Hydrogeological Assessment Report- 138 Robert Street East, Penetanguishene, ON

September 19, 2022

Prepared for:
Gerrits Engineering Ltd.

Cambium Reference: 14863-001

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1.0 Introduction

Cambium Inc. (Cambium) was retained by Gerrits Engineering Ltd. (Client) to complete a hydrogeological assessment of the property located at 138 Robert Street East, Town of Penetanguishene, ON (Site). The hydrogeological study was undertaken to ascertain the soil and groundwater conditions at the Site, assess any impacts on the surrounding natural environment due to the proposed development, and provide recommendations or mitigative measures.

Currently the Site is undeveloped with open field area and mature trees. The total area of the Subject Property is approximately 31.6 hectares (78.1 acres). It is understood that the proposed development will be a mixed-use development containing residential and employment areas. There will a mixture of low and medium density residential buildings, a park, a stormwater management facility, and employment buildings. Water and wastewater services will be provided by the Town of Penetanguishene.

1.1 Scope of Work

This hydrogeological investigation 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 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 monitoring wells installed during the geotechnical investigation to characterize general groundwater flow conditions and elevations.

- **In-Situ Hydraulic Conductivity Tests:** results of soil sample testing completed during the geotechnical investigation and single well response tests for the monitoring wells were utilized to estimate the hydraulic conductivity of underlying soils and/or bedrock, and to assess the potential dewatering requirements, if any.

- **Water Balance (Preliminary):** a preliminary water balance assessment was completed for the proposed development using the Thornthwaite-Mather approach and Environment Canada climate data to determine the potential change in groundwater recharge between pre- and post-development conditions.

- **Source Water Impact Assessment:** as the Site is situated within a groundwater vulnerable area Wellhead Protection Area Q1/Q2 (WHPA-Q1/Q2) with moderate stress and partly within a Highly Vulnerable Aquifer (HVA) area, a Source Water Protection assessment was completed to detail threats to groundwater in terms of water quality and quantity.

- **Report Preparation:** this hydrogeological assessment report was prepared to present the methodology, results, findings, and recommendations of the work scope described above.

The hydrogeological assessment was conducted in conjunction with a geotechnical investigation completed by Cambium at the Site. Results from the geotechnical investigation have been incorporated into this report.

1.2 Site Description

The site is located in the Town of Penetanguishene within the County of Simcoe. The property currently is undeveloped and covers a total area of approximately 31.6 ha. Of this area, approximately 4.3 ha consists of open field area (southwestern portion of Site), and the remainder is covered with mature trees (woodlot). The Site is bordered by residential and commercial areas to the north, school properties to the west, and wooded areas to the east and south.

The Site's regional location is illustrated in Figure 1. A site plan showing property boundaries and surrounding areas is provided in Figure 2. The proposed development plan is presented in Appendix A.

2.0 Physical Setting

The physical environment of the Site is detailed in the following subsections.

2.1 Topography and Drainage

The Site is located on a peninsula within Severn Sound, in the southeastern portion of Georgian Bay. Shoreline is situated approximately 1.8 km to the northwest (Penetang Harbour) and southeast (Midland Bay) (SSEA, 2022). Based on the topographic survey of the area, the property has a topographic high of approximately 241 m above sea level (masl) in the northeast portion of the Site sloping to the lowest elevation of approximately 229 masl in the southwest. An unevaluated wetland area is noted to be present by in the northern part of the Site (MECP, 2022a).

2.2 Environmental Features

A review of information provided by the Ministry of Environment, Conservation and Parks (MECP) Source Protection Information Atlas (SPIA) (MECP, 2022a) indicates the Site is situated within the South Georgian Bay-Lake Simcoe (SGBLS) Source Protection Region, under Severn Sound Source Protection Authority jurisdiction. The northern portion of the Site is within the Town of Penetanguishene Wellhead Protection Area D (WHPA-D) for the Payette municipal wells (SGBLS, 2015a). In this area, groundwater would take between 5 and 25 years to reach the protected well. A vulnerability score of 2 is identified for the zone, which indicates the area poses a relatively negligible risk to municipal water supply.

Available mapping indicates no significant wetlands or woodlands are situated on the Site and a review of the Ministry of Natural Resources and Forestry's (MNRF) Natural Heritage System database further indicates the Site does not have any Areas of Environmental Significance or Areas of Natural and Scientific Interests (ANSI).

2.3 Physiography

The Site is located in the physiographic region known as the Simcoe Uplands. The uplands are comprised of a series of broad, rolling, till plains separated by steep-sided flat-floored valleys. Boulder pavement, sand, and silt appear at surface in the Penetang Peninsula as it was at one

time submerged by the glacial Lake Algonquin. Till in the area consists of gritty loam derived from Pre-Cambrian rock. (Chapman, L.J. and D.F. Putnam, 1984)

2.4 Overburden Geology

According to Miscellaneous Release – Data 128 from the Ontario Geological Survey (Ontario Geological Survey, 2010), the Site is underlain primarily by till (stone-poor, sandy silt to silty sand textured till). Coarse-textured glaciolacustrine deposits (sand, gravel, minor silt, and clay), are identified in the property's northern edge. (Ontario Geological Survey, 1989).

2.5 Bedrock Geology

According to Miscellaneous Release – Data 219 from the Ontario Geological Survey (Armstrong, D.K. and Dodge, J.E.P., 2007), the Site is underlain by limestone bedrock of the Gull River Formation (Middle Ordovician Simcoe Group rocks). This formation is subdivided into three members. The lower member is characterized by grey to greenish grey fine-crystalline dolomitic limestones and calcareous dolostones up to 15 m thick. Light grey to white microcrystalline limestone up to 9m thick comprises the middle member, and the upper member is identified as grey, micro- to fine-crystalline limestone up to 3 m thick. (Ontario Geological Survey, 1989).

3.0 MECP Well Records Assessment

Cambium accessed the MECP Water Well Information System (WWIS) to review water well records within 500 m of the Site (MECP, 2022b). A total of 20 records were identified, all of which describe wells installed into overburden materials. The dominant type of well use is domestic water supply, however industrial and observation/monitoring wells are also reported. The locations of wells records identified within 500 m of the Site are illustrated in Figure 3. A summary of water well information, including total depth, static water level, and recommended pumping rate, is presented in Table 1. Further details are provided in Appendix B.

Table 1 MECP Water Well Information Summary

		Depth (mbgs)	Depth Water Found (mbgs)	Static Water Level (mbgs)	Recommended Pumping Rate (L/min)
Overburden Wells Count = 20	Minimum	4.57	2.29	27	18
	Maximum	86	83	53	227
	Average (median)	53.8	50.14	42.5	41

Further summary of well record information is as follows:

- Generally, the overburden lithology is described as a variable configuration of sand and gravel with layers of clay reported at some locations. These sediments are consistent with the coarse-textured glaciolacustrine deposits identified to the north of the Site.
- The aquifer in the glaciolacustrine deposits is productive; the median average recommended pumping rate for the overburden wells is 41 L/min.
- Based on the lithology, depth water found, and static water level, it is interpreted that overburden wells are completed within an unconfined to semi-confined aquifer.
- Bedrock was not reported on any well record reviewed.

4.0 Borehole Drilling and Monitoring Well Installation

A total of six boreholes were drilled at the Site as part of a geotechnical investigation completed by Cambium. Three boreholes were completed as monitoring wells and four soil samples were submitted for laboratory analyses. The following subsections describe the results obtained for this work.

4.1 Borehole Investigation

Cambium completed a geotechnical investigation at the Site on April 25, 2022, to assess the subsurface conditions at the Site. A total of six boreholes, designated as BH101-22 through BH106-22, were advanced to pre-determined depths of 6.7 m below ground surface (mbgs). Three boreholes (BH101-22, BH103-22, and BH104-22) were outfitted as monitoring wells to measure shallow groundwater levels monitoring and characterize the local groundwater regime across the Site. Borehole/monitoring well locations are identified in Figure 4. Borehole logs are included in Appendix C.

A summary of general lithological details is presented below.

Topsoil

A surficial layer of loose brown topsoil containing organics was encountered in all boreholes with thicknesses ranging from approximately 0.13 m to 0.20 m.

Overburden

The dominant lithology encountered during the borehole investigation was sand to silty sand, with trace gravel. In the upper sections of each borehole, above depths ranging between 1.52 mbgs and 3.05 mbgs, the material was described as loose overburden soils. Below these depths, the material was described as compact to very dense till.

All sand/silty sand sediments were identified as moist. Saturated sediments indicative of groundwater was not encountered during the borehole drilling at the Site. Groundwater was observed in BH101-22 following installation of a monitoring well and further details are discussed in Section 4.2.

Bedrock

Bedrock was not encountered during the borehole investigation at the Site. Drilling was terminated at pre-determined depths of 6.7 mbgs.

