deemed necessary.

The monitoring wells were installed to depths ranging from 3.1 mbgs to 4.7 mbgs. Groundwater was not encountered upon installation of the monitoring wells, or during a subsequent Site visit in 2020. On October 13, 2023, water levels of MW101-20 and MW103-20 were reported dry and MW102-20 was 4.33 mbgs (elevation of 270.62 masl).

The conceptual water balance indicates that upon development of the Site groundwater infiltration will reduce by 67%. If a portion of the runoff generated from the proposed structures is captured and re-infiltrated at the Site, then the pre-development infiltration rate can be achieved (thereby satisfying WHPA Q2 policies).

A qualified stormwater management engineer should be retained to design re-infiltration features. Groundwater infiltration features should target the native soils underlying the fill. Additional infiltration in-situ testing should be completed (as needed) to support the detailed design of groundwater infiltration features.

There will be a one level basement at a depth was known to be 272.5 masl at the time this document was prepared. Presumably, construction excavations will be advanced around 1 m below the lowest floor elevation to approximately 271.5 masl. The depth of groundwater in all the wells is below the maximum excavation depth of the structure. Therefore, it is likely that

dewatering efforts during construction of the proposed townhouse development will be minimal. Water levels should be measured at the on-site monitoring wells on a regular basis for at least a 12-month period to confirm hydrogeological conditions.

7.0 Closing

We trust that the information in this submission meets your current requirements. If you have questions or comments regarding the contents of this document, please do not hesitate to contact the undersigned.

Respectfully submitted,

Cambium Inc.

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8.0 References

Cambium Inc. (2023). *Geotechnical Investigation Report, 189-197 Duckworth Street, Barrie, Ontario.*

Chapman, L.J. and D.F. Putnam. (1984). *The Physiography of Southern Ontario: Ontario Geological Survey, Special Volume 2.*

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Ontario Ministry of Municipal Affairs and Housing. (1997). Supplementary Guidelines to the Ontario Building Code 1997. SG-6 Percolation Time and Soil Descriptions, Toronto, Ontario.

9.0 Standard Limitations

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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

HYDROGEOLOGICAL ASSESSMENT

CYGNUS DEVELOPMENTS
189 - 197 Duckworth Street,
Barrie, Ontario

LEGEND

- Monitoring Well
- Site (approximate)

Notes:
- Overlay was created by Caricari Lee Architects, Project no. 23010, drawing no. A 1.31, titled Site Pla (Roof View), dated September 2023.
- Base mapping features are © King's Printer of Ontario, 2022 (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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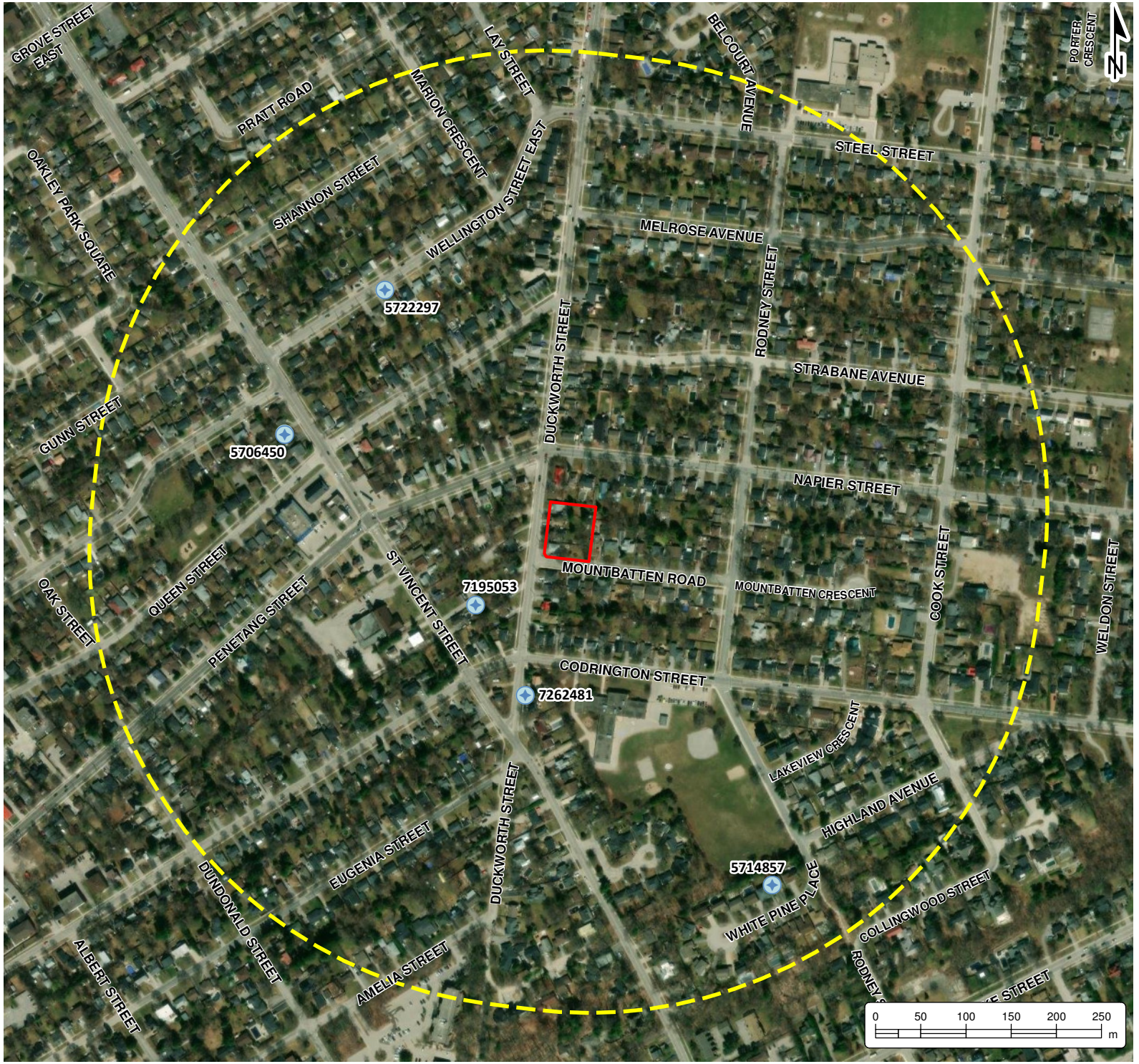
BOREHOLE LOCATION PLAN

