



Hydrogeological Assessment Report, 103 & 107 Napier Street and 95 Cook Street, Barrie, Ontario.

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Prepared for:
2556055 Ontario Inc

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1.0 Introduction

Cambium Inc. (Cambium) was retained by 2556055 Ontario Inc (the Client) c/o Innovative Planning Solutions to complete a hydrogeological assessment of the property located at 103 and 107 Napier Street and 95 Cook Street, City of Barrie, Ontario (the Site).

The hydrogeological assessment is required as part of the application process for Official Plan Amendment and Zoning By-law Amendment to permit 35 new townhomes, including 13, 2-storey towns and 22, 3-storey towns. The total area of the property is approximately 0.98 hectares (2.43 acres).

The purpose of the hydrogeological assessment is to assess the subsurface conditions at the Site in terms of soil and groundwater conditions, water levels and elevations to characterize the local groundwater regime for the construction of a townhouse complex and two single-family dwellings, along with associated parking, driveways, and landscaped areas.

1.1 Scope of Work

This hydrogeological assessment was conducted with the following tasks:

- **Review of available background information:** a review of available geological and hydrogeological information for the site and surrounding areas and the previous investigation reports completed for the Site, was conducted to provide background information to allow for characterization of the Site's soil and groundwater conditions.
- **Detailed site inspection:** an inspection of the Site was completed to review existing site conditions including identification of any hydrogeological features such as significant areas of potential groundwater recharge or areas of groundwater discharge.
- **Measurement of groundwater levels:** groundwater levels were measured in the existing monitoring wells to establish and/or confirm the general groundwater flow condition. Long-term, four-season water level monitoring is also being completed.
- **In-Situ Hydraulic Conductivity Tests:** completed in-situ hydraulic conductivity tests or Single well Response Tests (SWRTs) in three monitoring wells to estimate the hydraulic



conductivity of the underlying soils and/or bedrock, which will be used for assessing the potential dewatering requirements.

- **In-Situ Soil Infiltration Tests:** will be completed during spring-summer months using the Guelph Permeameter equipment at selected LID locations to assess the soil percolation and infiltration rates.
- **Water Balance (Preliminary):** a preliminary water balance study was completed for the proposed development using the Thornthwaite-Mather approach and the climatic data obtained from Environment Canada.
- **Source Water Protection:** an assessment of Source Water Protection and Site development will be completed to estimate likely impacts of the development on City's water supply.
- **Report Preparation:** a hydrogeological report was prepared presenting the results, findings, and recommendations of this investigation.

It should be noted that a geotechnical investigation is being completed concurrently at the Site by Cambium. The data or information obtained in the current and former investigations has been incorporated into this hydrogeological assessment report.

1.2 Site Description and Site Development

The total area of the property is approximately 0.98 ha (2.43 acres) in size and is located southeast of the corner of Cook Street and Napier Street. At the time of the study, the Site was developed as two separate parcels which consisted of the following:

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

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



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

The ground elevation at the Site was relatively flat, and is bordered by Cook Street to the west, Napier Street to the north and by residential dwellings on the other two sides.

It is proposed that the Site be developed into a residential development consisting of 35 townhouse units organized into six separate blocks with associated driveways, landscape areas and parking areas. Water and wastewater services are being provided by the City of Barrie.

The regional location of the Site is outlined on Figure 1, the property and surrounding areas outlined on Figure 2 and the proposed development plan is included in Appendix A.



2.0 Environmental Features

To assess environmental features, databases maintained by the Ministry of Natural Resources and Forestry (MNR), the Ministry of Environment, Conservation and Parks (MECP), and the Lake Simcoe Region Conservation Authority (LSRCA) were reviewed.

Based on the data reviewed, the Site is situated within Barrie Creeks Subwatershed, under the authority of the LSRCA Source Protection Area. The local drainage continues south and southeastward discharging into the Lake Simcoe which is situated at about 600 m south of the Site.

No wetlands or woodlands are situated on the Site. The majority of the Site is covered with built up and paved areas. The Site is not situated within the LSRCA regulated areas as per Ont. Reg. 179/06 and therefore, development restrictions do not apply to the proposed development.

As per MNR Natural Heritage System database the Site does not have any Areas of Environmental Significance or Areas of Natural and Scientific Interest (ANSI).

As shown on the Ministry of Environment, Conservation and Parks (MECP) Source Water Protection Atlas map and Lake Simcoe Source Protection Plan, the Site is not located in groundwater vulnerable areas such as

- Wellhead Protection Area (WHPA-A, B, C and D),
- Highly Vulnerable Area (HVA)
- Issue Contributing Area (ISA), or
- Significant Groundwater Recharge Area (SGRA).

However, the Site is within a WHPA Q1 and Q2, related to groundwater recharge management area surrounding a municipal water supply aquifer (Appendix A).



3.0 Physical Setting

3.1 Topography and Drainage

The Site is located within the Barrie Creeks subwatershed of the Lake Simcoe watershed area. Based on the regional topographic map of the area, the general slope of the terrain is south and southeastwards with an elevation of about 270 meters above sea level (masl) in the north and northwest to about 265 masl in the east and southeast with gradual slope towards Lake Simcoe (Appendix A).

Based on the borehole location survey, the highest elevation of about 270.6 masl was noted in the northwest, with ground sloping southeast to the lowest elevation of about 268.17 masl, indicating generally a flat to gently sloping topography across the Site.

3.2 Physiography

The Site is located in the physiographic region known as Simcoe Uplands in the northern portion of the Barrie Creeks subwatershed and is defined as distinct upland areas of rolling till plains that are broken up by steep-sided, flat-floored valleys. In the Barrie area, these valleys tend to be oriented from east to west. The Simcoe Uplands generally make up the topographic highs, rising up to 100 m above the adjacent Simcoe Lowlands. Simcoe Uplands are characterized by a deposition of a variety of coarse and fine grained sediments (Chapman & Putnam, 1984).

3.3 Overburden Geology

In general, the study area is characterized by glaciolacustrine deposits, interpreted to have been deposited by the Laurentide Ice Sheet during the Wisconsinian glaciations. The Paleozoic bedrock topography appears to strongly influence the overlying Quaternary sediment thickness and distribution (OGS, 2019) The overburden is primarily consisting of stone-poor, carbonate-derived silty to sandy till.



3.4 Bedrock Geology

According to Miscellaneous Release – Data 219 from the Ontario Geological Survey (Chapman, L.J. and D.F. Putnam, OGS, 2007), the bedrock in the area of the Site consists of Middle Ordovician rocks from the Simcoe Group. The Simcoe Group consists of four formations that dip gently towards the southwest: Gull River Formation, Bobcaygeon Formation, Verulam Formation and the Lindsay Formation from oldest to youngest. Simcoe Group primarily composed of limestone, dolostone, shale, arkose, and sandstone formations.



4.0 MECP Well Records Assessment

The Ministry of Environment Conservation and Parks (MECP) Water Well Information System (WWIS) was accessed to review water well records in the area of the Site. There were only three well records located within approximately 500 m radius of the Site (Figure 3).

As per the MECP records, the wells were installed between 1977 and 2016 to depth ranging from 6.1 mbgs to 128.3 mbgs. Overburden generally consisted of brown to grey fine to coarse sand and silt with gravel and cobbles, trace clay.

MWCP Well Records #7188109 and #7262481 were installed as monitoring wells, while #5714857 was installed as water supply well, however, the well was dry and was later abandoned. No data was available about the static water levels and/or recommended yield rates.

Well records are presented in Appendix B.



5.0 Borehole Drilling and Monitoring Well Installation

5.1 Borehole Investigation-Geotechnical

Cambium completed a geotechnical investigation at the Site on December 8, 2021. A total of four boreholes, designated as BH101-21 through BH104-21, were advanced to depths ranging from 6.2 m to 6.6 m below ground surface (mbgs). Three of the boreholes were outfitted as monitoring wells and designated as MW101-21, MW102-21, and MW104-21. Borehole locations are depicted on Figure 4 . Borehole logs are included in Appendix C.

Following is the general stratigraphy as encountered at the Site during the investigation.

Topsoil

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

The topsoil consisted of a black silt with some sand and organics and was found to be up to 760 mm thick.

Fill

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

The inferred fill soils consisted of a brown sand with some silt and trace organics in MW101-21 and a brown silt with some sand, and trace gravel in BH103-21. The fill soils ranged in thickness from 760 mm to 850 mm and extended to depths ranging from 0.9 mbgs to 1.5 mbgs.

Sand to Silty Sand

Native sand to silty sand materials were encountered in all boreholes beginning at depths ranging from 0.8 mbgs to 1.5 mbgs. The sand to silty sand soils extended to the termination



depths of all boreholes except MW102-21 and were found to contain varying amounts of gravel and clay.

Silt to Sandy Silt

A layer of silt was found underlying the native sandy soils in MW102-21 and extended to the termination depth of 6.6 mbgs. The silt was found to contain some clay with traces of sand and gravel. In BH104-21, a layer of sandy silt with trace amounts of gravel and clay was encountered below the topsoil, between depths of approximately 0.8 mbgs and 1.5 mbgs.

Clayey Silt

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

Bedrock

Bedrock was not encountered during the geotechnical investigation. Drilling was terminated at depths of between 6.2 mbgs and 6.6 mbgs.

Well construction details are presented below in Table 1.

Table 1 Monitoring Well Installation Details

Borehole	Termination Depth (mbgs)	Ground Elevation (masl)	Screen Details	
			Screen Top (masl)	Screen Bottom (masl)
MW101-21	6.5	270.36	267.26	264.26
MW102-21	6.6	269.08	265.98	262.98
MW104-21	6.2	268.17	265.07	262.07

5.2 Groundwater Elevations

As part of hydrogeological assessment, stabilized water level monitoring was completed. Groundwater levels were measured on two occasions during December 20, 2021, and January 27, 2022. The recorded groundwater levels are presented in Table 2 below.



A long-term twelve month water level monitoring is being completed at the Site to characterize the seasonal water table elevations across the Site. A separate letter report will be submitted after the conclusion of the monitoring at the Site.

Table 2 Measured Groundwater Levels

Well		MW101-21	MW102-21	MW104-21
Top of Pipe Elevation (masl)		271.34	270.03	269.13
Ground Surface Elevation (masl)		270.36	269.08	268.17
Stick-up (m)		0.98	0.95	0.96
Dec. 20, 2021	Water Level (mbgs)	Dry	5.40	5.19
	Groundwater Elev.(masl)	-	263.68	262.98
Jan. 27, 2022	Water Level (mbgs)	Dry	5.75	5.27
	Groundwater Elev.(masl)	-	263.33	262.93
Feb. 18, 2022	Water Level (mbgs)	Dry	5.93	5.24
	Groundwater Elev.(masl)	-	263.15	262.93
March 21, 2022	Water Level (mbgs)	Dry	5.77	5.22
	Groundwater Elev.(masl)	-	263.15	262.95
April 21, 2022	Water Level (mbgs)	Dry	5.58	5.19
	Groundwater Elev.(masl)	-	263.50	262.98
May 16, 2022	Water Level (mbgs)	Dry	5.63	5.12
	Groundwater Elev.(masl)	-	263.45	263.05
Jun 17, 2022	Water Level (mbgs)	Dry	5.85	5.21
	Groundwater Elev.(masl)	-	263.22	262.96
Aug. 8, 2022	Water Level (mbgs)	Dry	5.95	5.26
	Groundwater Elev.(masl)	-	263.13	262.91
Sept. 14, 2022	Water Level (mbgs)	Dry	6.04	5.35
	Groundwater Elev.(masl)	-	263.04	262.82
Oct. 19, 2022	Water Level (mbgs)	Dry	Dry	5.43
	Groundwater Elev.(masl)	-	-	262.74

As presented above, monitoring well MW101-21 was dry during all the monitoring events, while groundwater levels in wells MW102-21 and MW104-21 ranged from 5.12 mbgs to 6.04 mbgs, and the elevations ranged from 262.98 masl to 263.68 masl, respectively.

The spring water levels ranged from 5.12 mbgs to 5.58 mbgs, while the elevation was between 262.95 masl and 263.50 masl.

The water level fluctuations (i.e. difference between the highest and the lowest water levels) were minimal with 0.63 m at MW101-21 and 0.23 at MW104-21.

5.3 Direction of Groundwater Flow

Based on the groundwater elevation data obtained from the monitoring events, a site-specific groundwater configuration map could not be constructed as only two monitoring wells had defined water levels. Based on the water table elevations at MW101-21 and MW104-21, a horizontal hydraulic gradient of 0.005 m/m was estimated, with general water table sloping towards southeast.