4.2 Monitoring Well Investigation

Three boreholes were completed as monitoring wells according to the details summarized in Table 2. Water levels in the wells were measured at three monitoring events during spring and summer seasons (Table 3). The dry conditions of MW103-22 and MW104-22 prevent groundwater levels and groundwater flow direction from being established at the Site. In-situ infiltration tests were also not conducted due to insufficient water in the monitoring wells.

Table 2 Monitoring Well Construction Details

Well ID	Ground Surface Elevation (masl)	Top of Well Casing Elevation (masl)	Well Depth (mbgs)	Screen Details	
				Top of Screen (mbgs)	Bottom of Screen (mbgs)
BH/MW101-22	236.62	237.55	6.03	2.98	5.98
BH/MW103-22	238.74	239.75	6.14	3.09	6.09
BH/MW104-22	230.75	231.78	6.14	3.09	6.09

Table 3 Water Level Monitoring Data

Well ID	Water Level (mbgs)		
	May 20, 2022	June 15, 2022	July 6, 2022
BH/MW101-22	5.86	3.39	5.86
BH/MW103-22	dry	dry	dry
BH/MW104-22	dry	dry	dry

The highest groundwater level and elevations were observed at 3.39 mbgs and 233.33 masl, respectively. It should be noted that the groundwater levels will vary seasonally and in response to the extreme weather events.

4.3 Physical Laboratory Testing

Physical laboratory testing, including grain size distribution analysis, was completed on four selected soil samples to confirm textural classification identified during field logging and to obtain percolation rate estimates. Analysis results are based on the Unified Soil Classification System (USCS) scale. A summary of results is provided in Table 4. Complete laboratory analysis reports are provided in Appendix D.

Based on grain size analysis data, the samples range from silty sand to sand, with some silt and trace gravel and trace clay. These results are consistent with lithological descriptions recorded in the field. Soil percolation rates ranged from 15 min/cm to 8 min/cm, with a geometric mean of 12 min/cm. This indicates the presence of moderate to high transmissive soils at the Site.

Table 4 Grain Size Analysis Summary

Sample ID	Depth (mbgs)	Description	% Gravel	% Sand	% Silt	% Clay	Percolation Times (min/cm)
BH101-22 SS5	3.0 – 3.7	Silty Sand, trace Gravel, trace Clay	6	63	23	8	15
BH103-22 SS2	0.8 – 1.4	Silty Sand, trace Gravel, trace Clay	5	72	20	3	12
BH103-22 SS6	4.9 – 5.2	Sand, some Silt, trace Gravel	9	77	14		8
BH106-22 SS4	2.3 – 2.9	Silty Sand, trace Gravel, trace Clay	3	67	24	6	15

4.4 Groundwater Flow Direction

Groundwater flow conditions could not be determined at the Site, as only one of the installed monitoring wells intersected the shallow water table. However, since the shallow groundwater flow mimics the topography, the shallow groundwater flow direction was inferred towards southwest.

4.5 In-Situ Infiltration Tests

Single well response tests could not be conducted due to either in-sufficient water column or wells being dry.

5.0 Construction Dewatering Requirements

Deep drilling or deep construction activities (piles, caissons, excavations, underground parking etc.) can create a transport pathway for contaminant migration into water supply aquifers. The requirements for construction dewatering generally depend on a Site's soil and groundwater conditions including soil type, soil permeability or hydraulic conductivity, local groundwater levels, and the design of the proposed works, such as the foundation and/or basement elevation, as well as the size of proposed structure/excavation.

It is proposed that the Site will be developed into a mixed-use property containing both residential and employment buildings. Specific construction details for the development are not currently available, however it is assumed that at least some of the residential developments will have basements. This will result in required excavation depths of approximately 3 m below existing grade. As the high water level measured in MW101-22 was 3.39 mbgs, it is possible that excavation for basements will not encounter the water table, and construction dewatering may not be required.

6.0 Water Balance Assessment

A water balance assessment was completed to determine the potential change in groundwater recharge that could occur due to the proposed development. Generally, any property can be categorized into three broad types of areas: paved, roof, and landscape/vegetated. Currently, the Site is undeveloped with all land landscape/vegetated. In the post-development scenario, the amount of paved and roof areas at the Site will usually increase and the amount of landscape/vegetated area will decrease. This has the potential to impact the amount of water that infiltrates into the ground and is available to replenish natural ground- and surface-water systems, which must be considered as part of the development process.

To compare the difference in infiltration that may result from the proposed development, a water balance calculation was completed to determine the amount of surplus water that is currently generated at the Site. Site characteristics such as surficial soil type, topography, and the amount of pervious and impervious areas were then used to estimate the volume of water infiltrating at the Site. Calculations were completed for both pre-and post-development scenarios, so that a comparison could be made to identify potential changes in infiltration as well as mitigation measures which could be employed to reduce development impacts.

Figure 4 presents the post-development plans of the proposed development. As a detailed breakdown of landscape and building details are yet to be determined, the paved, roof, and landscape areas for the developed lots were calculated based on an assumption that each surface type comprises 10%, 50%, and 40% of the total developed lot area, respectively. Table 5 provides a summary of statistics for the total areas for each type of surface at the Site for both pre- and post-development scenarios. Further discussion of each component completed for the water balance assessment is provided in the following subsections.

Table 5 Summary of Pre- and Post-Development Areas

Type of Land Coverage	Pre-Development Areas (m^2)	Post-Development Areas (m^2)
Paved Area	0	93,843
Roof Area	0	109,865
Landscape/Vegetated Area	316,220	112,512
Total (m^2)	**316,220**	**316,220**

6.1 Water Budget and Total Water Surplus

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 the ground or be used for transpiration 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 soil water storage (mm/year)

Total water surplus is defined as the difference between precipitation and evapotranspiration. It is the amount of water per unit area that can either infiltrate into on-site soils or be directed off-site as runoff. An assumption for the calculation of water surplus is that changes in soil water storage are negligible over the course of a year. It is also assumed that the catchment area for

the water balance described above is completely contained within Site boundaries (i.e. the model does not account for catchment areas that extend off-site).

An annual water budget for the Site was calculated using the thirty-year climate normal data (1981-2010) provided by Environment Canada for the Midland Water Pollution Control Plant weather station (Climate ID 6115127), located approximately 4 km southeast (Environment Canada, 2022). A detailed table outlining the calculations is provided in Appendix E. In summary, the average annual precipitation and evapotranspiration at the Site is estimated to be 1041 mm/year and 540 mm/year, respectively. Therefore, the water surplus at the Site is estimated to be 501 mm/yr.

6.2 Annual Infiltration and Runoff

To determine the amount of water infiltrated into on-site soils annually, the total volume of water available is multiplied by an infiltration factor (IF). The total volume of water available is obtained by multiplying the water surplus value determined from the water balance described above by the total permeable landscape area at the Site. The infiltration factor, which ranges from 0 to 1, is estimated based on topography, soils and cover as per the Stormwater Management Planning and Design Manual (Ministry of the Environment, 2003). As outlined in Table 6, the infiltration factor at the Site was assigned a value of 0.7.

Table 6 Determination of Infiltration Factor

Factor	Value
Topography	Flat land, avg. slope < 0.6 m/km = 0.3
Soil	Loam = 0.3
Cover	Cultivated Land = 0.1
Infiltration Factor (IF)	0.7

The annual volume of water that infiltrates at the site is calculated as follows:

$$I\ (m^3/yr) = Water\ Surplus\ (m/yr) * Total\ landscape\ area(m^2/yr) * Infiltration\ Factor$$

The annual infiltration at the Site is expected to vary based on a number of factors (i.e. actual precipitation, variation in soil composition, soil compaction, etc.).

The annual runoff that occurs at the Site varies between permeable and impermeable surfaces. On permeable landscape surfaces, the runoff is calculated as the difference between total precipitation and annual infiltration. On impermeable surfaces where there is no infiltration, the runoff is calculated as 90% of precipitation, with the remaining 10% of precipitation lost directly to evaporation.

Annual infiltration and runoff volumes were calculated for the Site for both pre- and post-development scenarios. Details of the calculations are provided in Appendix E. A discussion of the water balance used to calculate the infiltration and runoff volumes for each scenario is provided in Section 6.3 and Section 6.4.

6.3 Pre-Development Water Balance

The water balance for existing conditions at the Site is summarized in Table 7. The pre-development infiltration rate and runoff rate was calculated to be 110,898 m³/yr and 47,528 m³/yr, respectively.

Table 7 Pre-Development Water Balance

Land Use		Area (m²)	Precipitation (m³)	Evapotranspiration (m³)	Infiltration (m³)	Run-off (m³)
Impervious Areas	Paved Area	-	-	-	-	-
	Roof Area	-	-	-	-	-
Pervious Areas	Landscape Area	316,220	329,185	170,759	110,898	47,528
Total		**316,220**	**329,185**	**170,759**	**110,898**	**47,528**

6.4 Post-Development Water Balance

The post-development water balance at the Site is summarized in Table 8. The post-development infiltration and runoff rates were calculated to be 39,458 m³/yr and 207,765 m³/yr, respectively.