Project No.:	18989-001	Date:	November 2020
		Rev.:	October 2023
Scale:	1:500	Projection:	NAD 1983 UTM Zone 17N
Created by:	MAT	Checked by:	CM
Figure:	1		

O:\GIS\MXDs\18900-18999\18989-001 Cygnus Developments Report Updates - 189 Duckworth St, Barrie\2023-10-19 Hydro G FIG 1 - Borehole Location Plan.mxd



HYDROGEOLOGICAL ASSESSMENT

CYGNUS DEVELOPMENTS

189 - 197 Duckworth Street,
Barrie, Ontario

LEGEND

- Water Well Record
- 500m Buffer
- Site (approximate)

Notes:
- Base mapping features are © King's Printer of Ontario, 2022 (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.
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WATER WELL RECORDS WITHIN 500m OF SITE

Project No.: 18989-001		Date: November 2020 Rev.: October 2023	
Scale: 1:6,000		Projection: NAD 1983 UTM Zone 17N	
Created by: MAT	Checked by: CM	Figure:	2

O:\GIS\MXDs\18900-18999\18989-001 Cygnus Developments Report Updates - 189 Duckworth St. Barrie\2023-10-19 Hydro G FIG 2 - Water Well Records.mxd

Appendix A

Proposed Development Plan

LOCATION MAP

DD DRAWING LIST	
NO.	**NAME**
A 0.00	COVER + STATISTICS
A 1.31	SITE PLAN (ROOF VIEW)
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A 3.22	SIDE EXTERIOR (WEST) ELEVATION
A 4.00	BUILDING SECTION
A 5.00	3D VIEW

LOT COVERAGE		
Name	**AREA (m2)**	**AREA (ft2)**
LOT COVERAGE	910.36 m²	9,799 ft²

UNIT AREA BREAKDOWN		
UNIT TYPE	**AREA (m2)**	**AREA (ft2)**
UNIT 1A	105.49 m²	1,135 ft²
UNIT 1B	138.80 m²	1,494 ft²
UNIT 2A	113.82 m²	1,225 ft²
UNIT 2B	138.77 m²	1,494 ft²
UNIT 3A	113.82 m²	1,225 ft²
UNIT 3B	138.77 m²	1,494 ft²
UNIT 4A	111.20 m²	1,197 ft²
UNIT 4B	136.15 m²	1,465 ft²
UNIT 5A	111.20 m²	1,197 ft²
UNIT 5B	136.15 m²	1,465 ft²
UNIT 6A	114.23 m²	1,230 ft²
UNIT 6B	138.80 m²	1,494 ft²
UNIT 7A	114.23 m²	1,230 ft²
UNIT 7B	138.80 m²	1,494 ft²
UNIT 8A	111.20 m²	1,197 ft²
UNIT 8B	136.15 m²	1,465 ft²
UNIT 9A	111.20 m²	1,197 ft²
UNIT 9B	136.15 m²	1,465 ft²
UNIT 10A	113.82 m²	1,225 ft²
UNIT 10B	138.77 m²	1,494 ft²
UNIT 11A	113.82 m²	1,225 ft²
UNIT 11B	138.77 m²	1,494 ft²
UNIT 12A	105.49 m²	1,135 ft²
UNIT 12B	138.80 m²	1,494 ft²
WATER METER ROOM	8.74 m²	94 ft²
TOTAL UNITS	3,003.11 m²	32,325 ft²

OUTDOOR AMENITY AREA BREAKDOWN		
AMENITY TYPE	**AREA (m2)**	**AREA (ft2)**
COMMON OUTDOOR AMENITY	126.98 m²	1,367 ft²
PRIVATE BALCONIES	104.98 m²	1,130 ft²
TOTAL UNITS	231.96 m²	2,497 ft²

PROJECT STATISTICS:

	REQUIRED / PERMITTED:	PROPOSED:
ZONING	R2 (EXISTING); RM2 (PROPOSED)	RM2
USE / BUILDING TYPE	STACKED TOWNHOUSES	STACKED TOWNHOUSES
LOT AREA	720.00 m² (MIN.)	2,930.32 m² (0.2935 ha)
LOT COVERAGE	35% OF LOT AREA = 1,025.61 m² (MAX.)	910.36 m² (31.1%)
LANDSCAPED OPEN SPACE	35% OF LOT AREA = 1,025.61 m² (MIN.)	681.03 m² (23.3%)
LANDSCAPED BUFFER		
REAR YARD (NORTH)	3.00 m (MIN.)	3.00 m
INT. SIDE YARD (EAST)	3.00 m (MIN.)	3.00 m
BUILDING SETBACKS		
FRONT (SOUTH) SETBACK	7.00 m (MIN.)	4.03 m
REAR (NORTH) SETBACK	7.00 m (MIN.)	10.52 m
INT. SIDE (EAST) SETBACK	1.80 m (MIN.)	26.32 m
EXT. SIDE (WEST) SETBACK	1.80 m (MIN.)	5.00 m
DAYLIGHT TRIANGLE SETBACK	3.00 m (MIN.)	1.87 m
LOT FRONTAGE	21.00 m (MIN.)	48.46 m
UNIT COUNT		24 UNITS
DENSITY	53 UPH (MAX.)	82 UPH
GROSS FLOOR AREA	60% OF LOT AREA = 1,758.19 m² (MAX.)	2,399.06 m² (81.9%)
DWELLING UNIT FLOOR AREA (MIN.)	n/a	105.49 m² - 138.80 m²
CONSOLIDATED OUTDOOR AMENITY*	12.00 m² / UNIT = 288.00 m² (MIN.)	5.29 m² / UNIT = 126.98 m²
BUILDING HEIGHT	10.00 m (MAX.)	12.73 m
PARKING		
STANDARD SPACES	n/a	27 SPACES
BARRIER-FREE SPACES*	1 TYPE A + 1 TYPE B	1 TYPE A + 1 TYPE B SPACES
TOTAL PARKING	1.5 / UNIT = 36 SPACES	29 SPACES
LOADING SPACE		
WIDTH	3.00m (MIN.)	3.00m
LENGTH	9.00m (MIN.)	9.00m
HEIGHT	4.00m (MIN.)	4.00m
DRIVE AISLE WIDTH	6.40m (MIN.)	6.40m

***NOTES:**
- BARRIER-FREE PARKING SPACES REQUIRED AND PROVIDED ARE INCLUDED IN THE TOTAL PARKING COUNT.
- REFER TO OUTDOOR AMENITY AREA BREAKDOWN TABLE FOR TOTAL OUTDOOR AMENITY AREA.