5.4 Particle Size Distribution

Physical soil laboratory testing was completed on four samples collected during the geotechnical drilling and percolation times (T-Times) were estimated based on the Unified Soil Classification System (USCS). Gradation charts for the particle size distribution tests are provided in Appendix D and are summarized in Table 3 below.

Table 3 Grain Size Analysis Data

BH	Depth (mbgs)	Description	% Gravel	% Sand	% Silt	% Clay	Percolation Rate (min/cm)
MW101-21-SS3	1.5 – 2.0	Silty Sand trace Clay	0	70	27	3	18
MW102-21-SS7	6.1 – 6.6	Clayey Silt, trace sand and gravel	1	4	77	18	40
BH103-21-SS4	2.3 – 2.7	Clayey Silt, some sand and trace gravel	1	13	63	23	45
MW104-21-SS5	3.0 – 3.5	Sand trace Silt trace Clay	0	88	9	3	10

Based on the data above, the percolation times (T-Times) ranged from as low as 45 min/cm to as high as 10 min/cm, with a geometric average of 23.85 min/cm.

Where applicable, the hydraulic conductivity values were calculated with Puckett's method for fine grained soil and Hazen's formula for granular soil. The estimated percolation time and hydraulic conductivity rates are provided in Table 4.



Table 4 Percolation Times and Hydraulic Conductivity

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

Based on the above, the geometric mean hydraulic conductivity was calculated at 3.05×10^{-5} m/sec.

Based on the results of the hydraulic conductivity (cm/s), the corresponding infiltration rate (mm/hr) will be estimated using the approximate relationship presented in the *Low Impact Development Stormwater Management Planning and Design Guide*” (TRCA and CVCA, 2010, Appendix C). Accordingly, the infiltration rates ranged from as low as 4 mm/hr to as high as 38 mm/hr.

6.0 Construction Dewatering

Construction dewatering is intended to lower the groundwater levels in the excavation area in order to ensure a dry and safe working condition.

The requirements for construction dewatering generally depend on the Site's soil and groundwater conditions including soil type, soil permeability or hydraulic conductivity, local groundwater levels, and the design of the proposed development, such as the foundation and/or basement elevation, as well as the size of proposed structure.

Proposed Development, Anticipated Excavation and Dewatering

The proposed development will include construction of 35 townhouse units organized into six separate blocks with associated driveways landscape areas and parking areas. The proposed townhouses might include a one level basement (Appendix A). Based on the grade elevations of the existing Church building and residential buildings at the Site, it was assumed that the established grade elevation or finished floor elevation (FFE) would be about 269.75 masl and the depth to the proposed one level basement would be 3.0 m at an elevation of 266.75 masl. Therefore, final excavation elevation would be 266.30 masl including an allowance (0.45 m) for the basement slab and the underneath granular base.

Based on the groundwater monitoring data, the highest measured and recorded spring groundwater elevation would be 263.50 masl, for the monitoring event of April 21, 2022. However, depth to water level and elevation were noted as 5.40 mbgs and 263.68 masl on December 21, 2021 and were considered as a worst-case-scenario.

The following assumptions and assumed parameters were considered in estimating the construction dewatering rate.

- The highest groundwater elevation was assumed at 263.68 masl.
- Established grade or finished floor elevation was assumed at 269.75 masl.
- One level basement excavation elevation was estimated at 266.30 masl.
- The target dewatering elevation (1 m below the basement level) would be 265.30 masl.



- The average hydraulic conductivity at 3.05×10^{-5} m/sec.

Based on the above data, the highest water table elevation of 263.80 masl is situated at about 1.50 m below the deepest excavation elevation of 265.30 masl. The open-cut excavation will cut through the native sand, silty sand and clayey silt sediments but will not be intersecting the groundwater table, as the water table lies well below the bottom excavation elevation.

Therefore, temporary short-term groundwater control (construction dewatering) will not be anticipated during the excavation for the one level basement.

Also, the one level basement slab elevation estimated at 266.30 masl, was well above the water table elevation of 263.80 masl and therefore, long-term permanent sub-drain drainage was not expected at the Site.



7.0 Water Balance Assessment

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.

The pre-development portion of the Site consists of a residential building, two smaller sheds south on Napier Street and a Church building with an entrance from Cook Street, in addition to landscape and paved areas.

It is understood that the Site be developed into a residential development consisting of 35 townhouse units organized into six separate blocks with associated driveways, landscape areas and parking areas. It is also understood that part of the existing Church building will be demolished to make a way for the proposed roadway.

Based on the available design information, the development area at the Site can be generally categorized into three types as paved area, roof area, and landscape areas. The pre- and post-development plans of the proposed development are shown in Figure 5 and Figure 6. respectively. A summary of the surface areas of the development is listed in Table 5.

Table 5 Pre- and Post-Development Site Statistics

Type of Land Coverage	Pre-Development Areas (m ²)	Post Development Areas (m ²)
Paved Area	2,683	2,744
Building Roof Area	603	2,937
Landscape/Vegetated Area	6,538	4,143
Total (m²)	9,824	9,824

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

7.1 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 the Barrie WPCC weather station (Climate Identifier: 6110557) located about 5 km from the Site. The data were available between the years 1973 to 2006 (i.e. 33 years). Accordingly, the average annual evapotranspiration was estimated to be about 545 mm/annum using the USGS Thornthwaite Monthly Water Balance methodology (Appendix E), and the average annual precipitation was recorded to be 933 mm/annum. Therefore, the available water surplus of the Site was calculated to be 388 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.

7.2 Infiltration Rates

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.

The Site is relatively a flat topography, and based on the results of the borehole investigation, the subsurface conditions at the Site consist predominantly of sandy silt to silty sand to a depth of about 6.6 mbgs, with intercalations of clayey silt between 2.3 mbgs and 3.0 mbgs.

The calculation of infiltration and runoff in the stages of pre-development and post-development is provided in Appendix E, and are presented in Table 6 and Table 9, below.

7.3 Pre-Development Water Balance

The water balance for the existing conditions of the Site is summarized in Table 6. The pre-development infiltration rate was calculated to be 1,649 m³/yr and the runoff rate was 3,647 m³/yr.



Table 6 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	2,683	2,503	250	-	2,253
	Roof Area	603	562.60	56	-	506
Pervious Areas	Landscape Area	6,538	6,100	3,563	1,649	888
Total			9,824	9,166	1,649	3,647
Assuming no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.						

7.4 Post-Development Water Balance

The post-development water balance is summarized in Table 7. The post-development infiltration rate was calculated to be 1,045 m³/yr and the runoff volume was estimated at 5,333 m³/yr.

Table 7 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	2,744	2,560	256	-	2,304
	Roof Area	2,937	2,740	274	-	2,466
Pervious Areas	Landscape Area	4,143	3,865	2,258	1,045	563
Total		9,824	9,166	2,788	1,045	5,333

7.5 Water Balance Comparison

The water balances of the pre-development and post-development scenarios are summarized below in Table 8.

Table 8 Water Balance Comparison

	Precipitation (m ³)	Evapotranspiration (m ³)	Infiltration (m ³)	Run- off (m ³)
Pre-Development	9,166	3,870	1,649	3,647
Post-Development	9,166	2,788	1,045	5,333
Change in Volume			604	1,686
Change in %			37	46

Based on the above, there is an infiltration deficit of about 604 m³/year compared to the pre-development infiltration. The runoff rate upon development of the Site will increase by 1,686 m³/year.

Table 9 Requirement of Infiltration from Roof Run-off

Volume of Pre-Development Infiltration (m ³ /annum)	1,649
Volume of Post-Development Infiltration (m ³ /annum)	1,045
Deficit from Pre to Post Development Infiltration (m ³ /annum)	604
% of Roof Runoff required to match the pre-development Infiltration	24

Based on the above calculations, a summary of the water balance could be provided as follows:

- 1) There is a net increase in run-off at the Site of about 1,686 m³/annum, from 3,647 m³/annum to 5,333 m³/annum. This increase is a result of the development of the Site with more impervious areas such as roof and paved areas and decrease in pervious landscape areas.
- 2) Post-development landscape area was decreased by about 2,395 m², when compared to the pre-development landscape, resulting in less infiltration across the Site.
- 3) Without implementing any mitigation measures, there is a net deficit of about 604 m³/annum in the post-development infiltration on a yearly basis.
- 4) Based on the estimation, a diversion of about 24% general roof water for infiltration, the proposed development would maintain the pre-development infiltration after the development. Therefore, Cambium would recommend the implementation of any



suitable Low Impact Development (LID) measures at the Site in its present design to account for the infiltration deficit.

7.6 Discussions on LID Measures

It is known that low impact development (LID) practices have received increasing attention as these strategies attempt to capture the runoff and mimic the natural hydrologic cycle.

In general, there are two primary categories of LIDs. The first promotes the infiltration of Stormwater close to the source. These infiltration type LIDs are preferred when hydrogeological and physical conditions are optimal and allow for their emplacement. The proposed development does not include any Stormwater management pond to enhance the lost infiltration due to the Site development with paved and roof areas. Therefore, the second option described below could be considered.

The second option captures and slowly releases the water to the groundwater water system through the process of storage and filtration by infiltration LIDs.

The roof surfaces included in the proposed development will generate approximately 2,466 m³/annum. In order to reduce the infiltration deficit and achieve water balance benefits, the option of roof downspout disconnection should be considered. This involves directing flow from roof downspouts to a pervious area that drains away from the building.

Properly connected downspouts, patio/yard drains and foundation drains will direct clean water to the ground surface, where it will infiltrate. Downspouts should discharge to a gradual sloped pervious area at least about 3 m away from the foundation that conveys runoff away from the building. Considering a conservative runoff reduction rate estimate for roof downspout disconnection at 25%, the general roof water for infiltration would fully compensate the infiltration deficit caused due to the Site development.

As another alternative, given the proposed Site layout, there is enough space available for the implementation of LID measures, either by means of infiltration galleries or infiltration trenches or any other suitable means. If requested, Cambium can complete in-situ soil infiltration tests during the spring/summer months using Guelph Permeameter at the proposed LID locations, if



any, in order to accurately estimate the infiltration rates for the design and implementation of LIDs across the Site.

It should be noted that, Cambium is not providing any design of LID facilities, it would be beneficial to consult with design engineers for the LID design recommendations.



8.0 Source Water Protection and Risk Management

As per the LSRCA Source Protection Plan (SPP), the Subject Site is located in a groundwater vulnerable area such as Wellhead Protection Area Q1/Q2 (WHPA-Q1/Q2) (Appendix A).

8.1 WHPA-Q1/Q2

WHPA Q1- refers to the area where activities that take water without returning it to the same source may be a threat; while WHPA Q2- refers to the area where activities that reduce recharge may be a threat. WHPA-Q1 (area affected by groundwater use) and WHPA-Q2 (area affected by recharge reduction) for the municipal wells in Barrie area were delineated through the application of a numerical groundwater flow model that considered all known high volume groundwater users. In other words, WHPA-Q2 delineates an area where there is potential for threats from reductions in groundwater recharge (i.e. new development).

In the present development scenario, the proposed development is for residential development and therefore, more impervious areas will be generated compared to the pre-development, thereby reducing groundwater recharge to the municipal aquifer.

Due to the fact that there is a net deficit in the infiltration compared to pre-development scenario and therefore, there is a negative impact to the groundwater recharge due to the proposed nature of the development in the study area. The water balance assessment for the proposed development indicated an infiltration deficit of 604 m³/annum.

Therefore, it is required to meet the pre-development water balance by implementing the Low Impact Development measures such as downspout disconnection techniques or any suitable measures where practicable, demonstrating recharge will be maintained across the Site.

Cambium also recommends using the Best Management Practices (BMPs) so as to avoid overland flow of any contaminants to the natural environment, especially to the Lake Simcoe.

The Site will be under municipal sewage service and as such is not expected to cause any groundwater contamination by nitrates.



The major land use practices at the proposed development do not include the storage & handling of large quantities of road salt and snow storage and handling, hence, the development of Salt Management Plans and Snow Storage Plans is not required for the proposed development.



9.0 Assessment of Potential Impacts

Based on the information available, the residential development at the Site is proposed to be developed with townhouse units with possible one level basement. There is no construction dewatering, either short-term or long-term involved at the Site due to deep water table conditions. The potential impacts due to the Site development were assessed as below.

9.1 Natural Features

As discussed, no natural features such as wetlands, woodlands, ponds, and creeks located on the Site, there should be no impacts on the local natural features, due to the Site development. The Site is not situated within the LSRCA regulated areas as per Ont. Reg. 179/06 and therefore, development restrictions do not apply to the proposed development.