Table 8 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	93,843	97,691	9,769	-	87,922
	Roof Area	109,865	114,369	11,437	-	102,933
Pervious Areas	Landscape Area	112,512	117,125	60,756	39,458	16,911
Total		**316,220**	**329,185**	**81,962**	**39,458**	**207,765**
Assuming no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.						

6.5 Water Balance Comparison

A comparison of water balances for the pre-development and post-development scenarios is summarized in Table 9. There is a net infiltration deficit of approximately 71,440 m^3/year, compared to the pre-development infiltration. The run-off rate upon development of the Site is projected to increase by 160,237 m^3/year.

Table 9 Water Balance Comparison

	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Pre-Development	329,185	170,759	110,898	47,528
Post-Development	329,185	81,962	39,458	207,765
Change in Volume	-	-88,796	-71,440	160,237
Change in %	-	-52%	-64%	+337%

6.6 Required Infiltration from Roof Runoff

To compensate for the post-development infiltration deficit, a portion of roof run-off water can be captured and directed towards infiltration. As the infiltration deficit volume is 71,440 m^3/yr and the total roof run-off volume is projected to be 102,933 m^3/yr, the percentage of roof run-off that is required to be redirected to maintain pre-development infiltration volumes is 69%. These details are summarized in Table 10.

Table 10 Requirement of Infiltration from Roof Runoff

Volume of Pre-Development Infiltration (m^3/yr)	110,898
Volume of Post-Development Infiltration (m^3/yr)	39,458
Deficit from Pre to Post Development Infiltration (m^3/yr)	71,440
Percentage of Roof Runoff required to match the pre-development infiltration (%)	69

6.7 Water Balance Assessment Summary

Based on the calculations detailed in the preceding subsections, a summary of the water balance assessment is as follows:

- Impervious post-development area (roof and pavement) is projected to increase by approximately 203,708 m^2 when compared to pre-development conditions.
- Without implementing any mitigation measures, it is estimated that the reduction of pervious surfaces at the Site will create a net deficit in infiltration of approximately 71,440 m^3 /yr.
- To regain the lost volume of water infiltrated, a diversion of approximately 69% of roof run-off would be required to maintain pre-development water balance conditions (assuming 100% of diverted water is infiltrated).
- Implementation of Low Impact Development measures would enhance the Site's ability to infiltrate diverted roof run-off water into pervious areas.

6.8 Discussions on LID Measures

Low Impact Development (LID) practices are widely implemented as a means to capture run-off and mimic the natural hydrologic cycle. It is important to maintain the natural hydrologic cycle as much as possible as decreases in infiltration reduce groundwater recharge and soil moisture replenishment and can also lead to reductions in stream baseflows which are needed to sustain aquatic life.

In general, there are two primary types of LIDs. The first promotes the infiltration of stormwater run-off close to the source. Infiltration type LIDs are preferred when hydrogeological and physical conditions are optimal and allow for their emplacement. The second type of LID captures and slowly releases stormwater to the surface water system through a process of storage and filtration by infiltration LIDs.

Infiltration targets at the Site may be achieved through LIDs and incorporation of a variety of stormwater management techniques including reduced lot grading, roof downspout

disconnection, roof leaders discharging to ponding areas or soak away pits, infiltration trenches, and grassed swales.

The development proposed at the Site includes 1.62 ha stormwater management facilities. It was assumed for water balance calculations that this area will function as a permeable landscape surface where infiltration will occur. There is also possibility for the area to be utilized for additional filtration and infiltration of run-off water from non-permeable surfaces at the Site.

Roof downspout disconnection is another LID option available for the Site. Considering a conservative run-off capture rate estimate of 25%, the total volume of roof run-off water available for infiltration is approximately 25,733 m^3/yr, leaving approximately 45,707 m^3/yr still to be compensated at the Site. Roof downspouts should only be disconnected where the minimum depth to the seasonally high water table is at least 1 m below the surface. As relatively deep water table conditions are present at the Site, this LID measurement will be feasible. Additional LID measures, such as infiltration trenches, infiltration galleries, soak-away pits etc., can be utilized to enhance infiltration in addition to roof downspout disconnects.

It should also be noted that Cambium is not providing the design of any LID measures and a civil design engineer should be involved in designing any suitable infiltration measures across the Site.

7.0 Source Water Protection and Risk Management

Based on MECP's SPIA database (MECP, 2022a), the Site is situated partly within Town of Penetanguishene's Payette Wellhead Protection Area D (WHPA-D) which has a vulnerability score of 2 (SGBLS, 2015a) and partly within a HVA which has a vulnerability score of 6 (Appendix A).

Wellhead protection areas are the areas of land surrounding a municipal well which are categorized based on the time it takes for groundwater to travel to the well. Within WHPA-D, contaminated groundwater would take between 5 years and 25 years to reach the protected well (SGBLS, 2105b). A vulnerability score of 2 (the lowest score available) indicates the area poses a relatively insignificant risk to source water contamination.

HVAs are aquifers that are more sensitive to contamination. In general, a HVA will consist of granular materials (e.g., sand and/or gravel) or fractured rock that has a high permeability and is near the surface of the ground. A noticeably clear benefit of protecting highly vulnerable areas is preventing drinking water contamination.

The northern part of the Site exists in an area of groundwater vulnerability with a score of 6 and threat activities are moderate, but not significant. Impervious surfaces such as parking lots, pedestrian walkways and other related surfaces that may receive salt application were not considered as significant. However, the Site is characterized by high permeability sandy deposits and the land use practices at the proposed development Site might have some minor impacts to the potable groundwater supplies.

Regardless of the apparent low risk from the proposed development, Cambium recommends using best management practices to avoid overland flow of any contaminants to the natural environment in surrounding areas.

The Site will be under municipal sewage and water services and as such the proposed development is not expected to cause any groundwater contamination by nitrates.

As a detailed development plan for the employment component of the Site is not currently available, potential contamination risks from this land use at the Site should be re-assessed once further information is available.

8.0 Assessment of Potential Impacts

It is proposed that the Site will be developed into a mixed-use property which contains both residential and employment areas. Specific construction details for the development are not currently available, however it is assumed that at least some of the residential developments will have basements. The potential impacts from the proposed development are discussed in the following subsections.

8.1 Natural Features

Although a sizable portion of the Site is heavily treed, no significant wetlands or woodlands are identified by SPIA to be present on the property. MNFR also indicates that the Site does not have any Areas of Environmental Significance or Areas of Natural and Scientific Interests (ANSI).

8.2 Water Supply Wells near the Site

Based on the Site-specific conditions and the nature of the proposed development, it is highly unlikely that large scale dewatering activity will take place and additionally, water well records from the surrounding area indicate that depth to water in the overburden aquifer (which provides local water supply) has a median average depth of 42.5 mbgs. It is therefore not expected that the water present in the shallow subsurface at the Site is connected to the water supply aquifer. Thus, no groundwater quality or quantity impacts on local water wells (private or public), are anticipated due to the proposed development.

8.3 Considerations on Drinking Water Vulnerability

As discussed in Section 7.0, the proposed development poses an insignificant risk to drinking water in the area. It is still recommended that best management practices be implemented at the Site as an initiative-taking measure to protect local groundwater supplies.

9.0 Conclusions and Recommendations

Cambium Inc. (Cambium) was retained by Gerrits Engineering Ltd. (the Client) to complete a hydrogeological assessment of the property located at 138 Robert Street East, Penetanguishene, ON.

The Site is situated within the South Georgian Bay-Lake Simcoe (SGBLS) Source Protection Region, under Severn Sound Source Protection Authority jurisdiction and is located within the Simcoe Uplands physiographic region.

Water level monitoring at the Site indicated the highest groundwater level and elevations at 3.39 mbgs and 233.33 masl, respectively as measured in MW101-22 on June 15, 2022. The other two monitoring wells installed at the Site are persistently dry.

Percolation rates (T-times) for selected soil samples collected during a geotechnical investigation at the Site ranged from 15 min/cm to 8 min/cm, with a geometric mean of 12 min/cm.

As excavation for residential basement construction may reach a maximum depth of 3 mbgs, and correlatively deep water table conditions, construction dewatering will not be required for the possible one level basements.

The water balance assessment for the Site indicates that the development will induce an infiltration deficit of approximately 71,440 m^3. This deficit should be mitigated by a combination of LID measures, including roof downspout disconnection and other infiltration measures such as infiltration trenches, infiltration galleries and other suitable methods at the Site.