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113 Miranda Avenue
Toronto, ON M6B 3W8
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www.caricarilee.com
CLA

PROJECT NAME
DUCKWORTH TOWNS
189 DUCKWORTH ST, BARRIE, ONTARIO

DRAWING TITLE
COVER + STATISTICS

No.	Date:	Issued / Revision:	By:

SCALE	1 : 128
PROJECT NO.	23010
DATE	SEPT 2023
DRAWN BY	AL
CHECKED BY	MNG

NORTH:

DRAWING NO.
A 0.00

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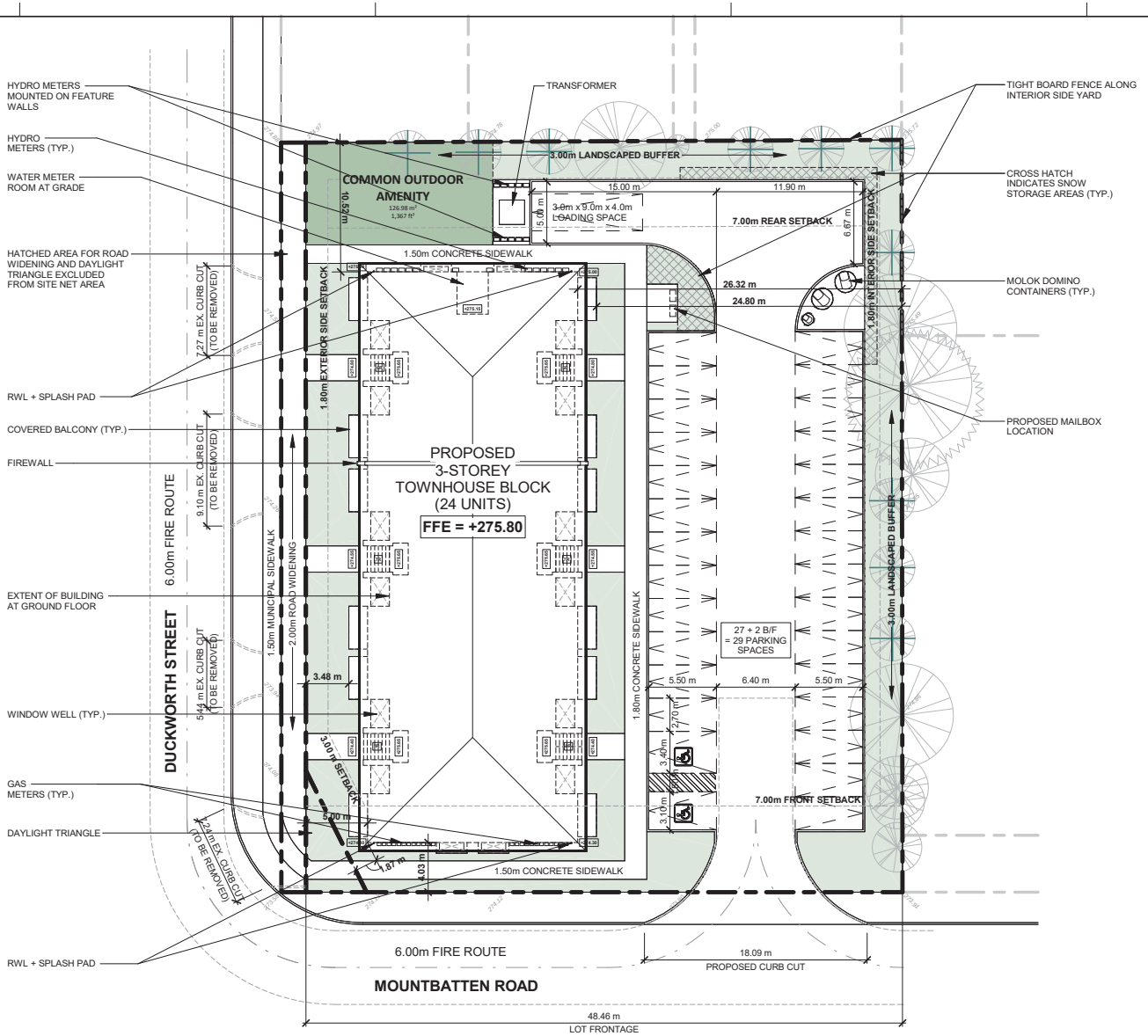

SITE PLAN LEGEND	
	EXISTING TREE
	PROPOSED TREE

1 **SITE PLAN (ROOF VIEW)**
1 : 350

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CLA

PROJECT NAME
DUCKWORTH TOWNS
189 DUCKWORTH ST, BARRIE, ONTARIO

DRAWING TITLE
SITE PLAN (ROOF VIEW)

No.	Date:	Issued / Revision:	By:

CONTRACTOR TO VERIFY ALL DIMENSIONS ON THE SITE AND REPORT ANY DICREPANCIES TO THE ARCHITECT BEFORE PROCEEDING WITH THE WORK.

SCALE	As indicated
PROJECT NO.	23010
DATE	SEPT 2023
DRAWN BY	AL
CHECKED BY	MNG

NORTH: PN TN

DRAWING NO.
A 1.31

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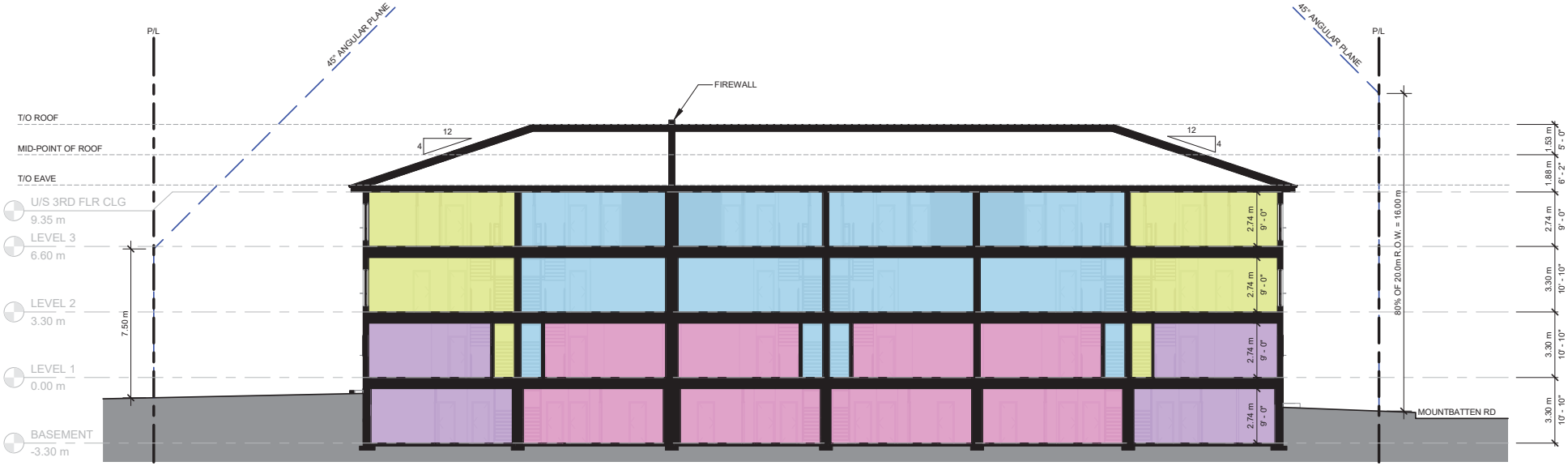