9.2 Water Supply Wells near the Site

The proposed development is being developed with one level basement, and that no dewatering will be required for the completion of the proposed development, therefore, impacts on the local water wells (private or public), if any will not be anticipated to be associated with the dewatering activity.

9.3 Considerations on Drinking Water Vulnerability

Based on the MECP Source Protection Information Atlas, the Site is situated within WHPA-Q1/Q2 area related to groundwater recharge management; therefore, it is required to meet the pre-development water balance by implementing the suitable Low Impact Development measures, demonstrating recharge will be maintained across the Site. Section 8 of this report has a detailed discussion on the issue of source water protection and all the land use policies such as following best management practices and utilizing LIDs to compensate infiltration deficit be implemented as recommended.



10.0 Conclusions And Recommendations

Cambium Inc. (Cambium) was retained by 2556055 Ontario Inc (the Client) to complete a hydrogeological assessment of the property located at 103 and 107 Napier Street and 95 Cook Street, City of Barrie, ON (the Site).

The Site has no wetlands or woodlands or any regulated areas that overlap the Site. As such, the proposed development restrictions under Ont. Reg. 179/06 made under the *Conservation Authorities Act, 1990*, do not apply to the proposed development.

The measured spring groundwater levels in the monitoring wells ranged from 5.12 mbgs to 5.58 mbgs, while the elevation was between 262.95 masl and 263.50 masl.

The water level fluctuations (i.e. difference between the highest and the lowest water levels) were minimal with 0.63 m at MW101-21 and 0.23 at MW104-21.

Groundwater flow direction could not be determined as only two monitoring wells had defined water levels and the third monitoring well was consistently dry.

Site development plan proposes the construction of a townhouse complex with a possible one level basement. The proposed development is not anticipated to involve any short-term construction dewatering or a permanent long-term sub-drain dewatering due to deep water table conditions across the Site. The highest water table elevation of 263.80 masl is situated at about 1.50 m below the deepest excavation elevation of 265.30 masl and therefore, no dewatering is expected at the Site.

The conceptual water balance indicates that there will be an infiltration deficit of about 604 m³/annum in the post-development infiltration upon development of the Site, compared to the pre-development. Based on the estimation, a diversion of 24% of general roof water for infiltration, the proposed development would maintain an enhanced infiltration after the development.

Considering a conservative runoff reduction rate estimate for roof downspout disconnection at 25%, the roof water for infiltration would fully compensate the infiltration deficit caused due to



the Site development. Therefore, Cambium would recommend the implementation of any Low Impact Development (LID) measures at the Site in its present design.

Since the Site is situated within a WHPA Q1/Q2, it is required to meet the pre-development water balance by implementing the Low Impact Development measures such as downspout disconnection techniques or any suitable measures where practicable, demonstrating pre-development recharge will be maintained across the Site.

Based on the hydrogeological investigation, no environmental impacts were anticipated due to the proposed Site development.



11.0 Closing

We trust that the information in this submission meets your current requirements. If you have any questions regarding the contents of this report, please contact the undersigned.

Respectfully submitted,

Cambium Inc.

Sudhakar Kurli, M.Sc. P.Geo.
Project Manager

Kevin Warner, M.Sc., P.Geo (Ltd). BCIN
Manager-Water & Wastewater



12.0 References

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13.0 Standard Limitations

Limited Warranty

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

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Site Assessments

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

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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

2556055 ONTARIO INC.
107 Napier Street and 95 Cook Street,
Barrie, Ontario

LEGEND

- Highway
- Major Road
- Minor Road
- Watercourse
- Water Area
- Provincial Park
- Wooded Area
- Built Up Area

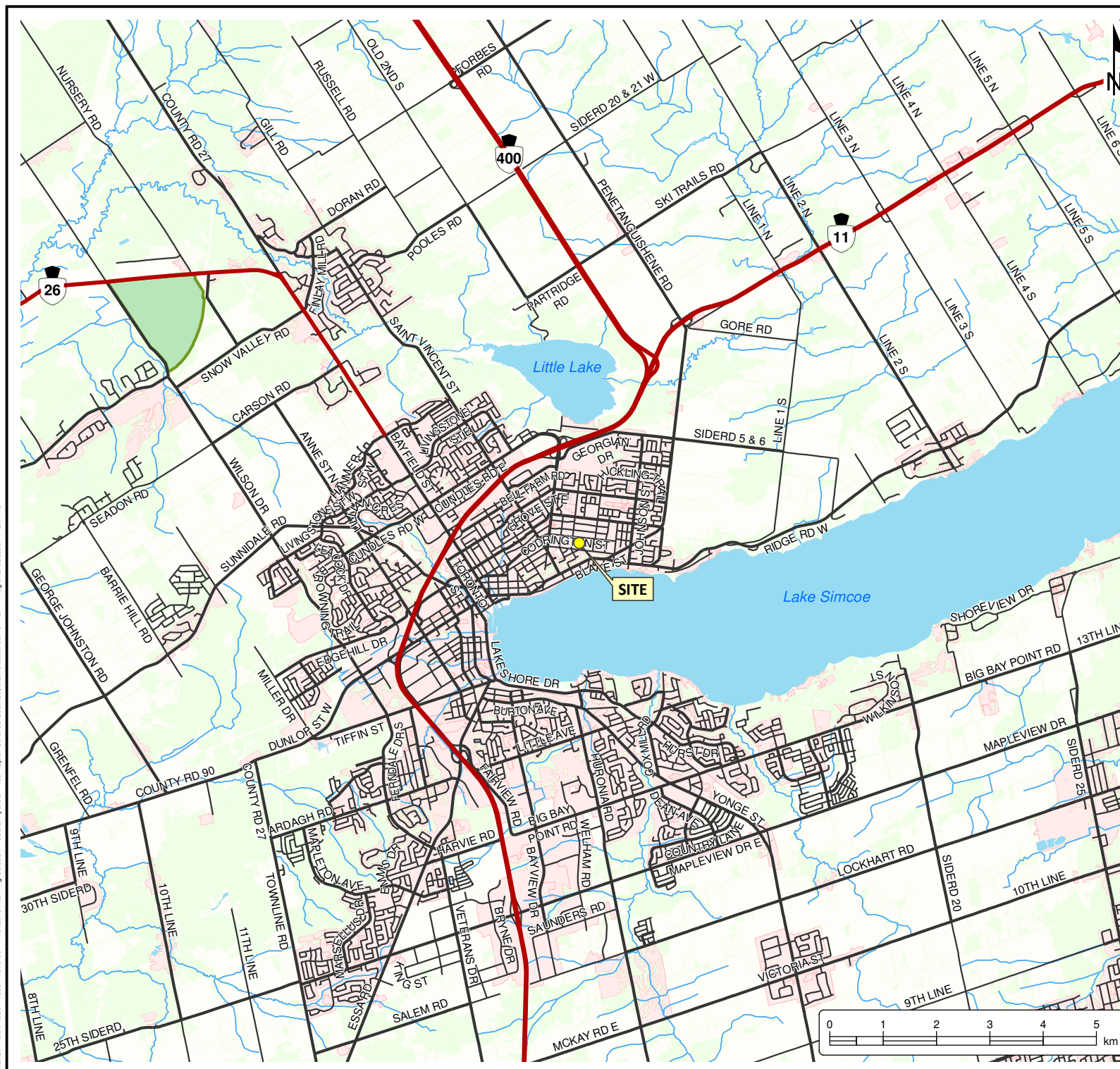
Notes:
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www.cambium-inc.com

REGIONAL LOCATION PLAN

Project No.:	14079-001	Date:	February 2022
Scale:	1:100,000	Projection:	NAD 1983 UTM Zone 17N
Created by:	MAT	Checked by:	SK
Figure:	1		





HYDROGEOLOGICAL ASSESSMENT

2556055 ONTARIO INC.
107 Napier Street and 95 Cook Street,
Barrie, Ontario

LEGEND

Site (approximate)

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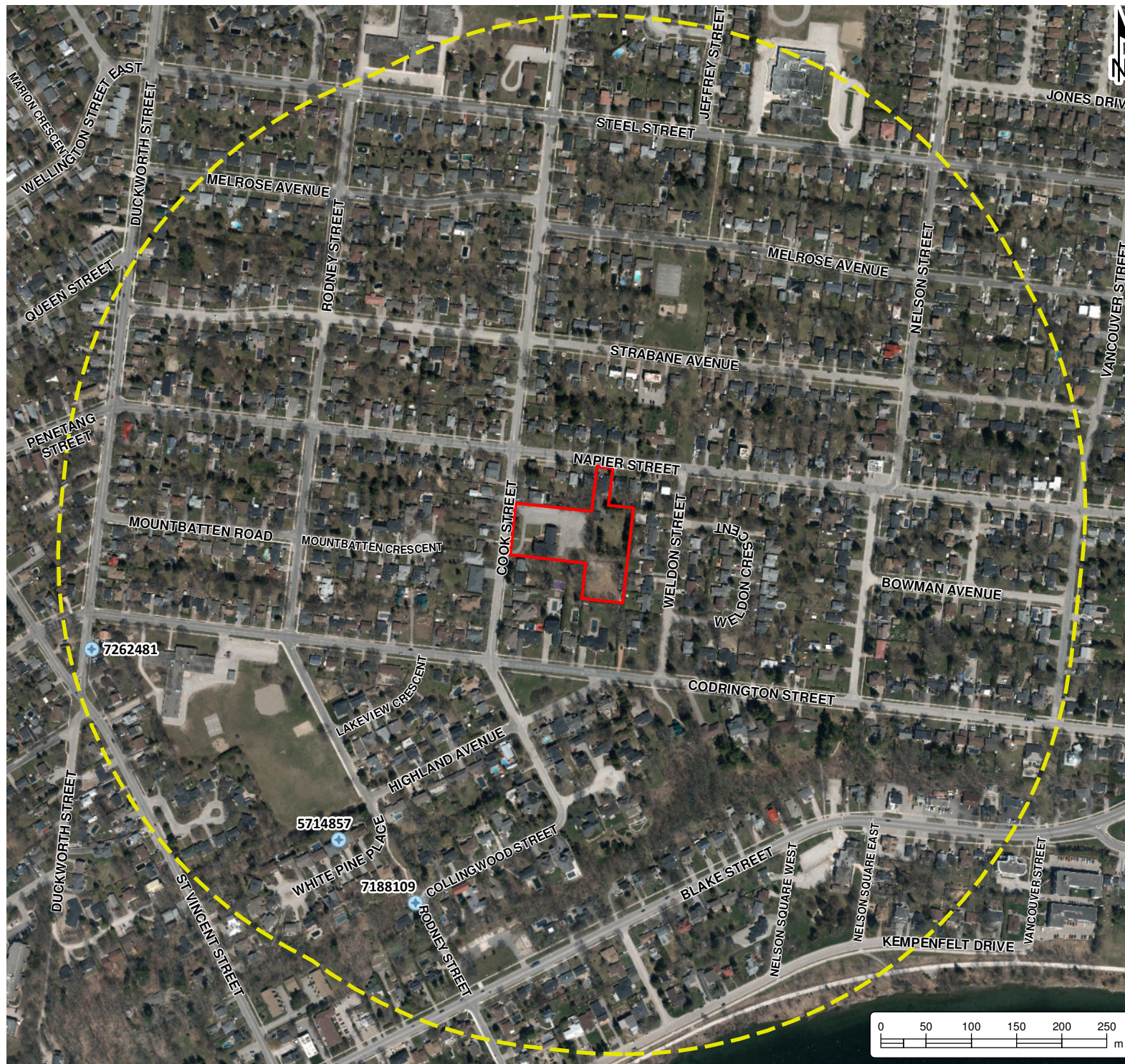


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SITE PLAN

Project No.:	Date: February 2022	
14079-001	Rev.:	
Scale:	Projection:	
1:1,000	NAD 1983 UTM Zone 17N	
Created by:	Checked by:	Figure:
MAT	SK	2

O:\GIS\MXDs\14000-14099\14079-001 Innovative Planning Solution - Geo & HydroG - 103 Napier St. & 95 Cook St., Barrie\2022-02-10 FIG 3 - MECP Well Records.mxd



HYDROGEOLOGICAL ASSESSMENT

2556055 ONTARIO INC.
107 Napier Street and 95 Cook Street,
Barrie, Ontario

LEGEND

-  Water Well Record
-  500m Study Area
-  Site (approximate)