The northern portion of the Site is within the Town of Penetanguishene Wellhead Protection Area (WHPA) for the Payette municipal wells. The area is within the zone designated as WHPA-D, where contaminated groundwater would take between 5 and 25 years to reach the municipal well. A vulnerability score of 2 is identified for the zone, which indicates that the area poses a relatively negligible risk to source water contamination.

A portion of the Site also exists in a highly vulnerable aquifer area with a vulnerability score of 6. Threat to the water supply aquifer from activities in such areas are moderate, but not

significant. The residential portions of the proposed development pose low groundwater quality or quantity risk to local water wells.

As a detailed development plan for the employment component of the Site is not currently available, potential contamination risks from this land use at the Site should be re-assessed once further information is available.

Regardless of the apparent low risk from the proposed development, Cambium recommends using best management practices at the Site to avoid overland flow of any contaminants to the natural environment in surrounding areas.

10.0 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,

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12.0 Standard Limitations

Limited Warranty

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

Reliance on Materials and Information

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

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

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

Site Assessments

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

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

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Limitation of Liability

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

Personal Liability

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

Appended Figures

HYDROGEOLOGICAL ASSESSMENT

GERRITS ENGINEERING LTD.
138 Robert Street East
Penetanguishene, Ontario

LEGEND

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

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

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

SITE LOCATION PLAN

Project No.: 14863-001		Date: September 2022 Rev.:	
Scale: 1:100,000		Projection: NAD 1983 UTM Zone 17N	
Created by: TLC	Checked by: RG	Figure:	1

O:\GIS\MXDs\14800-14899\14863-001 138 Robert Street LP - GEO - 138 Robert St., Penetanguishene\2022-05-18 FIG 1 - Site Location Plan.mxd

GEOTECHNICAL INVESTIGATION

GERRITS ENGINEERING LTD.
138 Robert Street East
Penetanguishene, Ontario

LEGEND

- Borehole
- Monitoring Well
- Site (approximate)

Notes:
- Site is approximate and was obtained from the County of Simcoe online GIS.
- Base mapping features are © Queen's Printer of Ontario, 2019 (this does not constitute an endorsement by the Ministry of Natural Resources or the Ontario Government).
- Distances on this plan are in metres and can be converted to feet by dividing by 0.3048.
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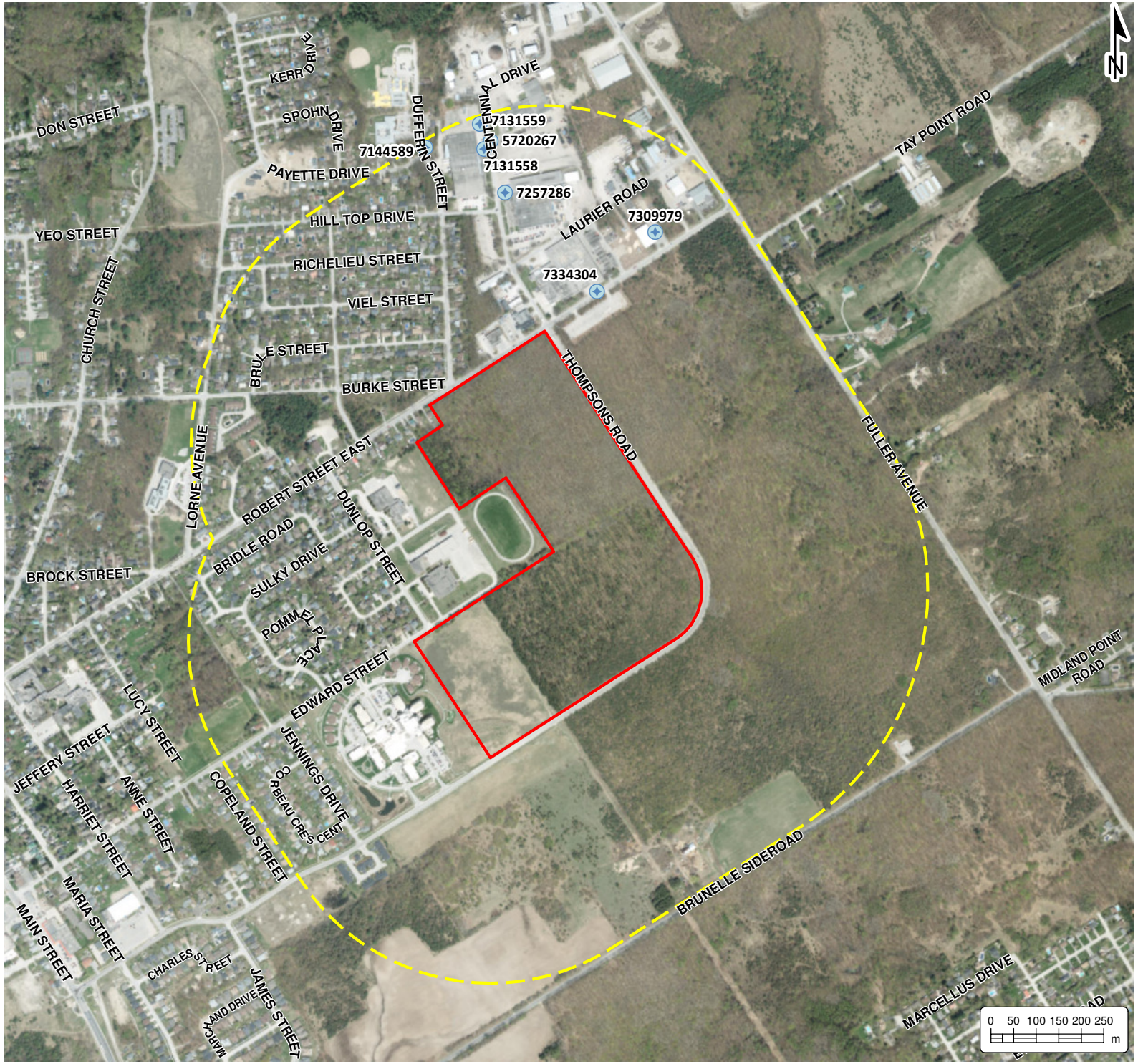
www.cambium-inc.com

BOREHOLE LOCATION PLAN

Project No.: 14863-001		Date: September 2022 Rev.:	
Scale: 1:10,000		Projection: NAD 1983 UTM Zone 17N	
Created by: TLC	Checked by: RG	Figure:	**2**

O:\GIS\MXDs\14800-14899\14863-001 138 Robert Street LP - GEO - 138 Robert St., Penetanguishene\2022-05-18 FIG 2 - Borehole Location Plan.mxd



HYDROGEOLOGICAL ASSESSMENT

GERRITS ENGINEERING LTD.
138 Robert Street East
Penetanguishene, Ontario

LEGEND

- Water Well Records
- 500m Study
- Site (approximate)

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

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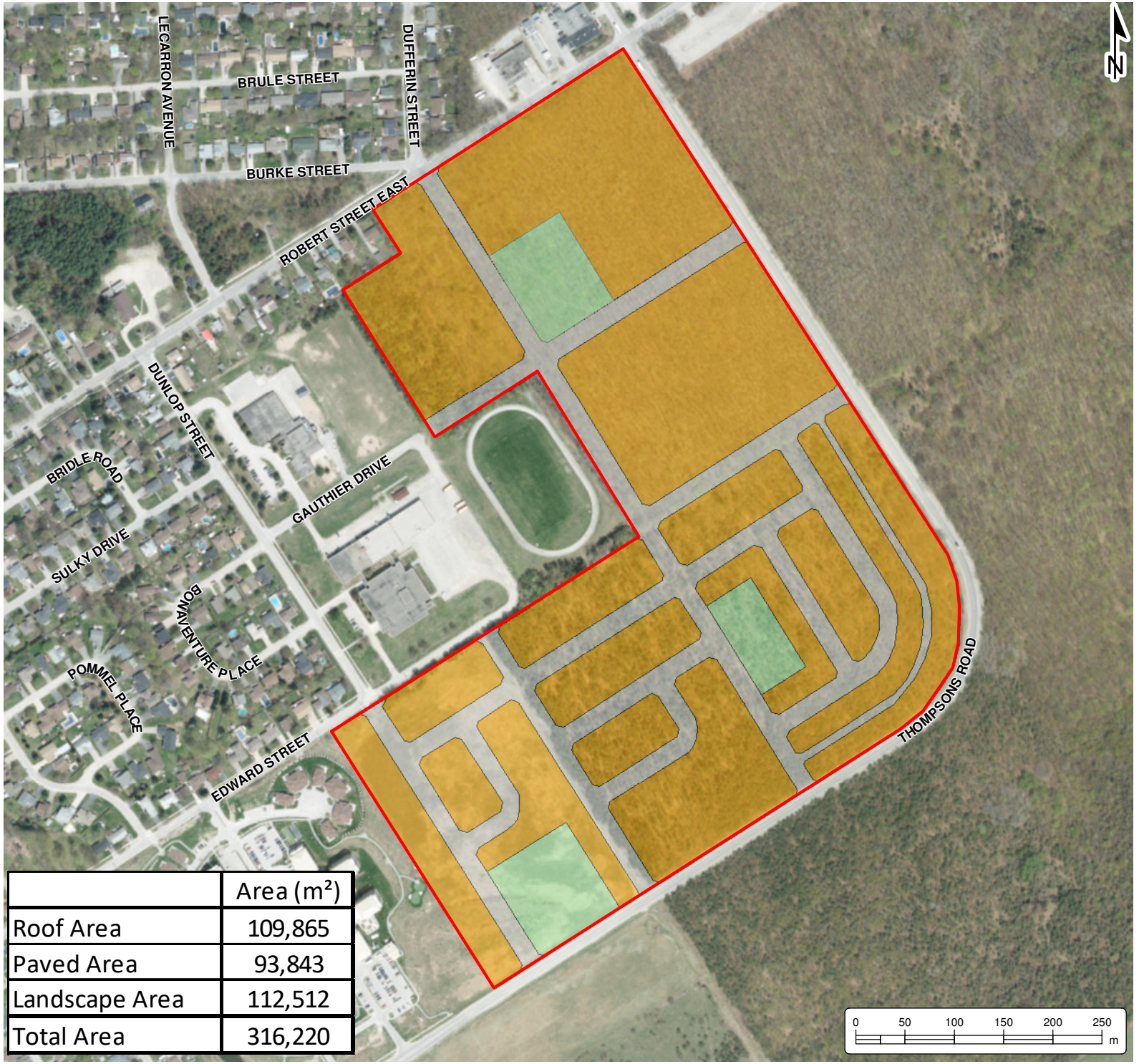
MECP WELL RECORDS WITHIN 500m OF SITE