1 **BUILDING SECTION 1**
1 : 200

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CLA

PROJECT NAME
DUCKWORTH TOWNS
189 DUCKWORTH ST, BARRIE, ONTARIO

DRAWING TITLE
BUILDING SECTION

No.	Date:	Issued / Revision:	By:

CONTRACTOR TO VERIFY ALL DIMENSIONS ON THE SITE AND REPORT ANY DICREPANCIES TO THE ARCHITECT BEFORE PROCEEDING WITH THE WORK.

THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION UNTIL COUNTERSIGNED.

SCALE	1 : 200
PROJECT NO.	23010
DATE	SEPT 2023
DRAWN BY	AL
CHECKED BY	MNG

NORTH:

DRAWING NO.
A 4.00

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Appendix B
Borehole Logs

Peterborough
Barrie
Oshawa
Kingston
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Log of Borehole: BH101-20

Client: Cygnus Developments
Project Name: Geotech Investigation - 189 to 197 Duckworth St.
Project No.: 10273-001
Contractor: Walker Drilling Ltd.
Method: Hollow Stem Augers
Date Completed: October 2, 2020
Location: 189 Duckworth Street, Barrie
UTM: 17T, 605493 m E, 49176988 m N
Elevation: 273.97 mASL

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture (25 50 75)	SPT (N) (10 20 30 40)	Well Installation	Remarks
0 / 0		Topsoil: Black sandy topsoil,compact, moist	1	SS	40	12			Cap	Top of Standpipe (TOS) elevation: 274.94 mASL. Standpipe dry when measured on October 15, 2020.
									Bentonite Plug	
									PVC Standpipe	
			2A							
-1 / 1		Sand and silt: Brown sand and silt, some clay, trace gravel, dense, moist	2B	SS	75	30				
		-very dense	3	SS	50	50/ 175 mm				GSA SS3: 5% Gravel 43% Sand 41% Silt 11% Clay
-2 / 2			4	SS	40	50/ 100 mm			Sand Pack	
-3 / 3		Sand: Brown sand, some silt, trace gravel, very dense, dry	5	SS	25	50/ 125 mm			PVC Screen	

Logged By: JD
Input By: JD

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Barrie
Oshawa
Kingston
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Log of Borehole: BH101-20

Client: Cygnus Developments
Project Name: Geotech Investigation - 189 to 197 Duckworth St.
Project No.: 10273-001
Contractor: Walker Drilling Ltd.
Method: Hollow Stem Augers
Date Completed: October 2, 2020
Location: 189 Duckworth Street, Barrie
UTM: 17T, 605493 m E, 49176988 m N
Elevation: 273.97 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
-4 / 4		Silty Sand: Brown silty sand, some gravel, very dense, dry	6	SS	25	50/ 100 mm			Sand Pack; PVC Screen; Cap	
		Borehole terminated at 4.7 mbgs.								

Logged By: JD
Input By: JD

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T: 866-217-7900
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Log of Borehole: BH102-20

Client: Cygnus Developments
Project Name: Geotech Investigation - 189 to 197 Duckworth St.
Project No.: 10273-001
Contractor: Walker Drilling Ltd.
Method: Hollow Stem Augers
Date Completed: October 2, 2020
Location: 197 Duckworth Street, Barrie
UTM: 17T, 605469 m E, 4917043 m N
Elevation: 274.96 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 / 0		Topsoil: Black sandy topsoil, loose, moist	1	SS	10	5			Cap	Top of Standpipe (TOS) elevation: 274.94 mASL. Standpipe dry when measured on October 15, 2020.
									Bentonite Plug	
		Gravelly Sand: Brown gravelly sand, trace silt, trace clay, dense, moist	2	SS	50	50/ 225 mm			PVC Standpipe	GSA SS2: 25% Gravel 65% Sand 8% Silt 2% Clay
-1 / 1										
		-less gravel	3	SS	70	50/ 250 mm				
-2 / 2										
		Sand and Silt: Brown sand and silt, some clay, trace gravel, dense, moist	4	SS	75	49			Sand Pack	
-3 / 3		-very dense	5	SS	75	50/ 280 mm			PVC Screen	GSA SS5: 7% Gravel 44% Sand 36% Silt 13% Clay

Logged By: JD
Input By: JD

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Log of Borehole: BH102-20

Client: Cygnus Developments
Project Name: Geotech Investigation - 189 to 197 Duckworth St.
Project No.: 10273-001
Contractor: Walker Drilling Ltd.
Method: Hollow Stem Augers
Date Completed: October 2, 2020
Location: 197 Duckworth Street, Barrie
UTM: 17T, 605469 m E, 4917043 m N
Elevation: 274.96 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
-4 — 4		-more clay	6	SS	13	50/ 75 mm			Sand Pack; PVC Screen; Cap	
		Borehole terminated at 4.6 mbgs.								