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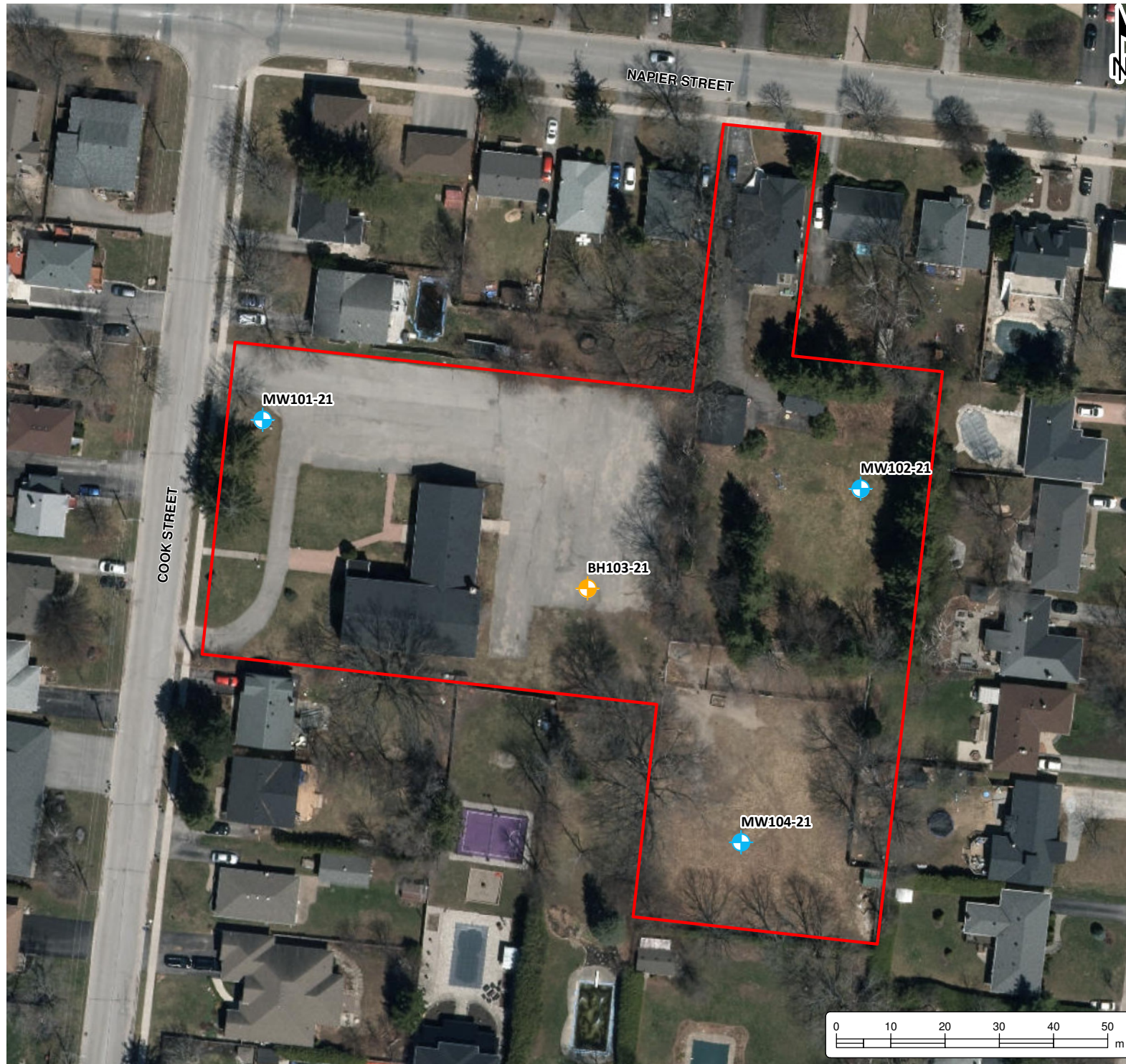


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MECP WELL RECORDS WITHIN 500m OF SITE

Project No.:	14079-001	Date:	February 2022
Scale:	1:6,000	Rev.:	
Created by:	MAT	Projection:	NAD 1983 UTM Zone 17N
Checked by:	SK	Figure:	3

O:\GIS\MXDs\14000-14099\14079-001 Innovative Planning Solution - Geo & HydroG - 103 Napier St. & 95 Cook St., Barrie\2022-02-10 FIG 4 - Borehole Location Plan.mxd



HYDROGEOLOGICAL ASSESSMENT

2556055 ONTARIO INC.
107 Napier Street and 95 Cook Street,
Barrie, Ontario

LEGEND

-  Borehole
-  Monitoring Well
-  Site (approximate)

Notes:

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BOREHOLE LOCATION PLAN

Project No.:	14079-001	Date:	February 2022
Scale:	1:1,000	Rev.:	
Created by:	MAT	Checked by:	SK
		Figure:	4

O:\GIS\MXD\14000-14099\14079-001 Innovative Planning Solution - Geo & HydroG - 103 Napier St. & 95 Cook St., Barrie\2022-02-10 FIG 5 - Pre-development Plan.mxd



	Area (m ²)
Roof Area	602.8
Paved Area	2,683.1
Landscaped Area	6,537.7

HYDROGEOLOGICAL ASSESSMENT

2556055 ONTARIO INC.
107 Napier Street and 95 Cook Street,
Barrie, Ontario

LEGEND

-  Roof
-  Paved
-  Landscaped
-  Site (approximate)

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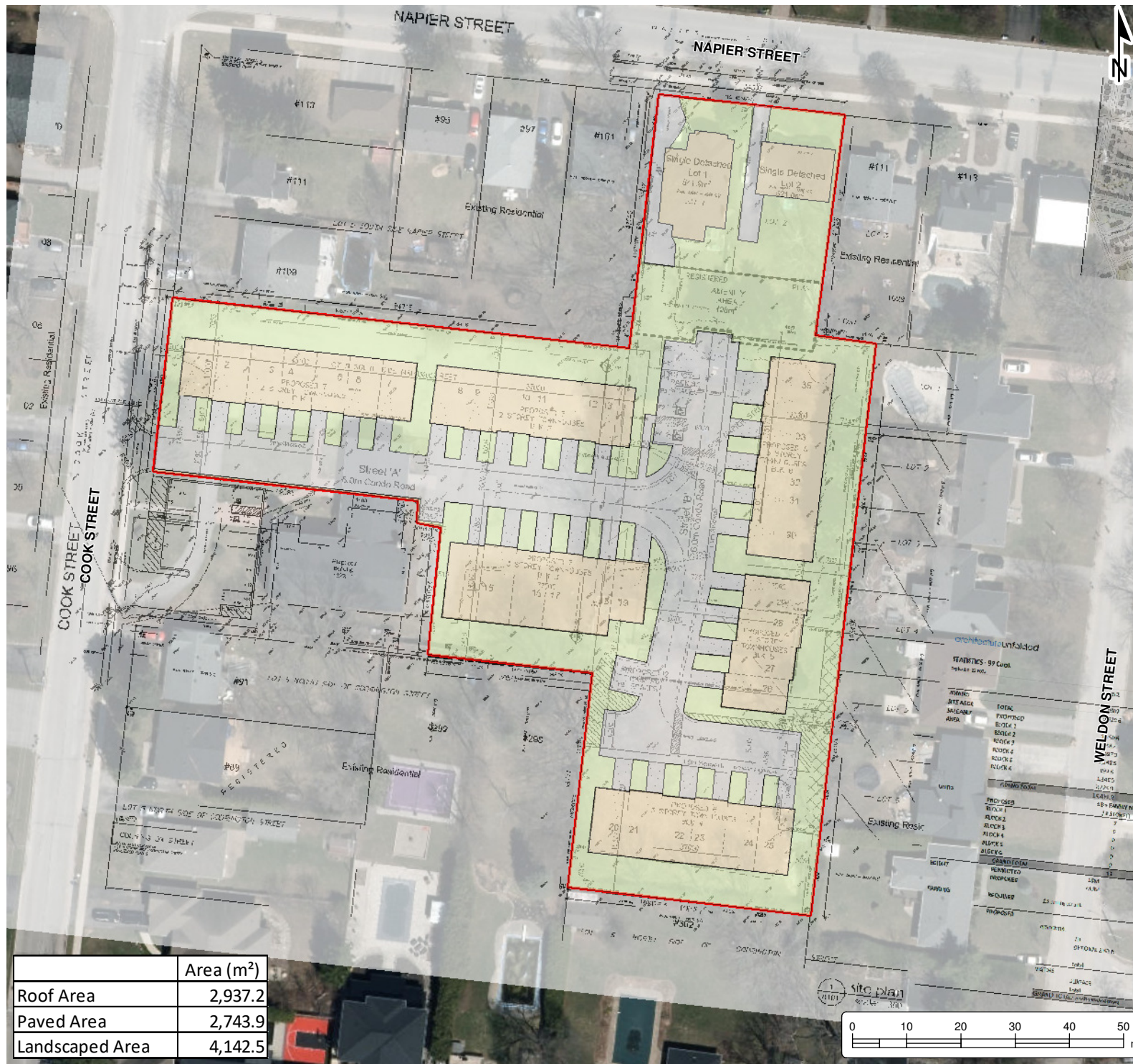


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PRE-DEVELOPMENT PLAN

Project No.: 14079-001	Date: November 2022
Scale: 1:1,000	Rev.: NAD 1983 UTM Zone 17N
Created by: MAT	Checked by: SK
Figure: 5	

O:\GIS\MXD\14000-14099\14079-001 Innovative Planning Solution - Geo & HydroG - 103 Napier St. & 95 Cook St., Barrie\2022-02-10 FIG 6 - Post-development Plan.mxd



HYDROGEOLOGICAL ASSESSMENT

2556055 ONTARIO INC.
107 Napier Street and 95 Cook Street,
Barrie, Ontario

LEGEND

- Roof
- Paved
- Landscaped
- Site (approximate)

Notes:

- Site Plan Overlay was created by Architecture Unfolded, Project no. 22-39, drawing no. A101, dated October 21, 2022.
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POST-DEVELOPMENT PLAN

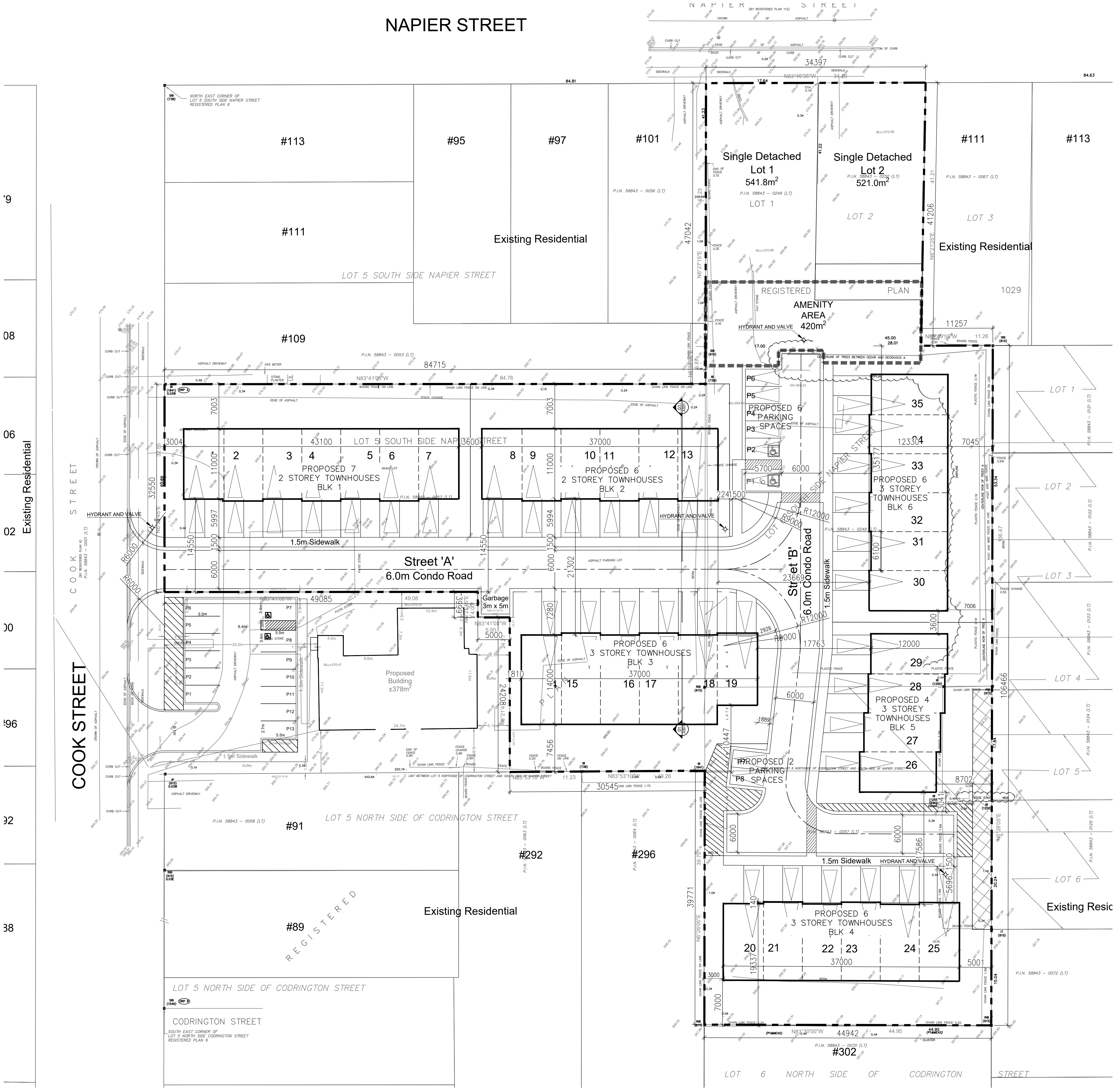
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Created by:	MAT	Checked by:	SK
Figure:			6