Project No.: 14863-001		Date: September 2022 Rev.:	
Scale: 1:12,000		Projection: NAD 1983 UTM Zone 17N	
Created by: PAS	Checked by: SK	Figure:	3

O:\GIS\MXDs\14800-14899\14863-001 138 Robert Street LP - GEO - 138 Robert St., Penetanguishene\2022-05-27 FIG 3 - MECP Well Records within 500m.mxd



	Area (m²)
Roof Area	109,865
Paved Area	93,843
Landscape Area	112,512
Total Area	316,220

HYDROGEOLOGICAL ASSESSMENT

GERRITS ENGINEERING LTD.
138 Robert Street East
Penetanguishene, Ontario

LEGEND

- Developed Area
- Paved Area
- Landscaped Area
- Site (approximate)

Notes:
- Site is approximate and was obtained from the County of Simcoe online GIS.
- Base mapping features are © Queen's Printer of Ontario, 2019 (this does not constitute an endorsement by the Ministry of Natural Resources or the Ontario Government).
- Distances on this plan are in metres and can be converted to feet by dividing by 0.3048.
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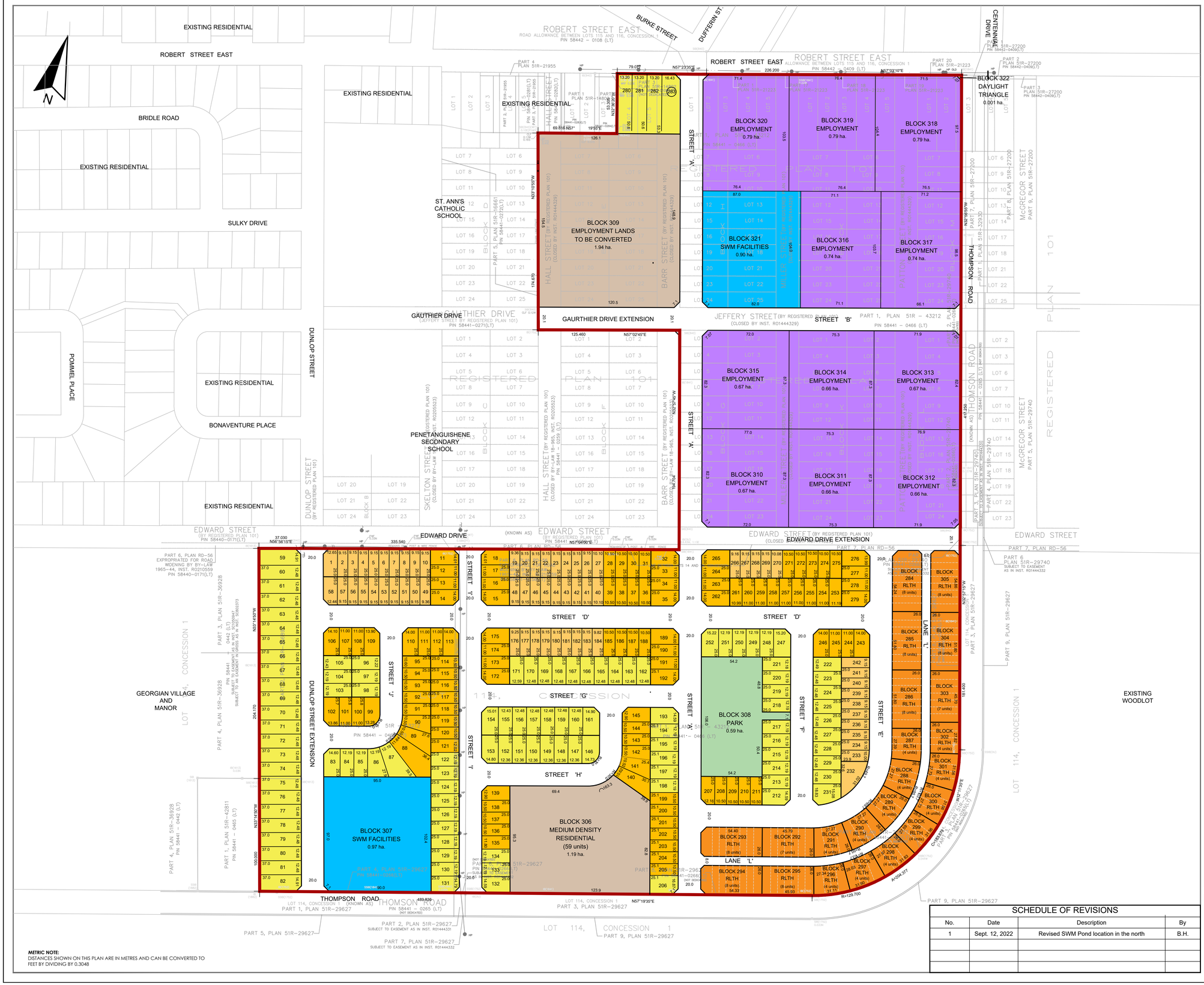
POST-DEVELOPMENT PLAN

Project No.: 14863-001		Date: September 2022 Rev.:	
Scale: 1:5,500		Projection: NAD 1983 UTM Zone 17N	
Created by: ACS	Checked by: SK	Figure:	4

O:\GIS\MXDs\1:4800-14899\14863-001 138 Robert Street LP - GEO - 138 Robert St., Penetanguishene\2022-07-18 FIG 4 - Post-Development Plan.mxd

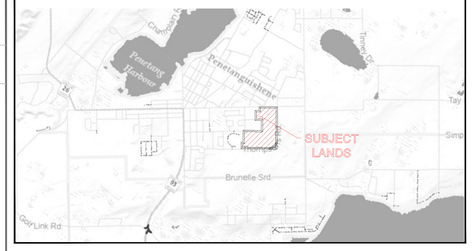
Appendix A

Site Plan and Background Information



KEY MAP

Scale: 1:50,000



DRAFT PLAN OF SUBDIVISION

PART OF LOTS 1, 2, 3 AND
ALL OF LOTS 4 TO 25 INCLUSIVE BLOCK E AND
ALL OF LOTS 1 TO 24 INCLUSIVE BLOCK G AND
ALL OF LOTS 1 TO 25 INCLUSIVE BLOCK H AND
ALL OF LOTS 1 TO 25 INCLUSIVE BLOCK I AND
ALL OF LOTS 1 TO 24 INCLUSIVE BLOCK K AND
PART OF LOTS 1, 4, 5, 8, 9, 12, 13, 16, 17, 20, 21 AND 24 BLOCK L AND
ALL OF LOTS 1 AND 2, PART OF LOTS 3, 7, 8, 11, 12, 15, 16, 19, 20 23 AND 24 BLOCK M
AND PART OF JEFFERY STREET, EDWARD STREET, HALL STREET AND BARR STREET
(CLOSED BY RO1444329)
AND ALL OF MILLER STREET AND PATTON STREET(CLOSED BY RO1444329)
REGISTERED PLAN 101
AND
PART OF LOT 114, CONCESSION 1
(GEOGRAPHIC TOWNSHIP OF TAY)
TOWN OF PENETANGUISHENE
COUNTY OF SIMCOE