Logged By: JD
Input By: JD

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Kingston
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Log of Borehole: BH103-20

Client: Cygnus Developments
Project Name: Geotech Investigation - 189 to 197 Duckworth St.
Project No.: 10273-001
Contractor: Walker Drilling Ltd.
Method: Hollow Stem Augers
Date Completed: October 2, 2020
Location: 195 Duckworth Street, Barrie
UTM: 17T, 605509 m E, 4917022 mN
Elevation: 275.23 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 / 0		Topsoil: Black sandy topsoil, compact, moist	1	SS	25	12			Cap	Top of Standpipe (TOS) elevation: 274.94 mASL. Standpipe dry when measured on October 15, 2020.
		Silty Sand: Brown silty sand, trace clay, trace gravel, very dense, moist							Bentonite Plug	
			2	SS	0	50/ 50 mm			PVC Standpipe	
-1 / 1										
			3	SS	50	50/ 100 mm				
-2 / 2									Sand Pack	
			4	SS	0	50/ 50 mm			PVC Screen	
		Gravelly Sand: Grey gravelley sand, some silt, very dense, moist								
-3 / 3				GS					Cap	
		Borehole terminated at 3.1 mbgs upon auger refusal.								

Logged By: JD
Input By: JD

Appendix C
Grain Size Analyses

Grain Size Distribution Chart

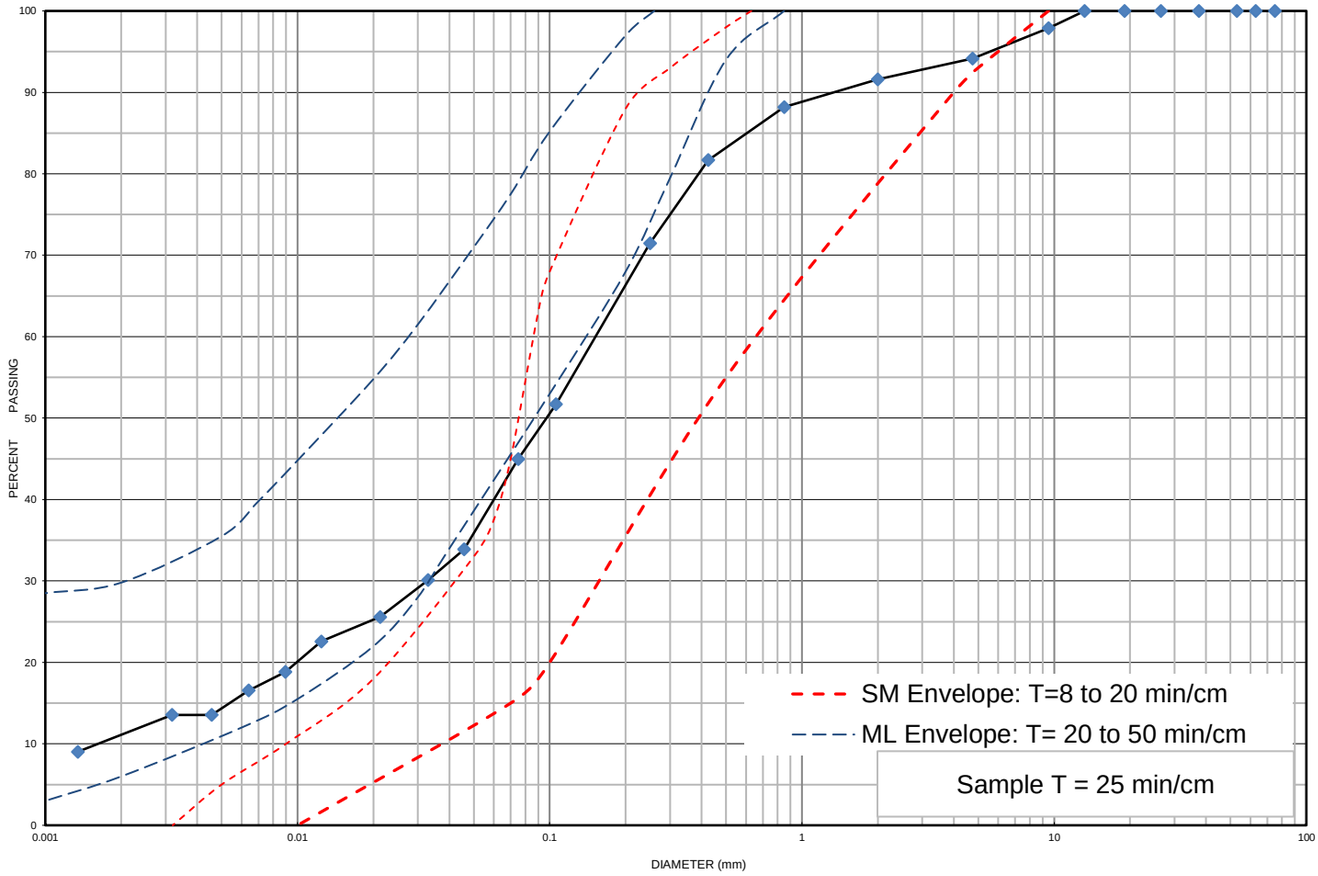
Project Number: *10273-001* **Client:** *Cygnus Developments*

Project Name: *Geo. & HydroG - 189 Duckworth St., Barrie*

Sample Date: *October 2, 2020* **Sampled By:** *Jon De Jong - Cambium Inc.*

Location: *BH 101-20 SS 2B* **Depth:** *0.9 m to 1.2 m* **Lab Sample No:** *S-20-1094*

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 101-20	SS 2B	0.9 m to 1.2 m	6	49	33	12	9.5

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Silty Sand some Clay trace Gravel	SM	0.1550	0.0320	0.0016	96.88	4.13

Additional information availabe upon request

Issued By: _____ *Date Issued:* *November 26, 2020*

(Senior Project Manager)

Cambium Inc. (Laboratory)

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194 Sophia St.| Peterborough | ON | K9H 1E5