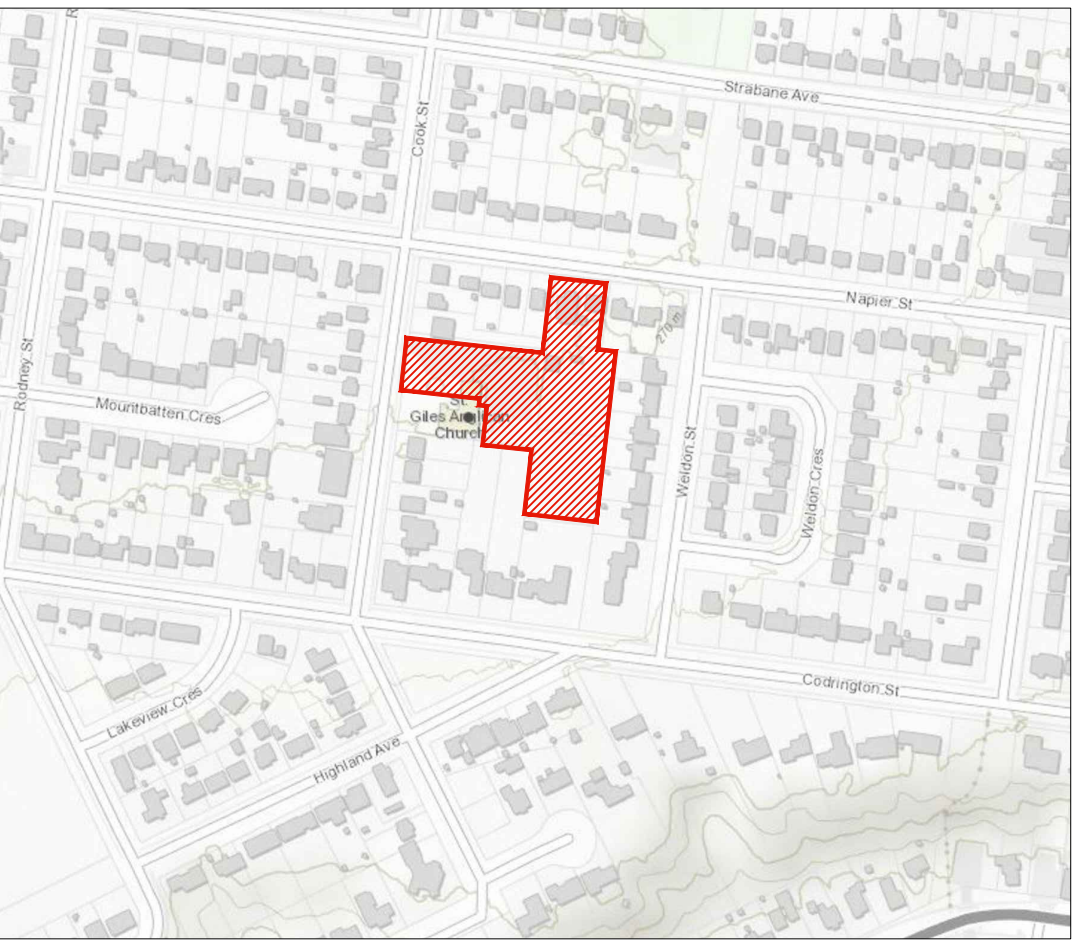
Appendix A

Site Development Plans

NAPIER STREET



1 site plan
A101 scale: 1:300



2 context plan
A101 nts

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These Contract Documents are the property of the architect. The architect bears no responsibility for the preservation of these documents by the Contractor. Upon completion of the project, the architect will provide written confirmation of the final disposition of the documents. The architect will retain the original documents for a period of five (5) years after the date of completion of the project.

Drawings are not to be scaled for construction. Contractor to verify all existing conditions and dimensions required to perform the work and report any discrepancies with the Contract Documents to the architect before commencing work.

Position of exposed or finished mechanical or electrical devices, fittings, and fixtures are indicated on architectural drawings. The locations shown on the architectural drawings govern over the Mechanical and Electrical drawings. Those items not clearly located will be located as directed by the architect.

These drawings are not to be used for construction unless noted below as "Issued for Construction".

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The Designer of these plans and specifications gives no warranty or representation to any party about the constructability of the represented by them, at construction or subcontractor must satisfy themselves when bidding and at all times that they can properly construct the work represented by these plans.

notes:

architectureunfolded		388 dufferin st., toronto, on. m6k 1z8, tel. (416) 601-5416			
STATISTICS - 99 Cook		2239			
September 22 2022		m2	ft2	acres	density (FSI)
ZONING		RM2			
SITE AREA	TOTAL	9,823.6	105,740	2.43	1.5
	SALEABLE AREA	PROPOSED			
BLOCK 1	1,150.6	12,385			
	988.2	10,637			
	1,497.3	16,117			
	1,348.5	14,515			
	892.8	9,610			
	1,348.5	14,515			
	7,225.9	77,779			
GRAND TOTAL		14,451.8	155,557.7		
UNITS	3B + FAMILY RM (2 STOREY)	3B + FAMILY RM (3 STOREY)	TOTAL		
	7	0	7		
	6	0	6		
	0	6	6		
	0	6	6		
	0	4	4		
	0	6	0		
GRAND TOTAL		13	22	35	
HEIGHT	PERMITTED	10M			
	PROPOSED	<10M			
PARKING	REQUIRED	1.5 parking per unit	53		
	PROPOSED				
		RESIDENTIAL			
		TH	70 (includes 7 BF spaces)		
		OPTIONAL 2ND P.	21 (not included in total)		
		Total	70		
		VISITORS			
		SURFACE	8		
		Total	8		
		GRAND TOTAL: (residential+visitors)	78		

3 statistics
A101

revisions: d-m-yr

architectural team :

mark zwicker
melina andretto

planning:

structural:

electrical:

mechanical:

landscape:

site services:

owner:

project:
95 Cook St
barrie, ontario

site and context
plan

oct. 21, 2022
as indicated
22-39
ma

date:
scale:
project:
drawn by:

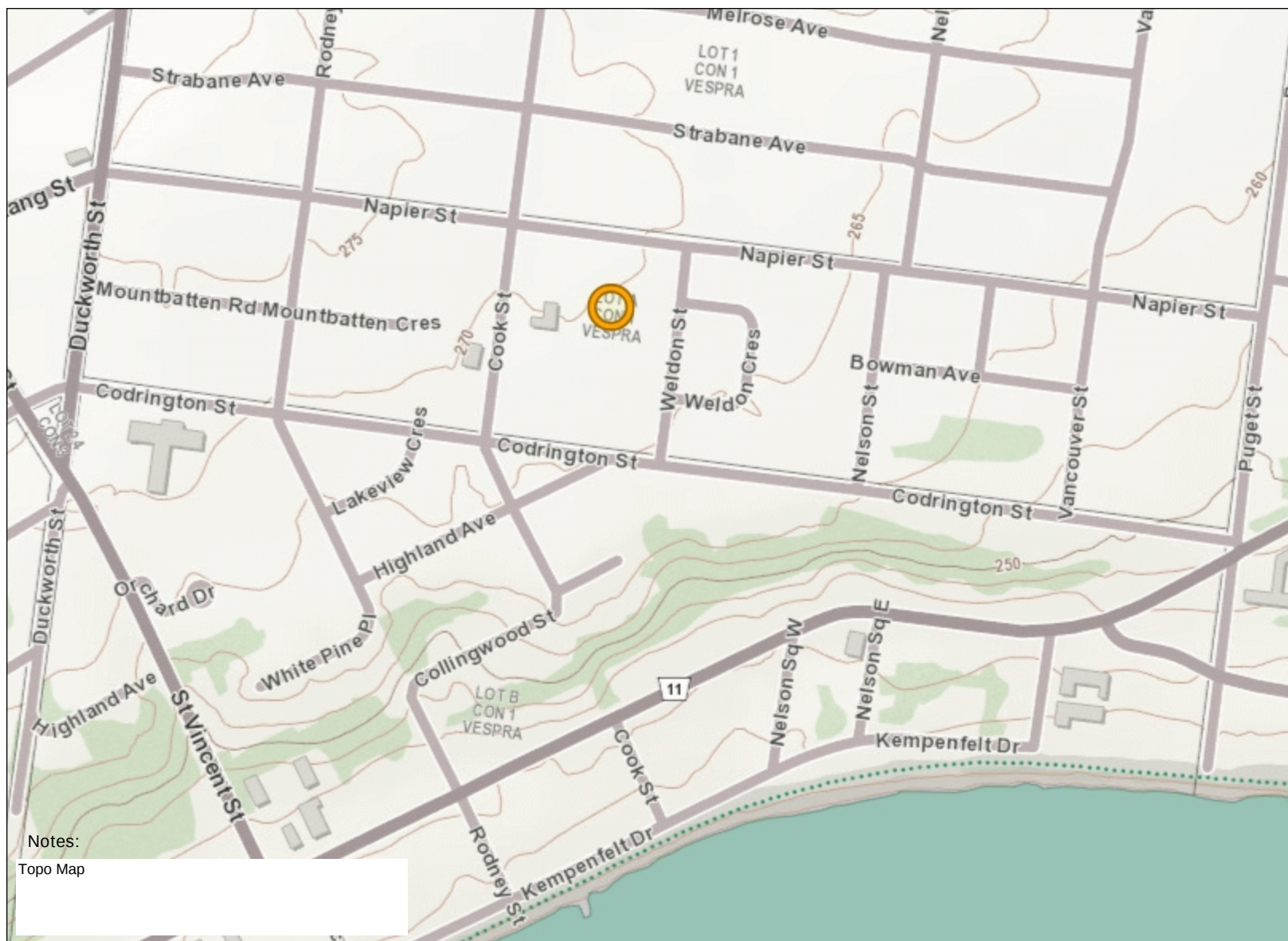


drawing number:
A101

Legend

ANSI

-  Earth Science Provincially Significant/sciences de la terre d'importance provinciale
-  Earth Science Regionally Significant/sciences de la terre d'importance régionale
-  Life Science Provincially Significant/sciences de la vie d'importance provinciale
-  Life Science Regionally Significant/sciences de la vie d'importance régionale
-  Conservation Reserve
-  Provincial Park
-  Natural Heritage System



Notes:

Topo Map

0.3 0 0.16 0.3 Kilometres

Absence of a feature in the map does not mean they do not exist in this area.