30 0 30 60 90 120 150

SCALE = 1:1500

LEGEND

SUBJECT LANDS - 31.62 ha

LAND USE SCHEDULE

Land Use	Lot / Block No.	Units	Area (ha.)	Area (ac.)	%
RESIDENTIAL SINGLE LOT *(9.15m / 30')*	Lots 1-10, 19-27, 40-58, 176-184, 232-242, 266-270	63	1.495	3.69	4.7
RESIDENTIAL SINGLE LOT *(10.50m / 34')*	Lots 11-18, 28-39, 88-95, 99-102, 106-121, 135-145, 172-175, 185-192,199-205, 207-211, 243-246, 253-265, 271-279	109	3.185	7.87	10.1
RESIDENTIAL SINGLE LOT *(12.19m / 40')*	Lots 59-87, 96-98, 103-105, 122-134, 146-171, 193-198, 206, 212-231, 247-252, 280-283	111	4.083	10.09	12.9
RESIDENTIAL REAR LANE TOWNHOUSES *(6.1m / 20')*	Blocks 284-305	126	2.244	5.54	7.1
RESIDENTIAL MEDIUM DENSITY *(50 upha.)*	Blocks 306, 309	155	3.127	7.73	9.9
STORMWATER MANAGEMENT FACILITIES	Block 307, 321		1.870	4.62	5.9
PARK	Block 308		0.593	1.46	1.9
EMPLOYMENT LANDS	Blocks 310 - 320		7.839	19.37	24.8
DAYLIGHT TRIANGLES	Block 321		0.001	0.01	0.0
STREETS	Street A - K (20.0m ROW) Lane 'L' (8.0m ROW)		7.185	17.76	22.7
TOTAL		564	31.622	78.14	100.0

OWNER'S CERTIFICATE

I, THE UNDERSIGNED, BEING THE REGISTERED OWNER OF THE SUBJECT LANDS, HEREBY AUTHORIZE INNOVATIVE PLANNING SOLUTIONS TO PREPARE THIS DRAFT PLAN OF SUBDIVISION AND TO SUBMIT SAME TO THE TOWN OF PENETANGUISHENE FOR APPROVAL.

DATE

SIGNING OFFICER
NAME OF FIRM

SURVEYOR'S CERTIFICATE

I CERTIFY THAT THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED AND THEIR RELATIONSHIP TO ADJACENT LANDS ARE ACCURATELY AND CORRECTLY SHOWN.

DATE

TOM KRCMAR, OLS
KRCMAR SURVEYORS LTD.

ADDITIONAL INFORMATION REQUIRED UNDER
SECTION 51(17) OF THE PLANNING ACT

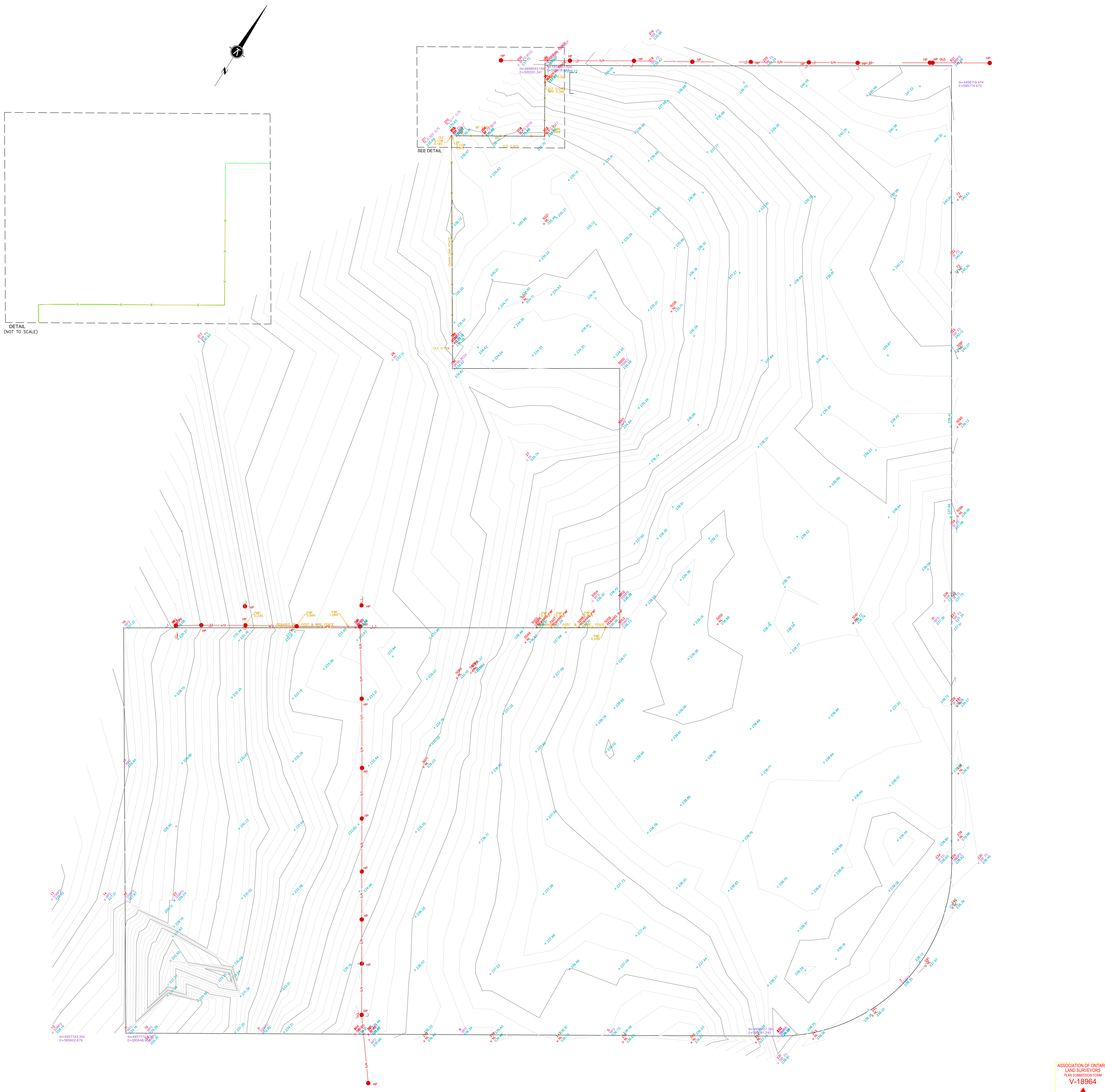
a) SHOWN ON PLAN
b) SHOWN ON PLAN
c) SHOWN ON PLAN
d) RESIDENTIAL, OPEN SPACE, EMPLOYMENT
e) SHOWN ON PLAN
f) SHOWN ON PLAN
f1) NONE
g) SHOWN ON PLAN
h) MUNICIPAL WATER
i) SANDY
j) SHOWN ON PLAN
k) MUNICIPAL SEPTIC SERVICES
l) NONE

SCHEDULE OF REVISIONS

No.	Date	Description	By
1	Sept. 12, 2022	Revised SWM Pond location in the north	B.H.

INNOVATIVE PLANNING SOLUTIONS
PLANNERS • PROJECT MANAGERS • LAND DEVELOPERS
647 WELHAM RD., UNIT 9, BARRIE, ONTARIO, L4N 0B7
tel: 705 • 812 • 3281 fax: 705 • 812 • 3438 e: info@ipsconsultinginc.com www.ipsconsultinginc.com

Date:	August 4, 2022	Drawn By:	BH
File:		Checked:	CS



PLAN OF SURVEY
SHOWING TOPOGRAPHICAL INFORMATION OF

PART OF LOTS 1, 2, 3 AND ALL OF LOTS 4 TO 25 INCLUSIVE BLOCK E AND ALL OF LOTS 1 TO 24 INCLUSIVE BLOCK G AND ALL OF LOTS 1 TO 25 INCLUSIVE BLOCK H AND ALL OF LOTS 1 TO 25 INCLUSIVE BLOCK I AND ALL OF LOTS 1 TO 24 INCLUSIVE BLOCK K AND PART OF LOTS 1, 4, 5, 8, 9, 12, 13, 16, 17, 20, 21 AND 24 BLOCK L AND ALL OF LOTS 1 AND 2, PART OF LOTS 3, 7, 8, 11, 12, 15, 16, 19, 20 23 AND 24 BLOCK M AND PART OF JEFFERY STREET, EDWARD STREET, HALL STREET AND BARR STREET (CLOSED BY RO1444329) AND ALL OF MILLER STREET AND PATTON STREET (CLOSED BY RO1444329) REGISTERED PLAN 101 AND PART OF LOT 114, CONCESSION 1

(GEOGRAPHIC TOWNSHIP OF TAY)

TOWN OF PENETANGUISHENE

COUNTY OF SIMCOE

SCALE 1:1000

20 0 20 40 60 80 100m

KRCMAR SURVEYORS LTD. 2022

METRIC: DISTANCES AND COORDINATES SHOWN HEREON ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048

BEARING

BEARINGS SHOWN HEREON ARE GRID DERIVED FROM GPS OBSERVATIONS OF OBSERVED REFERENCE POINTS 'A' AND 'B' USING THE LEICA SMARTNET RTK NETWORK AND ARE REFERRED TO THE 6° UTM COORDINATE SYSTEM, ZONE 17, CENTRAL MERIDIAN 81°00' WEST LONGITUDE.
(NAD 83 (CSRS)(2010)).