Grain Size Distribution Chart

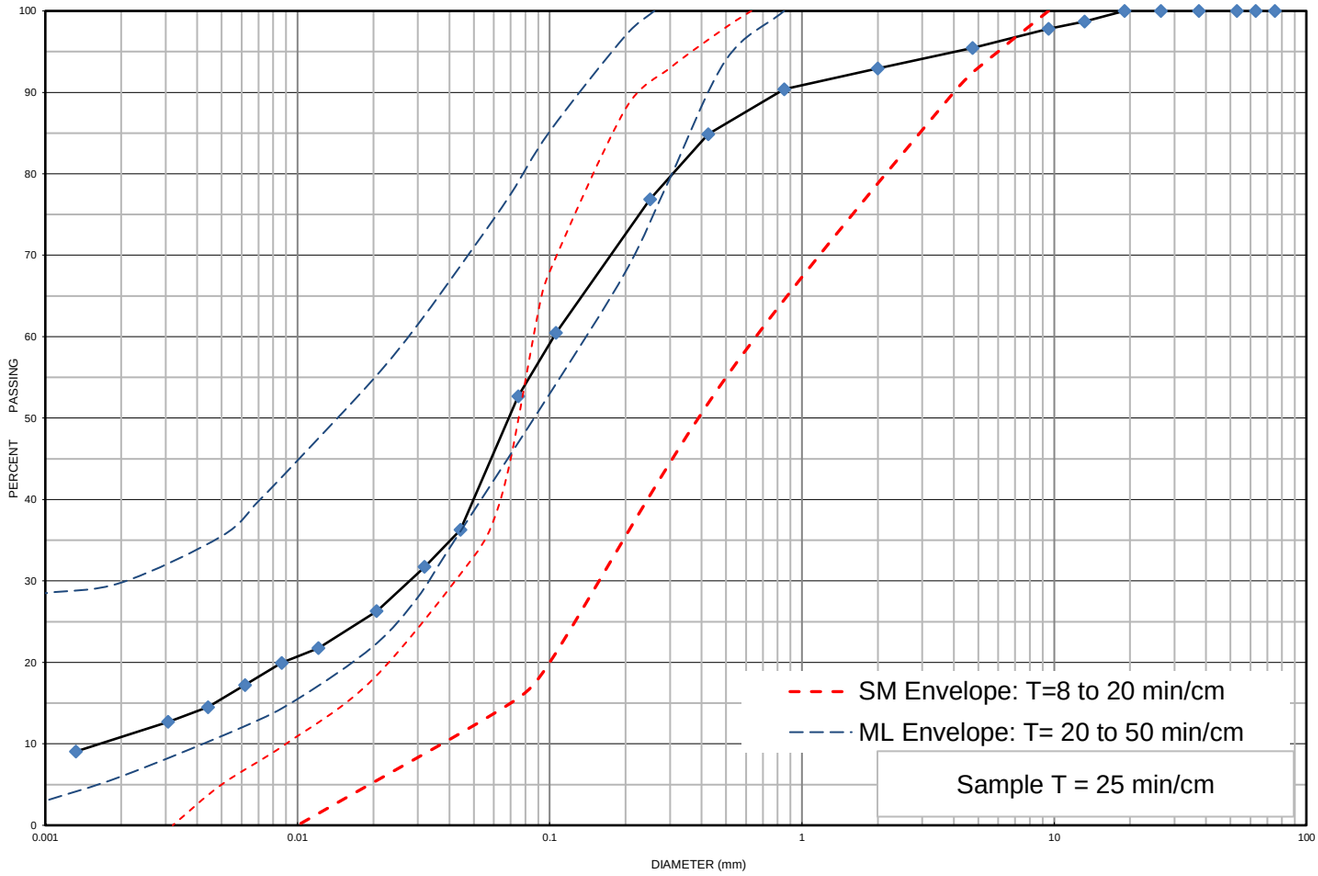
Project Number: *10273-001* **Client:** *Cygnus Developments*

Project Name: *Geo. & HydroG - 189 Duckworth St., Barrie*

Sample Date: *October 2, 2020* **Sampled By:** *Jon De Jong - Cambium Inc.*

Location: *BH 101-20 SS 3* **Depth:** *1.5 m to 1.8 m* **Lab Sample No:** *S-20-0822*

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 101-20	SS 3	1.5 m to 1.8 m	5	43	41	11	9.9

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Sand and Silt some Clay trace Gravel	ML	0.1100	0.0180	0.0016	68.75	1.84

Additional information availabe upon request

Issued By: _____ *Date Issued:* *November 24, 2020*

(Senior Project Manager)

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Grain Size Distribution Chart

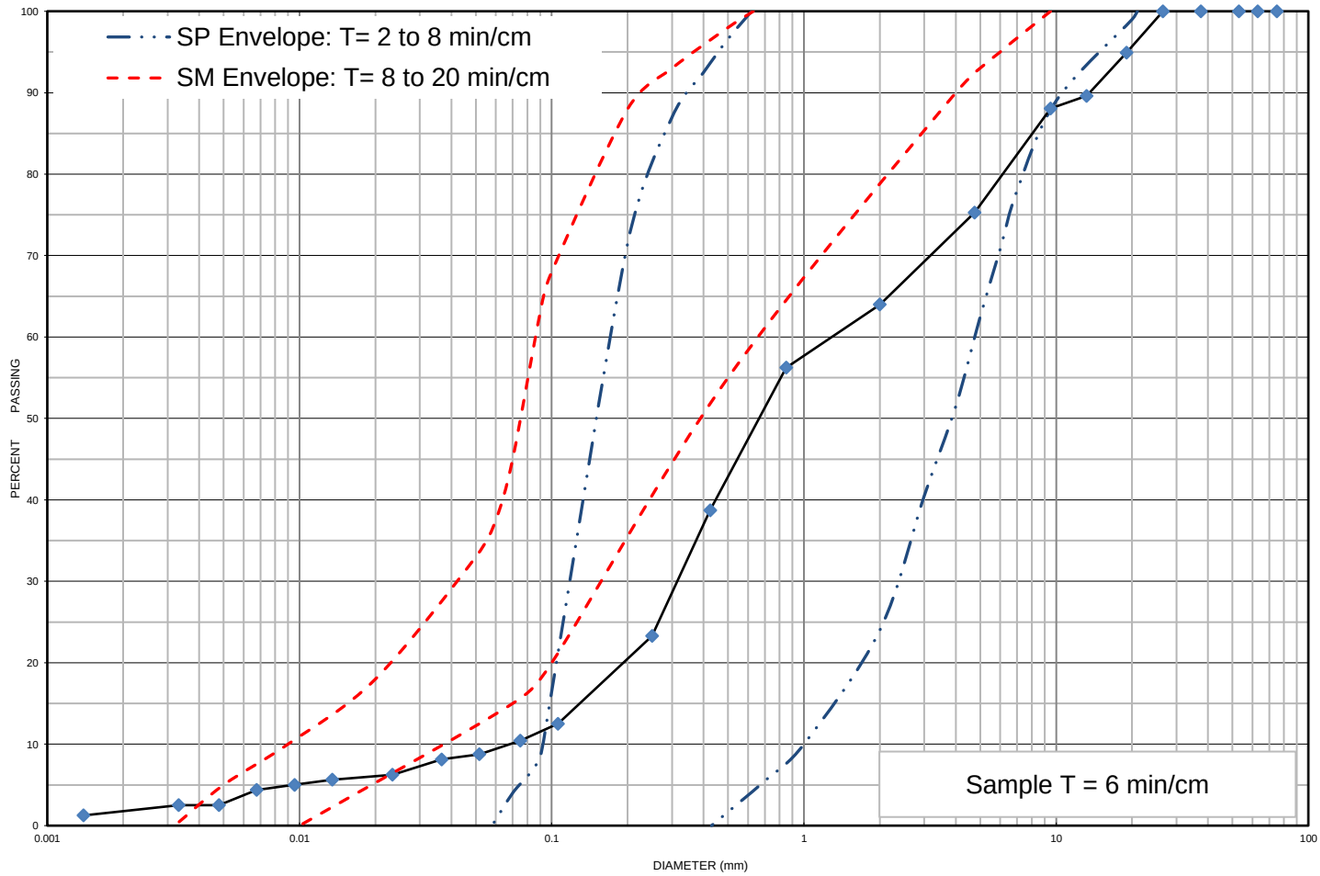
Project Number: *10273-001* **Client:** *Cygnus Developments*