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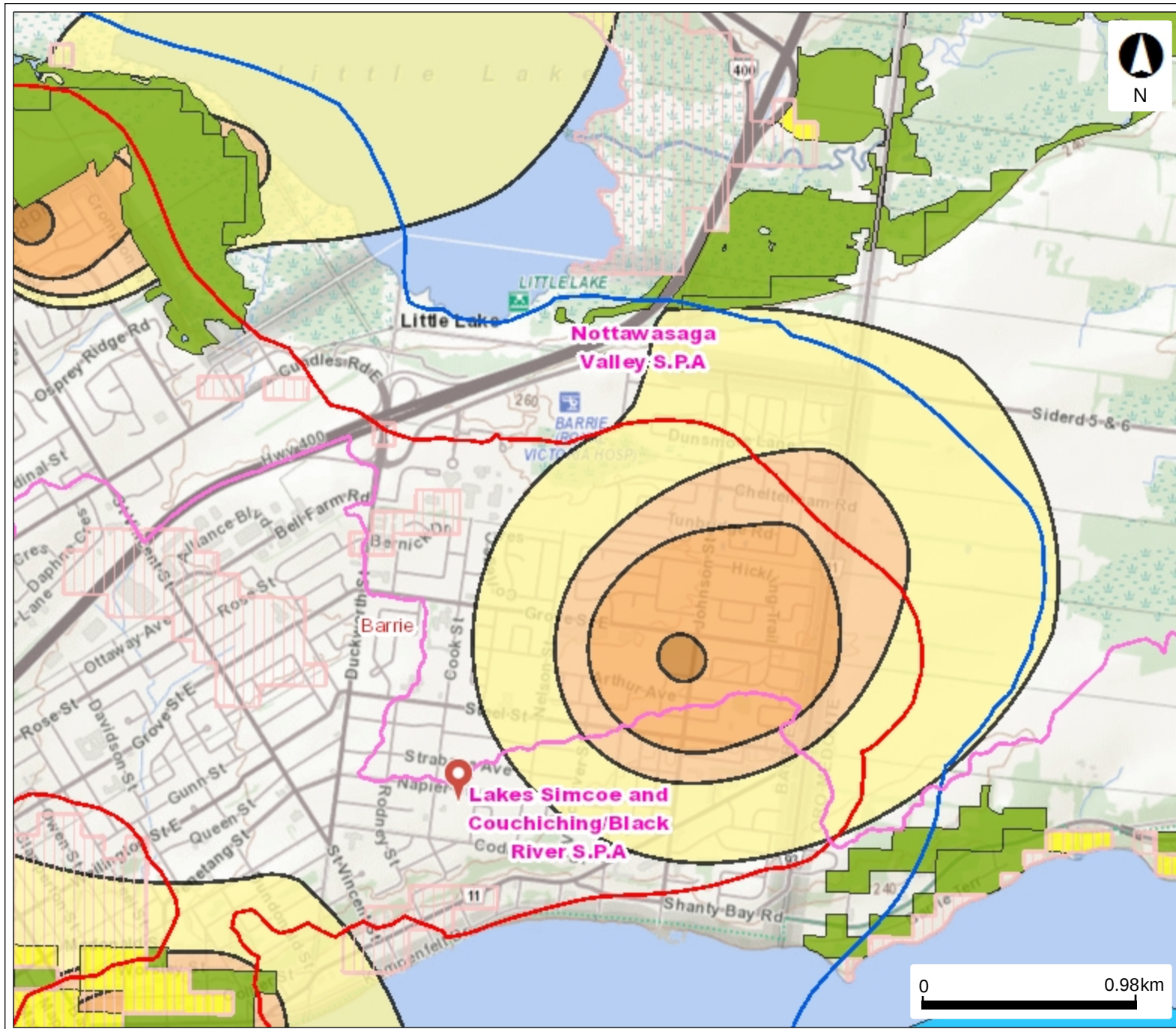
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WHPA Q1/Q2 Areas



Legend

- Source Protection Areas
- Wellhead Protection Area Q1
- Wellhead Protection Area Q2
- Highly Vulnerable Aquifers
- Significant Groundwater Recharge Area
 - 0
 - 2
 - 4
 - 6
- Wellhead Protection Area
 - A
 - B
 - C
 - C1
 - D
 - F
- Intake Protection Zone 1
- Event Based Areas
- Intake Protection Zone 2

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Appendix B

MECP Well Records



Ministry of the
Environment

The Ontario Water Resources Act

WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11

5714857

MUNICIPALITY
57501

CON.

COUNTY OR DISTRICT Simcoe	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE Barrie	CON., BLOCK, TRACT, SURVEY, ETC. —	LOT 25-27
OWNER (SURNAME FIRST) BARRIE PUC	ADDRESS Bayfield St Barrie	DATE COMPLETED DAY 28 MO 11 YR 77	
NORTHING 605700		EASTING 4916400	
ELEVATION 0850		BASIN CODE 22	

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET	
				FROM	TO
Brown	clay	gravel + boulders	stiff	0	19
Brown	clay	gravel	stiff	19	27
Grey	clay		hard	27	43
Grey	clay	gravel	stiff	43	49
Grey	clay	sand	layers	49	73
Blue	clay		hard	73	186
Grey	clay	sand	layers	186	245
Grey	clay		stiff	245	253
Grey	clay		hard	253	277
Grey	sand	(silty)	packed	277	324
Grey	clay		hard	324	333
Grey	clay	sand	layers	333	345

31 00196051113 002760511173 004340573 004920511173 00732052874 018630573 1
32 02482052874 027720573 03242288479 033320573 03452052874 03852280679 1

41 WATER RECORD	
WATER FOUND AT - FEET	KIND OF WATER
10-13	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
15-18	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
20-23	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
25-28	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
30-33	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD	
INSIDE DIAM. INCHES	MATERIAL
10-11	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE
17-18	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE
24-25	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE

SCREEN	SIZE(S) OF OPENING (SLOT NO.)	DIAMETER	LENGTH
		INCHES	FEET
	MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN	

61 PLUGGING & SEALING RECORD	
DEPTH SET AT - FEET	MATERIAL AND TYPE
FROM TO	(CEMENT GROUT, LEAD PACKER, ETC.)
10-13	14-17
18-21	22-25
26-29	30-33

71 PUMPING TEST	PUMPING TEST METHOD	10 PUMPING RATE	11-14 DURATION OF PUMPING
	1 ☐ PUMP 2 ☐ BAILER	GPM	15-16 HOURS 17-18 MINS
	STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVEL DURING
	19-21	22-24	15 MINUTES 26-28 30 MINUTES 29-31 45 MINUTES 32-34 60 MINUTES 35-37

LOCATION OF WELL	
IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.	
DRILLERS REMARKS:	

74 FINAL STATUS OF WELL	1 ☐ WATER SUPPLY 2 ☒ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL	5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED
75-76 WATER USE	1 ☐ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL 5 ☐ OTHER	5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED
77 METHOD OF DRILLING	1 ☐ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION	6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

CONTRACTOR	NAME OF WELL CONTRACTOR	LICENCE NUMBER
	Int'l. Water Supply Co.	2801
	ADDRESS	
	Bay 310 Barrie.	
NAME OF DRILLER OR BORER	LICENCE NUMBER	
Signature of Contractor	SUBMISSION DATE	
John Wal	9 12 77	

OFFICE USE ONLY	DATA SOURCE	CONTRACTOR	DATE RECEIVED
	1	2801	040178
	DATE OF INSPECTION	INSPECTOR	
	REMARKS:		
CSS.ES			



The Ontario Water Resources Act

WATER WELL RECORD

11

Page 2 of 2 #15714857

MUNICIPAL

CON

COUNTY OR DISTRICT Simcoe		TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE Barrie		CON., BLOCK, TRACT, SURVEY, ETC. —		LOT 25-27
OWNER (SURNAME FIRST) Barrie P.A.C.		ADDRESS Bayfield St. Barrie		DATE COMPLETED DAY 28 MO Nov YR 77		48-53
U 11-2-07-02		ZONE 42		EASTING 20		NORTHING 20
RC 10		ELEVATION 10		RC 10		BASIN CODE 10

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

[illegible]

③ 042120573

32

41		WATER RECORD			
WATER FOUND AT - FEET		KIND OF WATER			
10-13	1	☐ FRESH	3	☐ SULPHUR	14
	2	☐ SALTY	4	☐ MINERAL	
15-18	1	☐ FRESH	3	☐ SULPHUR	19
	2	☐ SALTY	4	☐ MINERAL	
20-23	1	☐ FRESH	3	☐ SULPHUR	24
	2	☐ SALTY	4	☐ MINERAL	
25-28	1	☐ FRESH	3	☐ SULPHUR	29
	2	☐ SALTY	4	☐ MINERAL	
30-33	1	☐ FRESH	3	☐ SULPHUR	34
	2	☐ SALTY	4	☐ MINERAL	

51 Casing & Open Hole RECORD				
INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET	
			FROM	TO
10-11	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE	12		13-14
17-18	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE	19		20-21
24-25	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE	26		27-28

SCREEN	SIZE(S) OF OPENING (SLOT NO.)	31-33	DIAMETER	34-38	LENGTH	39-40
			INCHES		FEET	
	MATERIAL AND TYPE		DEPTH TO TOP OF SCREEN		41-44	50
					FEET	

61		PLUGGING & SEALING RECORD	
DEPTH SET AT - FEET		MATERIAL AND TYPE (CEMENT GROUT LEAD PACKER, ETC.)	
FROM	TO		
10-13	14-17		
18-21	22-25		
26-29	30-33	80	

71	PUMPING TEST METHOD		10 PUMPING RATE		11-14 DURATION OF PUMPING	
	1 ☐ PUMP 2 ☐ BAILER		GPM		15-16 _____ HOURS 17-18 _____ MINS	
	STATIC LEVEL		25 WATER LEVELS DURING		1 ☐ PUMPING 2 ☐ RECOVERY	
	19-21		22-24		45 MINUTES 60 MINUTES	
	FEET		FEET		FEET FEET	
	IF FLOWING, GIVE RATE		30-41 GPM		42 WATER AT END OF TEST	
RECOMMENDED PUMP TYPE		RECOMMENDED PUMP SETTING		RECOMMENDED PUMPING RATE		
☐ SHALLOW ☐ DEEP		FEET		FEET GPM		
50-53						

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.

See Page #1

DRILLERS REMARKS:

FINAL STATUS OF WELL	54 1 ☐ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL	5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED
	55-56 WATER USE	1 ☐ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER _____
METHOD OF DRILLING	57 1 ☐ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION	6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

CONTRACTOR	NAME OF WELL CONTRACTOR		LICENCE NUMBER
	Inter. Water Supply Co		2801
	ADDRESS		
	Box 310 Barrie Ont.		
	NAME OF DRILLER OR BORER		LICENCE NUMBER
	H. Peterman		
	SIGNATURE OF CONTRACTOR		SUBMISSION DATE
			DAY _____ MO _____ YR _____

OFFICE USE ONLY	DATA SOURCE	58	CONTRACTOR	59-62	DATE RECEIVED	63-68	8
	DATE OF INSPECTION			INSPECTOR			
	REMARKS:						

Measurements recorded in: ☐ Metric ☒ Imperial

Well Owner's Information

First Name Last Name / Organization E-mail Address ☐ Well Constructed by Well Owner

Mailing Address (Street Number/Name) Municipality Province Postal Code Telephone No. (inc. area code)

Well Location

Address of Well Location (Street Number/Name) Township Lot Concession

County/District/Municipality City/Town/Village Province Ontario Postal Code

UTM Coordinates Zone Easting Northing Municipal Plan and Sublot Number Other

Overburden and Bedrock Materials/Abandonment Sealing Record (see instructions on the back of this form)

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft)
brown	sand	silt	dense	0' 20'

Annular Space		
Depth Set at (m/ft)	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0' 8'	Bontando chips	8'
8' 20'	silica sand	12'

Method of Construction		Well Use	
☒ Cable Tool	☐ Diamond	☐ Public	☐ Commercial
☒ Rotary (Conventional)	☐ Jetting	☐ Domestic	☐ Municipal
☐ Rotary (Reverse)	☐ Driving	☐ Livestock	☐ Test Hole
☐ Boring	☐ Digging	☐ Irrigation	☐ Cooling & Air Conditioning
☐ Air percussion		☐ Industrial	
☐ Other, specify		☐ Other, specify	

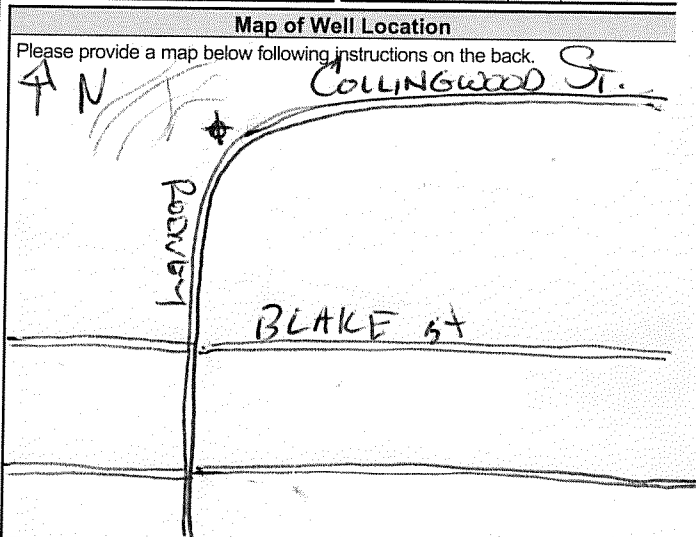
Construction Record - Casing			Status of Well	
Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft)	
2"	Plastic	3/16	0' 10'	☐ Water Supply
				☐ Replacement Well
				☐ Test Hole
				☐ Recharge Well
				☐ Dewatering Well
				☒ Observation and/or Monitoring Hole
				☐ Alteration (Construction)
				☐ Abandoned, Insufficient Supply
				☐ Abandoned, Poor Water Quality
				☐ Abandoned, other, specify
				☐ Other, specify