DISTANCES SHOWN HEREON ARE GROUND DISTANCES AND CAN BE CONVERTED TO GRID DISTANCES BY MULTIPLYING BY A COMBINED SCALE FACTOR OF 0.99998.

NOTES

ALL FOUND MONUMENTS ARE BY KRCMAR SURVEYORS LTD. O.L.S. UNLESS OTHERWISE NOTED.

ALL PLANTED MONUMENTS ARE IRON BARS (IB) UNLESS OTHERWISE NOTED.

LEGEND

■	DENOTES SURVEY MONUMENT FOUND
□	DENOTES SURVEY MONUMENT PLANTED
SIB	DENOTES STANDARD IRON BAR
SSIB	DENOTES SHORT STANDARD IRON BAR
RIB	DENOTES ROUND IRON BAR
RSIB	DENOTES ROUND STANDARD IRON BAR
IB	DENOTES IRON BAR
(M)	DENOTES MEASURED
(S)	DENOTES SET
(OU)	DENOTES ORIGIN UNKNOWN
(WIT)	DENOTES WITNESS
(P1)	DENOTES PLAN 51R–43212
(P2)	DENOTES PLAN 51R–42811
(P3)	DENOTES PLAN 51R–29627
(P4)	DENOTES PLAN 51R–14802
(P5)	DENOTES PLAN 51R–35689
(P6)	DENOTES PLAN 51R–36928
(650)	DENOTES CHARLES P. O'DALE, LTD, O.L.S.
(840)	DENOTES J. M. HARVEY, O.L.S.
(1613)	DENOTES EPLETT WOROBEC SURVEYING LTD, O.L.S.
(1841)	DENOTES PETER T. RAIKES, O.L.S.
(1882)	DENOTES BOWERS JONES FOURNIER SURVEYING LTD, O.L.S.
(1752)	DENOTES G. L. PRESTON, O.L.S.
(1370)	DENOTES KRCMAR SURVEYORS LTD. O.L.S.
BF	DENOTES BOARD FENCE
CLF	DENOTES CHAIN LINK FENCE
PWF	DENOTES POST & WIRE FENCE
WRF	DENOTES WOOD RAIL FENCE
● HP	DENOTES HYDRO POLE
-)	DENOTES DOWN GUY ANCHOR
—O/H—	DENOTES HYDRO SERVICE (OVERHEAD)

SURVEY REPORT

1. THE RE–ESTABLISHMENT OF THE SUBJECT PROPERTY BOUNDARIES IS BASED ON INFORMATION CONTAINED IN THE RELEVANT TITLE DOCUMENTS, REGISTERED PLANS AND ON THE EVIDENCE OF PRIOR SURVEYS FOUND DURING THE COURSE OF PREPARING THE SUBJECT SURVEY.
2. THE TYPE AND LOCATION OF THE EXISTING BUILDINGS AND OTHER IMPROVEMENTS, FENCES ETC., ON OR NEAR THE SUBJECT PROPERTY ARE AS SHOWN ON THE SURVEY PLAN.
3. COMPLIANCE WITH MUNICIPAL ZONING REQUIREMENTS IS NOT CERTIFIED BY THIS REPORT.
4. LAND COMPRISES ALL OF PIN 58441–0466(LT).
5. PIN 58441–0466(LT) IS IN LAND TITLES CONVERSION QUALIFIED.

TOTAL SITE AREA = 31.6216 ha

SURVEYOR'S CERTIFICATE

I CERTIFY THAT:

1. THIS SURVEY AND PLAN ARE CORRECT AND IN ACCORDANCE WITH THE SURVEYS ACT, THE SURVEYORS ACT AND THE REGULATIONS MADE UNDER THEM.
2. THE SURVEY WAS COMPLETED ON THE 17th DAY OF MAY, 2022

DATE __________ , 2022

STUART M. MOORE
ONTARIO LAND SURVEYOR

ASSOCIATION OF ONTARIO LAND SURVEYORS
PLAN SUBMISSION FORM
V-18964
THIS PLAN IS NOT VALID UNLESS IT IS AN EMBOSSED ORIGINAL COPY ISSUED BY THE SURVEYOR In accordance with Regulation 1026, Section 29(3).

MUNICIPAL ADDRESS: No. 138 ROBERT STREET EAST, PENETANGUISHENE

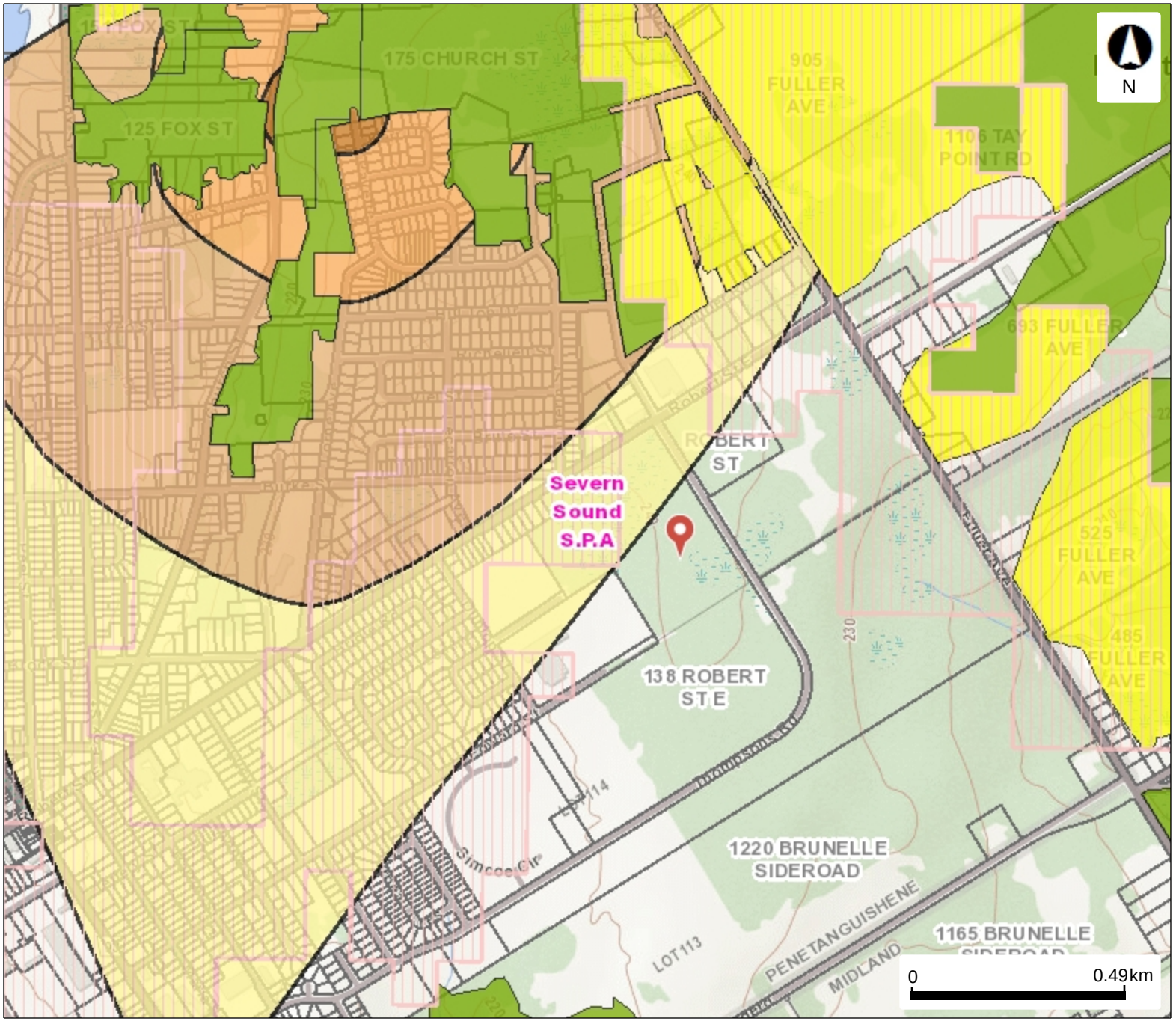
FIELD: A.A./L.S.	DRAWN: J.M.	CHECKED: S.M.M.	JOB NO: 22-523
DWG NAME: 22-523BT01	PLOT INFO: 09:12 19/May/2022	WORK ORDER NO: 36099	