Project Name: *Geo. & HydroG - 189 Duckworth St., Barrie*

Sample Date: *October 2, 2020* **Sampled By:** *Jon De Jong - Cambium Inc.*

Location: *BH 102-20 SS 2* **Depth:** *0.8 m to 1.2 m* **Lab Sample No:** *S-20-0880*

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 102-20	SS 2	0.8 m to 1.2 m	25	65	8	2	4.9

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Gravelly Sand trace Silt trace Clay	SW	1.400	0.310	0.070	20.00	0.98

Additional information available upon request

Issued By: _____ *Date Issued:* *November 24, 2020*

(Senior Project Manager)

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Grain Size Distribution Chart

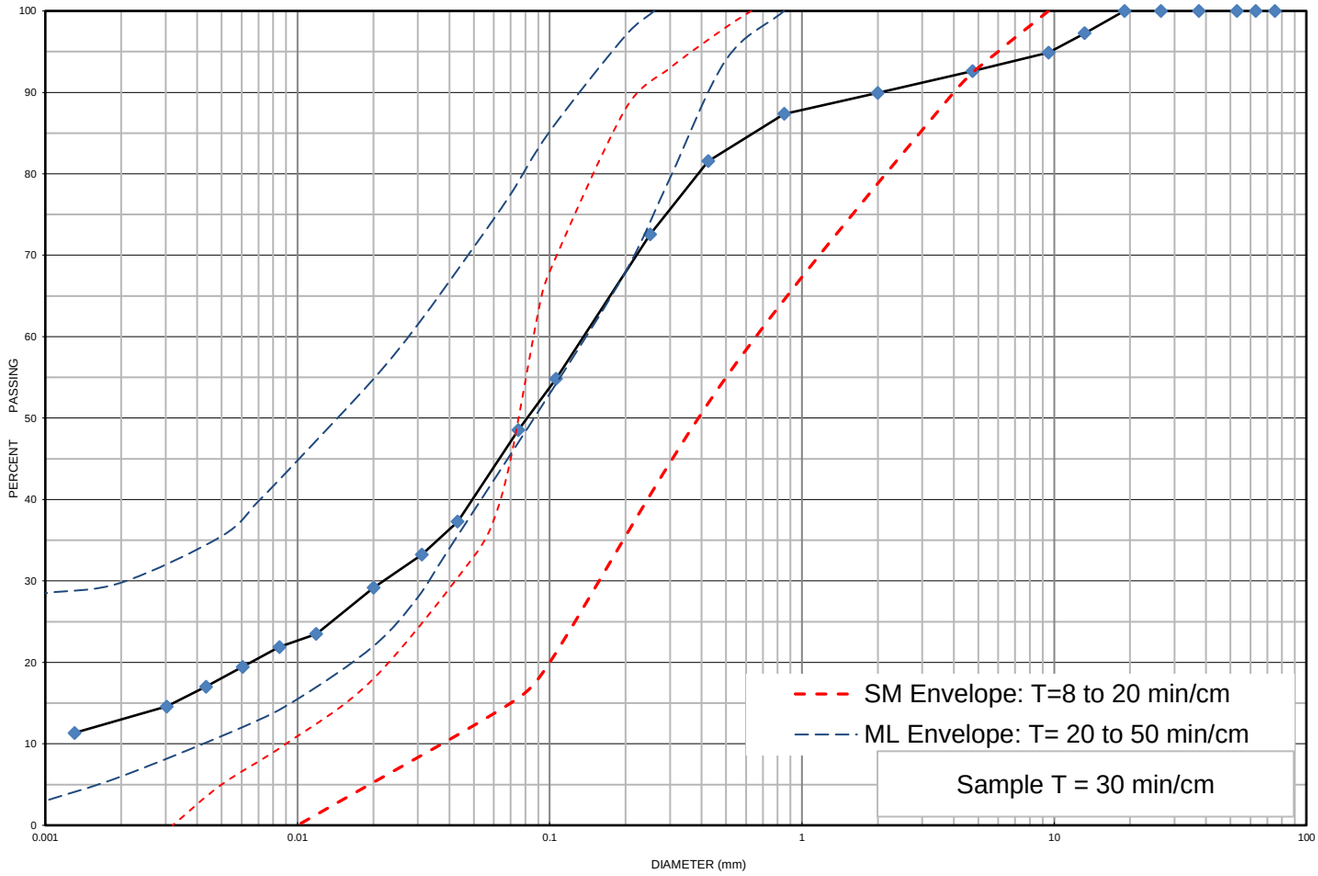
Project Number: *10273-001* **Client:** *Cygnus Developments*

Project Name: *Geo. & HydroG - 189 Duckworth St., Barrie*

Sample Date: *October 2, 2020* **Sampled By:** *Jon De Jong - Cambium Inc.*

Location: *BH 102-20 SS 5* **Depth:** *3 m to 3.5 m* **Lab Sample No:** *S-20-0821*

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 102-20	SS 5	3 m to 3.5 m	7	44	36	13	9.7

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Sand and Silt some Clay trace Gravel	SM	0.145	0.022	0.000	-	-

Additional information availabe upon request

Issued By: _____ *Date Issued:* *November 24, 2020*

(Senior Project Manager)

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Appendix D
Water Balance Information

Water Balance Calculations

189-197 Duckworth Street, Barrie, ON

THORNTHWAITE-TYPE MONTHLY WATER-BALANCE MODEL

modified from Dingman 2015: Box 6-8 (pg 299) using ET model of Hamon (1963)

		Input Data				Computed Values							
											Surplus	402	mm/yr
Weather Station Location:	**Barrie WPCP**					**Latitude:**	**44.4**	**degree**					
Solar Declination (degree)	-20.6	-12.6	-1.5	10.0	19.0	23.1	21.0	13.4	2.6	-9.0	-18.5	-23.0	
DayLength (hr)*	9.1	10.3	11.8	13.3	14.6	15.3	14.9	13.8	12.3	10.8	9.5	8.7	
Available Water Storage Capacity		0.18	m/m		**Root Depth**	460	mm			**SOILmax**	82.8	mm	

MONTHLY WATER BALANCE DATA

Temperatures in C, water-balance terms in mm.