Construction Record - Screen			Status of Well	
Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft)	
2"	Plastic	010	10' 20'	☐ Water Supply
				☐ Replacement Well
				☐ Test Hole
				☐ Recharge Well
				☐ Dewatering Well
				☒ Observation and/or Monitoring Hole
				☐ Alteration (Construction)
				☐ Abandoned, Insufficient Supply
				☐ Abandoned, Poor Water Quality
				☐ Abandoned, other, specify
				☐ Other, specify

Water Details		Hole Diameter	
Water found at Depth (m/ft)	Kind of Water: ☐ Fresh ☐ Untested ☐ Gas ☐ Other, specify	Depth (m/ft)	Diameter (cm/in)
None		0' 20'	4 1/4

Well Contractor and Well Technician Information			
Business Name of Well Contractor	Well Contractor's Licence No.		
LONDON SOIL TEST LTD	7190		
Business Address (Street Number/Name)	Municipality		
B.R.6	DUNDALK		
Province	Postal Code	Business E-mail Address	
ON	N6C1B0		
Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)		
519 4555 7777	COLLETTE RAYMOND		
Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted	
3552		20120906	

Results of Well Yield Testing					
After test of well yield, water was:		Draw Down		Recovery	
☐ Clear and sand free		Time (min)	Water Level (m/ft)	Time (min)	Water Level (m/ft)
☐ Other, <i>specify</i> _____		Static Level			
If pumping discontinued, give reason:		1		1	
Pump intake set at (m/ft)		2		2	
Pumping rate (l/min / GPM)		3		3	
Duration of pumping		4		4	
_____ hrs + _____ min		5		5	
Final water level end of pumping (m/ft)		10		10	
If flowing give rate (l/min / GPM)		15		15	
Recommended pump depth (m/ft)		20		20	
Recommended pump rate (l/min / GPM)		25		25	
Well production (l/min / GPM)		30		30	
Disinfected?		40		40	
☐ Yes ☐ No		50		50	
		60		60	



Comments:		Ministry Use Only	
STICK-UP CASING		Audit No.	
		Z146878	
		Received	SEP 27 2012



Appendix C

Borehole Logs



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

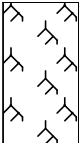
Log of Borehole:

MW101-21

Page 1 of 1

Client: Innovative Planning Solutions
Contractor: Landshark Drilling
Location: 95 Cook Street, Barrie, Ontario

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

SUBSURFACE PROFILE				SAMPLE											
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture			SPT (N)			Well Installation	Remarks
								25	50	75	10	20	30	40	
270	0		Topsoil: Black silt, some sand, some organics, loose, moist [TOPSOIL]	1	SS	40	4								Monument Cap Bentonite Plug PVC Standpipe <

Logged By: BW

Input By: BW



Client: Innovative Planning Solutions

Project Name: 103 Napier Street and 95 Cook Street, Barrie, ON **Project No.:** 14079-001

Contractor: Landshark Drilling

Method: Hollow Stem Auger

Date Completed: December 8, 2021

Location: 103 Napier Street, Barrie, Ontario

UTM: 17T: 4916970 m north, 606025 m east

Elevation: 269.08 mASL

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

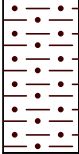
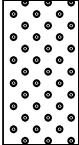
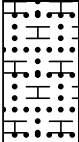
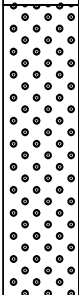
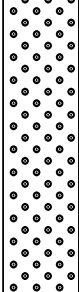
Logged By: BW

Input By: BW



Client: Innovative Planning Solutions
Contractor: Landshark Drilling
Location: 95 Cook Street, Barrie, Ontario

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

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

**MW104-21**

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

Logged By: BW **Input By:** BW



Appendix D

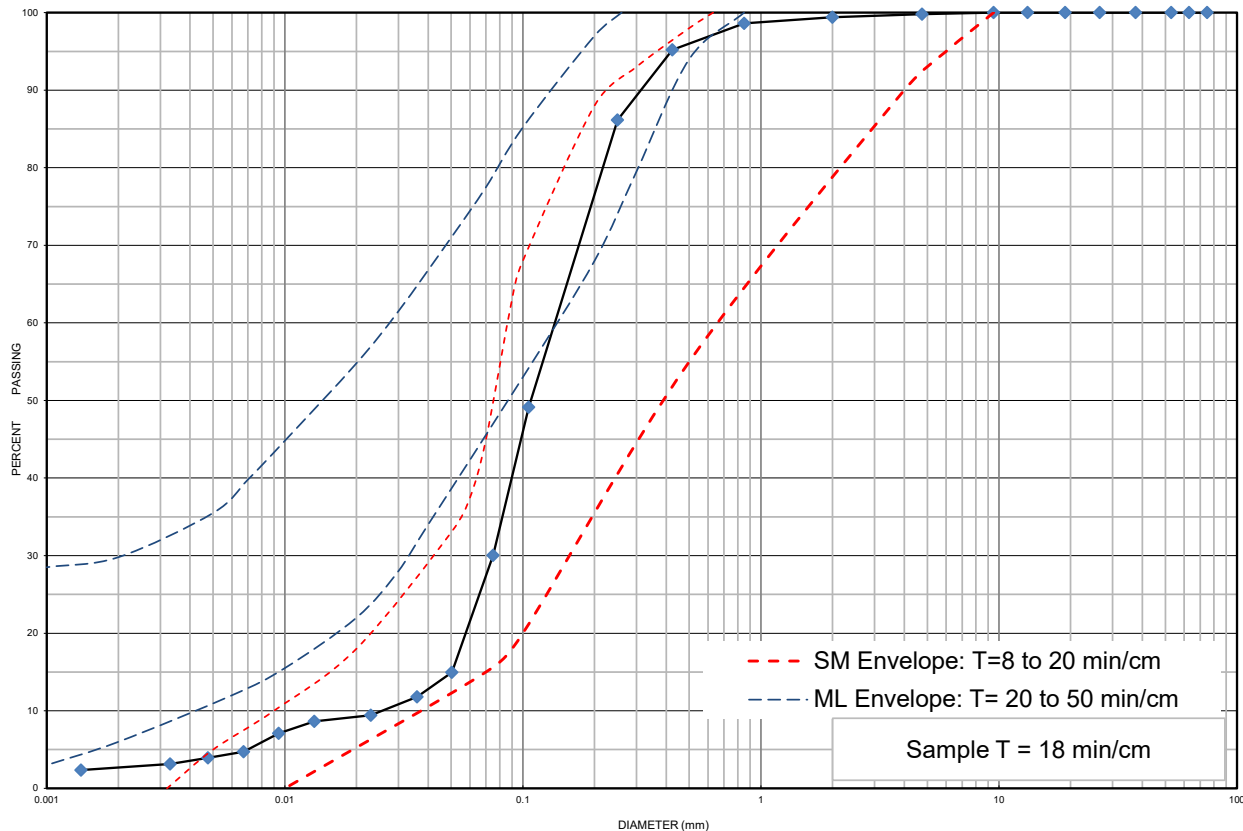
Grain Size Analysis Data



Grain Size Distribution Chart

Project Number: 14079-001 **Client:** Innovative Planning Solutions
Project Name: 103 Napier St. & 95 Cook St., Barrie
Sample Date: December 8, 2021 **Sampled By:** Ben White - Cambium Inc.
Location: BH 101-21 SS 3 **Depth:** 1.5 m to 2 m **Lab Sample No:** S-21-1686

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



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

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 101-21	SS 3	1.5 m to 2 m	0	70	27	3	6.6
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Silty Sand trace Clay		SM	0.145	0.0750	0.0	5.58	1.49

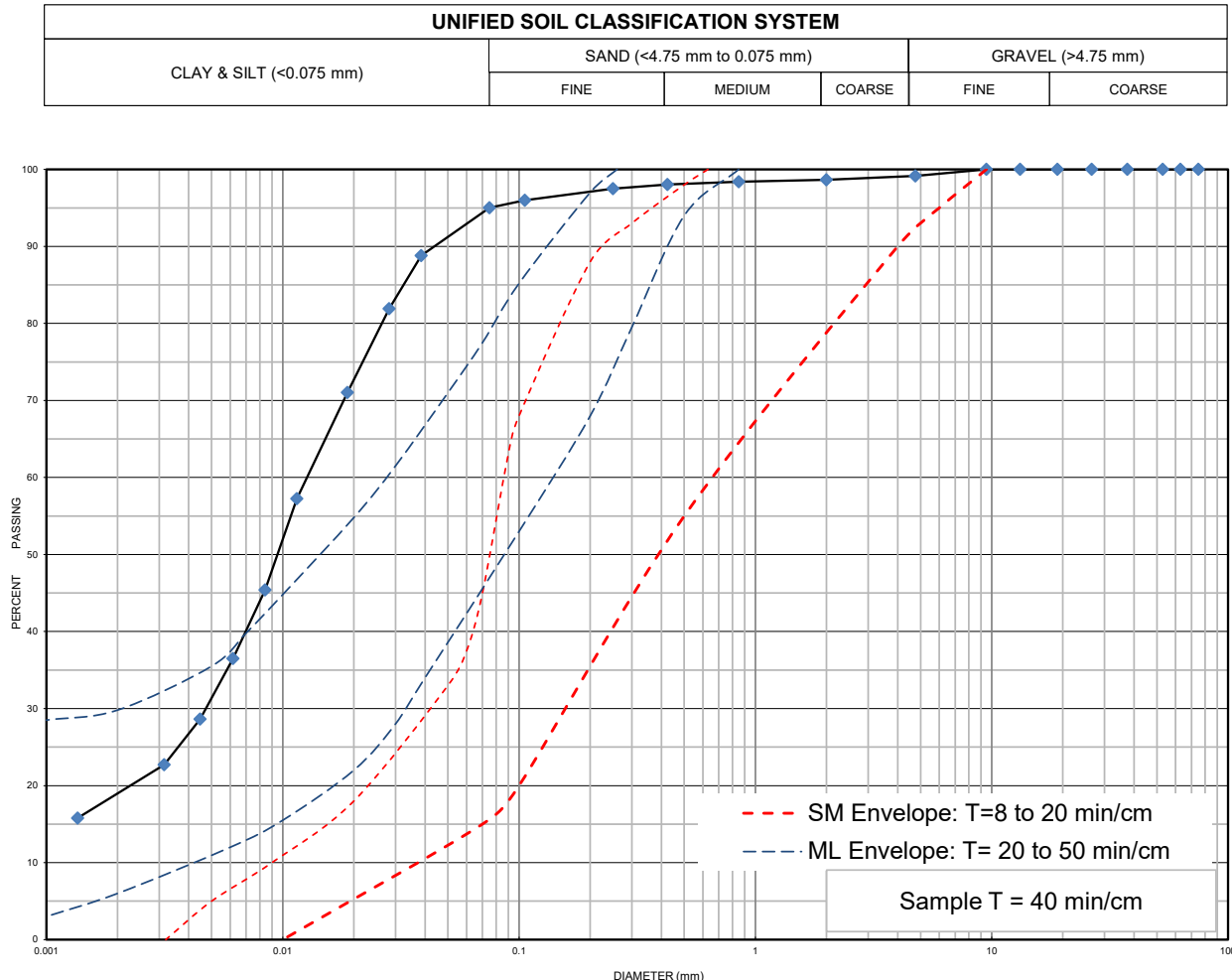
Additional information available upon request

Issued By:  **Date Issued:** January 24, 2022
 (Senior Project Manager)



Grain Size Distribution Chart

Project Number: 14079-001 **Client:** Innovative Planning Solutions
Project Name: 103 Napier St. & 95 Cook St., Barrie
Sample Date: December 8, 2021 **Sampled By:** Ben White - Cambium Inc.
Location: BH 102-21 SS 7 **Depth:** 6.1 m to 6.6 m **Lab Sample No:** S-21-1687



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

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 102-21	SS 7	6.1 m to 6.6 m	1	4	77	18	17.0
Description	Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c	
Silt some Clay trace Sand trace Gravel	ML	0.014	0.0047	-	-	-	

Additional information available upon request

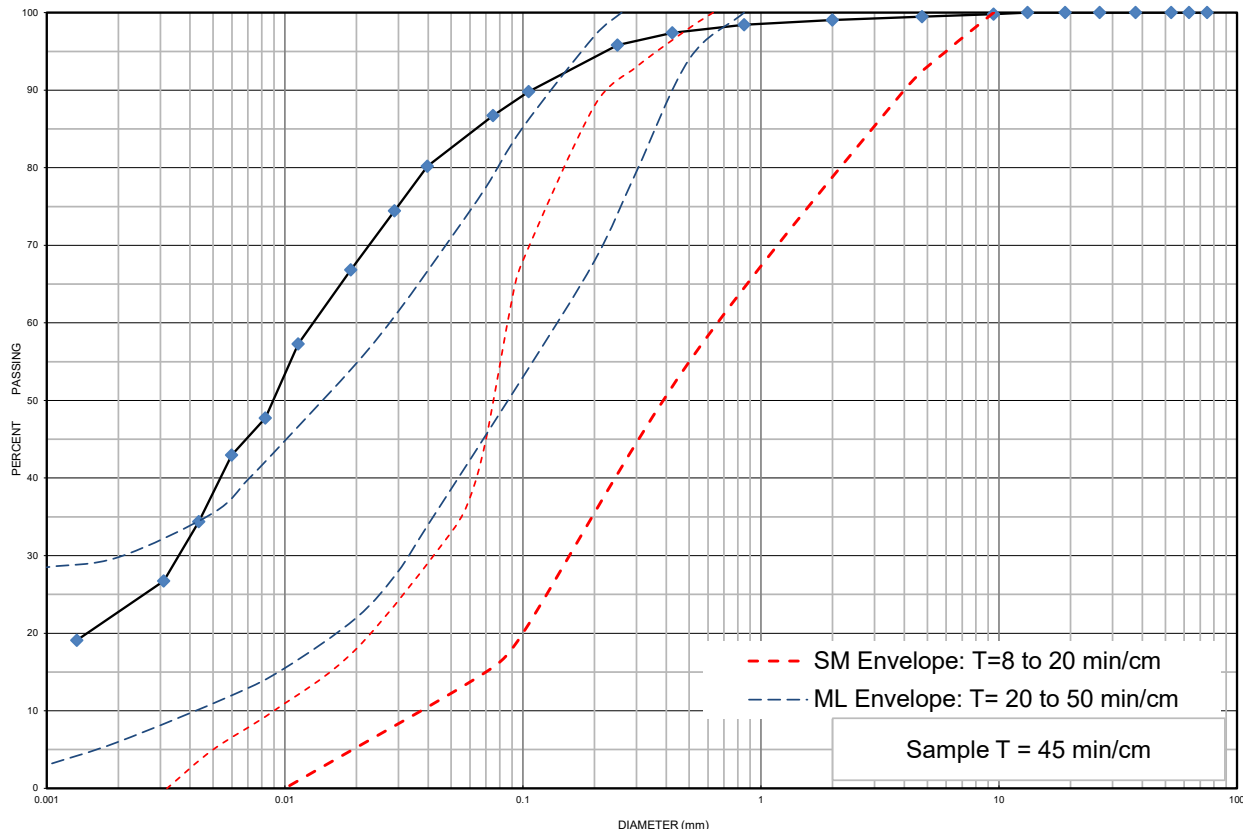
Issued By: (Senior Project Manager) **Date Issued:** January 24, 2022



Grain Size Distribution Chart

Project Number: 14079-001 **Client:** Innovative Planning Solutions
Project Name: 103 Napier St. & 95 Cook St., Barrie
Sample Date: December 8, 2021 **Sampled By:** Ben White - Cambium Inc.
Location: BH 103-21 SS 4 **Depth:** 2.3 m to 2.7 m **Lab Sample No:** S-21-1688

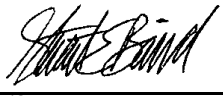
UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



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

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 103-21	SS 4	2.3 m to 2.7 m	1	13	63	23	16.8
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Clayey Silt some Sand trace Gravel		ML	0.014	0.0036	-	-	-

Additional information available upon request

Issued By: 
 (Senior Project Manager)

Date Issued: January 24, 2022

Cambium Inc. (Laboratory)
 866.217.7900 | cambium-inc.com
 194 Sophia St. | Peterborough | ON | K9H 1E5

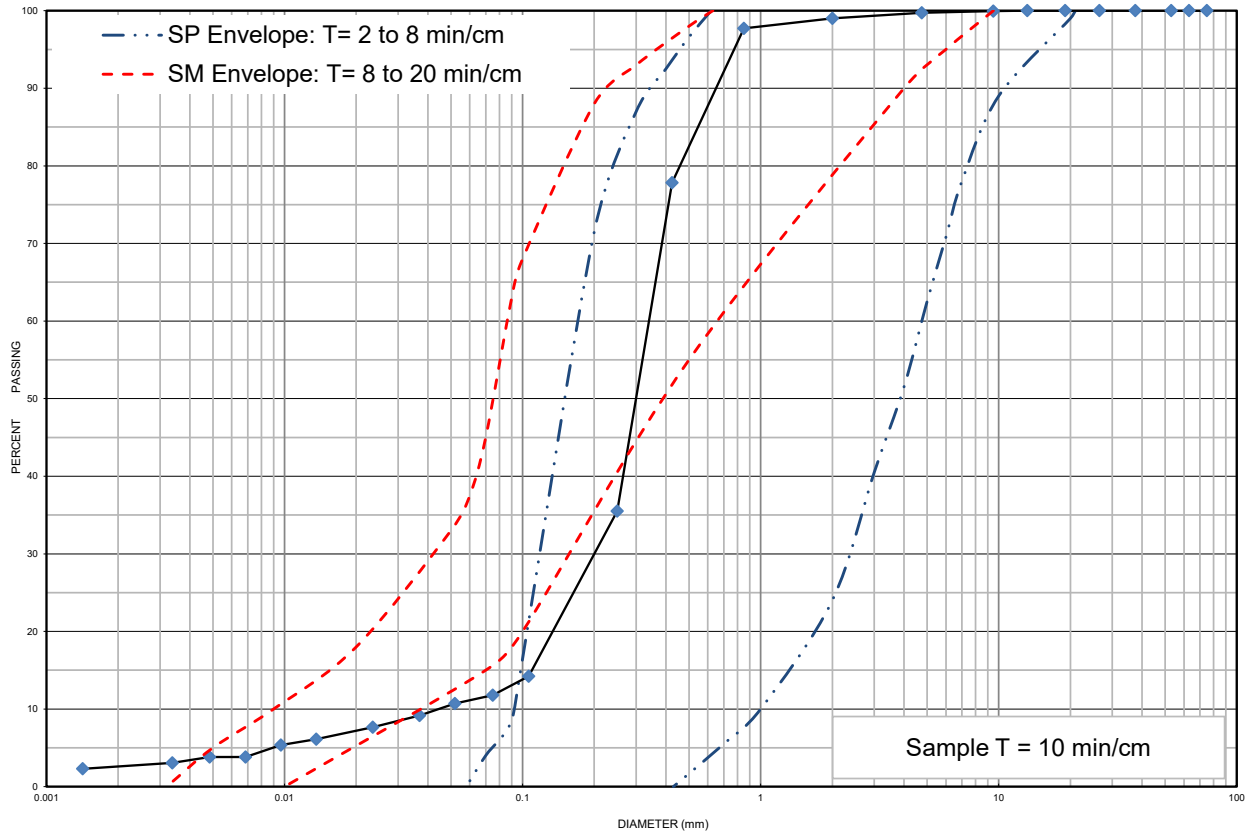
Form: L6V.2 - Grad.Hydo



Grain Size Distribution Chart

Project Number: 14079-001 **Client:** Innovative Planning Solutions
Project Name: 103 Napier St. & 95 Cook St., Barrie
Sample Date: December 8, 2021 **Sampled By:** Ben White - Cambium Inc.
Location: BH 104-21 SS 5 **Depth:** 3 m to 3.5 m **Lab Sample No:** S-21-1689

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



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

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 104-21	SS 5	3 m to 3.5 m	0	88	9	3	6.4
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Sand trace Silt trace Clay		SW	0.345	0.2000	0.0	7.67	2.58

Additional information available upon request

Issued By: 
(Senior Project Manager)

Date Issued: January 24, 2022



Appendix E

Thornthwaite Water Balance

Barrie

	THORNTHWAITE-TYPE MONTHLY WATER-BALANCE MODEL													
	modified from Dingman 2001: ex. 7-13, Box 7-3 using ET model of Hamon (1963)													
	Input Data					Computed Values				Surplus	388	mm/yr		
	Location: Barrie			Lat. =	44.2 degree			SOILmax =		150 mm				
					0.77 rad									
Declination (deg)	-21.3	-13.3	-2.0	9.8	18.9	23.3	21.3	13.7	3.0	-9.0	-18.6	-23.3		
Declination (rad)	-0.37	-0.23	-0.03	0.17	0.33	0.41	0.37	0.24	0.05	-0.16	-0.32	-0.41		
DayLength (hr)*	9.0	10.2	11.7	13.3	14.6	15.3	15.0	13.8	12.4	10.8	9.5	8.7		
*For lat. > 66.5, replace #NUM! with 24 in summer; 0 in winter.														
			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	
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	
P	83	62	58	62	82	85	77	90	94	78	89	74	933	
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		
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		
RAIN	0	0	0	58	82	85	77	90	94	78	40	0	604	
SNOW	83	62	58	4	0	0	0	0	0	0	49	74	329	
PACK	183	244	302	20	0	0	0	0	0	0	27	100		
MELT	0	0	0	286	20	0	0	0	0	0	22	0	329	
INPUT (W _m)	0	0	0	344	103	85	77	90	94	78	62	0	932	
PET	0	0	0	40	68	100	116	100	69	40	23	0	557	
W _m - PET	0	0	0	304	35	-15	-39	-10	25	38	39	0		
SOIL	150	150	150	150	150	136	105	98	123	150	150	150		
Δ SOIL	0	0	0	0	0	-14	-31	-7	25	27	0	0		
ET	0	0	0	40	68	99	108	97	69	40	23	0	545	
SURP=W-ET- Δ SOIL	0	0	0	304	35	0	0	0	0	10	39	0	388	
DEFIC=PET-ET	0	0	0	0	0	1	8	3	0	0	0	0	12	

DETAILED WATER BALANCE CALCULATIONS
103 Napier Street and 95 Cook Street, City of Barrie, ON

1 Climate Information

Precipitation	933 mm/a
Actual Evapotranspiration	545 mm/a
Water Surplus	388 mm/a

2 Infiltration Rates

Table 2 Approach - Infiltration factors

Topography: Flat to Gently Sloping Land	0.3
Soil Type: predominantly open silty sand to sandy silt	0.25
Cover: Open Land	0.1
Total	0.65

Infiltration (0.65 x 388)	252 mm/a
Run-off (388-252)	136 mm/a

Table 3 Approach - Typical Recharge Rates

Coarse Sand and Gravel	>250	mm/a
Fine to medium sand	200-250	mm/a
Silty sand to sandy silt	150-200	mm/a
Silt	125-150	mm/a
Clayey Silt	100- 125	mm/a
Clay	<100	mm/a

Site development area is underlain predominantly by sandy silt to silty sand.

Based on the above, the recharge rate is typically	150-200	mm/a
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3 Pre-Development Property Statistics

	ha	m2
Paved Area	0.27	2,683
Roof Area	0.06	603
Landscape Area	0.65	6,538
Total	0.98	9824

4 Post-Development Property Statistics

	ha	m2
Paved Area	0.27	2,744
Total Building Roof Area	0.29	2,937
Landscape Area	0.41	4,143
Total Land Area	0.98	9824

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	2,683	2,503	250	-	2,253
	Roof Area	603	563	56	-	506
Pervious Areas	Landscape Area	6,538	6,100	3,563	1,649	888
		9,824	9,166	3,870	1,649	3,647

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	2,744	2,560	256	-	2,304
	Roof Area	2,937	2,740	274	-	2,466
Pervious Areas	Landscape Area	4,143	3,865	2,258	1,045	563
		9,824	9,166	2,788	1,045	5,333

7 Comparison of Pre- and Post -Development

	Precipitation (m ³)	Evapotranspiration (m ³)	Infiltration (m ³)	Run-off (m ³)
Pre-Development	9,166	3,870	1,649	3,647
Post-Development	9,166	2,788	1,045	5,333
Change in Volume			604	1,686
Change in %			37	46

8 Requirement for Infiltration of Roof Run-off

Volume of Pre-Development Infiltration (m ³ /annum)	1,649
Volume of Post-Development Infiltration (m ³ /annum)	1,045
Deficit from Pre to Post Development Infiltration (m ³ /annum)	604
Percentage of Roof Runoff required to match the pre-development infiltration (%)	24