Month:	J	F	M	A	M	J	J	A	S	O	N	D	Year
TEMPERATURE (T)	-7.7	-6.6	-2.1	5.6	12.3	17.9	20.8	19.7	15.3	8.7	2.7	-3.5	
PRECIPITATION (P)	82.5	61.8	58.1	62.2	82.4	84.8	77.2	89.9	94.0	77.5	88.9	73.6	933
RAIN	16.6	16.0	29.2	56.6	82.3	84.8	77.2	89.9	94.0	75.2	66.0	22.2	710
SNOW	66	46	29	6	0	0	0	0	0	2	23	51	223
MELT FACTOR (F)	0.00	0.00	0.00	0.93	1.00	1.00	1.00	1.00	1.00	1.00	0.45	0.00	
PACK	130	176	205	14	0	0	0	0	0	0	13	64	
MELT	0	0	0	196	14	0	0	0	0	2	10	0	223
INPUT (W)	17	16	29	253	96	85	77	90	94	78	76	22	933
POTENTIAL ET (PET)	0	0	0	39	68	97	116	100	67	40	23	0	548
NET INPUT (ΔW)	17	16	29	214	29	-12	-38	-10	27	38	54	22	
SOIL MOISTURE (SOIL)	83	83	83	83	83	72	45	40	67	83	83	83	
ΔSOIL	0	0	0	0	0	-11	-27	-5	27	16	0	0	0
ET	0	0	0	39	68	96	104	95	67	40	23	0	531
SURPLUS=W-ET-DSOIL	17	16	29	214	29	0	0	0	0	22	54	22	402

Notes:

Precipitation, Rain, Temperature, and Latitude are inputted parameters

SOILmax = available water storage capacity * root depth

m = month

D = Day length (hrs) $=2*\cos^{-1}(-\tan(\text{Latitude})*\tan(\text{Declination}))/0.2618$ [calculation is in radians]

$SNOW_m = P_m - RAIN_m$

$F_m = 0$ if $T_m <= 0^oC$; $F_m = 0.167*T_m$ if $0^oC<T_m<6^oC$; $F_m = 1$ if $T_m>=6^oC$

$PACK_m = (1-F_m)*(SNOW_m+PACK_{m-1})$

$MELT = F_m*(SNOW_m+PACK_{m-1})$

$W_m = RAIN_m+MELT_m$.

PET = 0 if $T_m<0$; otherwise $PET = 2.98*0.611*\exp(17.3*T_m/(T_m+237))/(T_m+237.2)*$Number of days in month [Hamon ET model (1963)]

$\Delta W_m = W_m - PET_m$

$SOIL = \min\{[\Delta W_m+SOIL_{m-1}], SOILmax\}$, if $\Delta Wm>0$; otherwise $SOIL = SOIL_{m-1} * \exp(\Delta W/SOILmax)$

$\Delta SOIL = SOIL_{m-1} - SOIL_m$

ET = PET if W_m > PET; otherwise, $ET=W_m-\Delta SOIL$

Pre- and Post-Development Water Balance Calculations

189-197 Duckworth Street, Barrie, ON

1 Climate Information

Precipitation	933	mm/yr
Actual Evapotranspiration	531	mm/yr
Water Surplus	402	mm/yr

2 Infiltration Rates

Table 2 Approach - Infiltration factors	
Topography: Flat to Gently Sloping Land	0.25
Soil Type: medium combinations of clay and loam	0.2
Cover: Cultivated land	0.2
Total Infiltration Factor	**0.65**

Infiltration (Water Surplus * Infiltration Factor)	**261**	mm/yr
Run-off (Water Surplus - Infiltration)	**141**	mm/yr

Table 3 Approach - Typical Recharge Rates		
Coarse Sand and Gravel	>250	mm/yr
Fine to medium sand	200-250	mm/yr
Silty sand to sandy silt	150-200	mm/yr
Silt	125-150	mm/yr
Clayey Silt	100- 125	mm/yr
Clay	<100	mm/yr

Site development area is underlain predominantly by sand and silty sand with gravel and trace clay.

Based on the above, the recharge rate is typically	200-250	mm/yr

3 Pre-Development Property Statistics	**ha**	**m^2**
Total Paved Area	0.02	223
Total Roof Area	0.06	648
Total Landscape Area	0.21	2,059
Total	**0.29**	**2,930**

4 Post-Development Property Statistics	**ha**	**m^2**
Total Paved Area	0.15	1,457
Total Roof Area	0.08	792
Total Landscape Area	0.07	681
Total	**0.29**	**2,930**

Pre- and Post-Development Water Balance Calculations

189-197 Duckworth Street, Barrie, ON

5 Pre-Development Water Balance

Land Use		Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Impervious Areas	Paved Area	223	208	21	-	187
	Roof Area	648	605	60	-	544
Pervious Areas	Landscape Area	2,059	1,921	1,093	538	290
	Totals	2,930	2,734	1,175	538	1,021

Assuming no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

6 Post-Development Water Balance

Land Use		Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Impervious Areas	Paved Area	1,457	1,360	136	-	1,224
	Roof Area	792	739	74	-	665
Pervious Areas	Landscape Area	681	635	362	178	96
	Totals	2,930	2,734	571	178	1,984

Assuming no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

7 Comparision of Pre- and Post -Development

	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Pre-Development	2,734	1,175	538	1,021
Post-Development	2,734	571	178	1,984
Change in Volume	0	- 603	- 360	963
Change in %	0	- 51	- 67	94

8 Requirement for Infiltration of Roof Run-off

Volume of Pre-Development Infiltration (m^3/yr)	538
Volume of Post-Development Infiltration (m^3/yr)	178
Deficit from Pre to Post Development Infiltration (m^3/yr)	360
Percentage of Roof Runoff required to match the pre-development infiltration (%)	54