1137 Centre Street Thornhill ON L4J 3M6 905.738.0053 F 905.738.9221 www.krcmar.ca

PLAN AVAILABLE AT www.ProtectYourBoundaries.ca

KRCMAR

HVA and WHPA-D Map



Legend

- Source Protection Areas
- Highly Vulnerable Aquifers
- Significant Groundwater Recharge Area
  - 0
  - 2
  - 4
  - 6
- Wellhead Protection Area
  - A
  - B
  - C
  - C1
  - D
  - F
- Assessment Parcel with Addre

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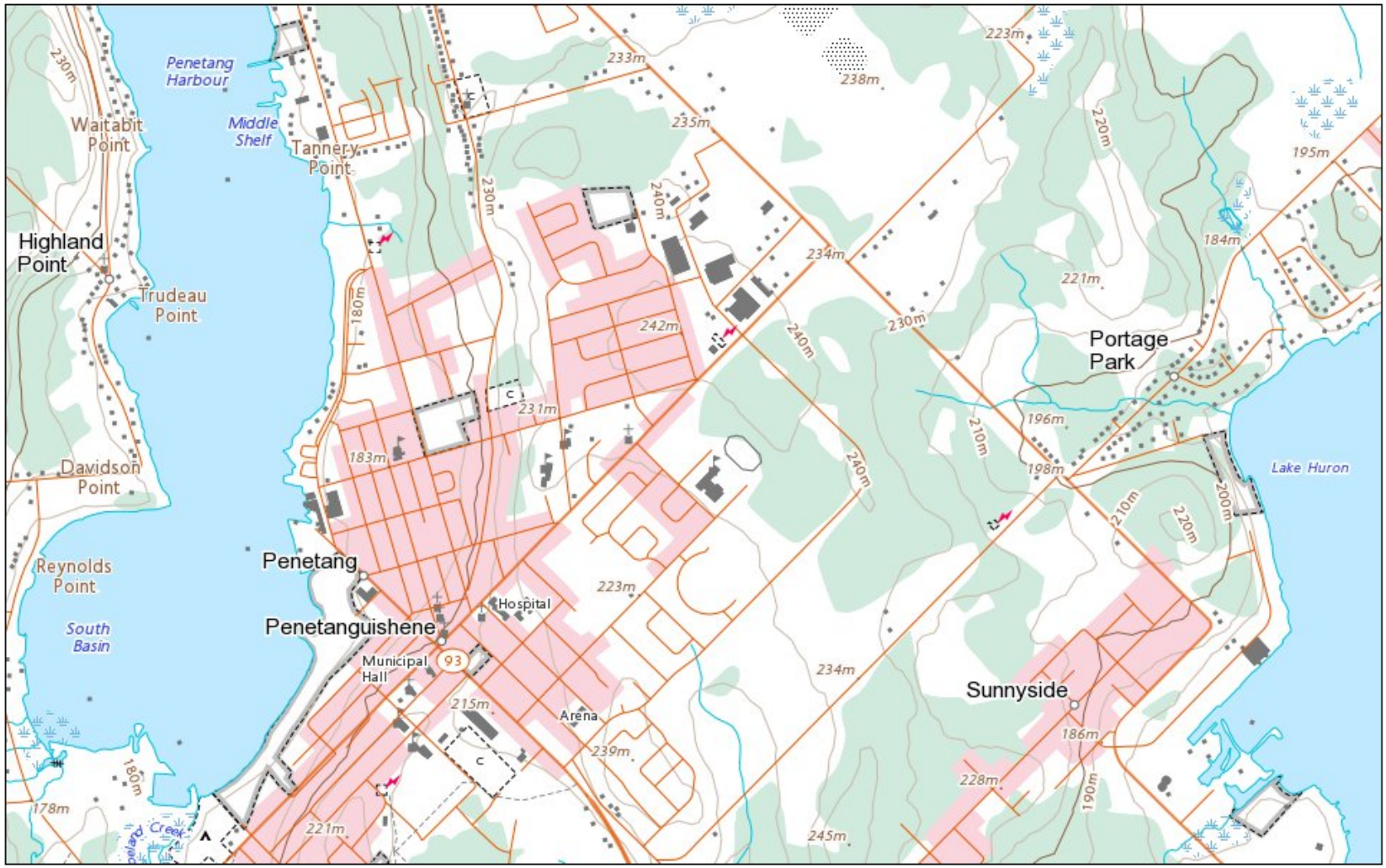
Ontario

Map Created: 8/8/2022
Map Center: 44.77498 N, -79.91781 W

Toporama



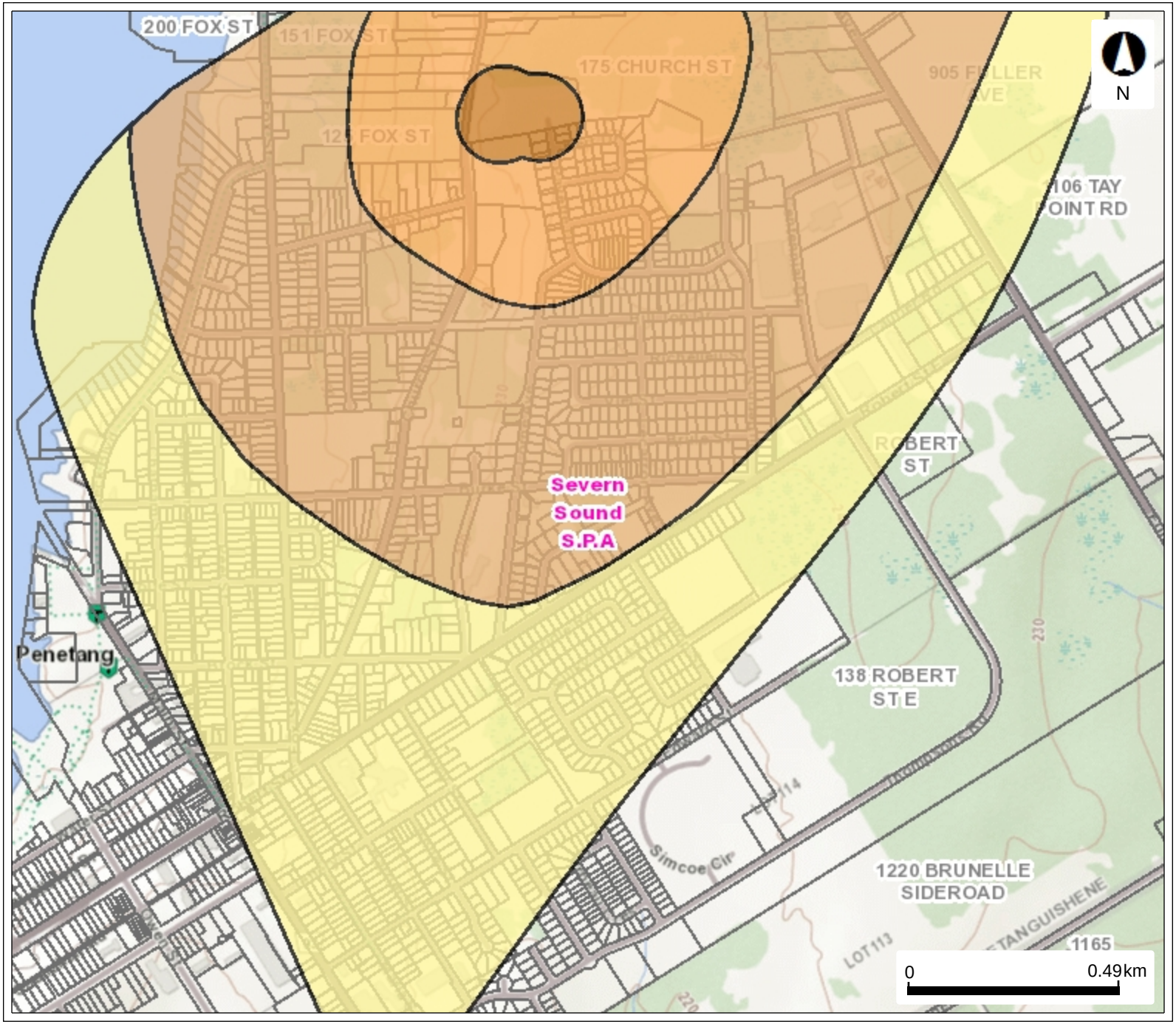
August 8, 2022

1:21,312

0 0.175 0.35 0.7 mi

0 0.275 0.55 1.1 km

Payette Wellhead Protection Area Designations



Legend

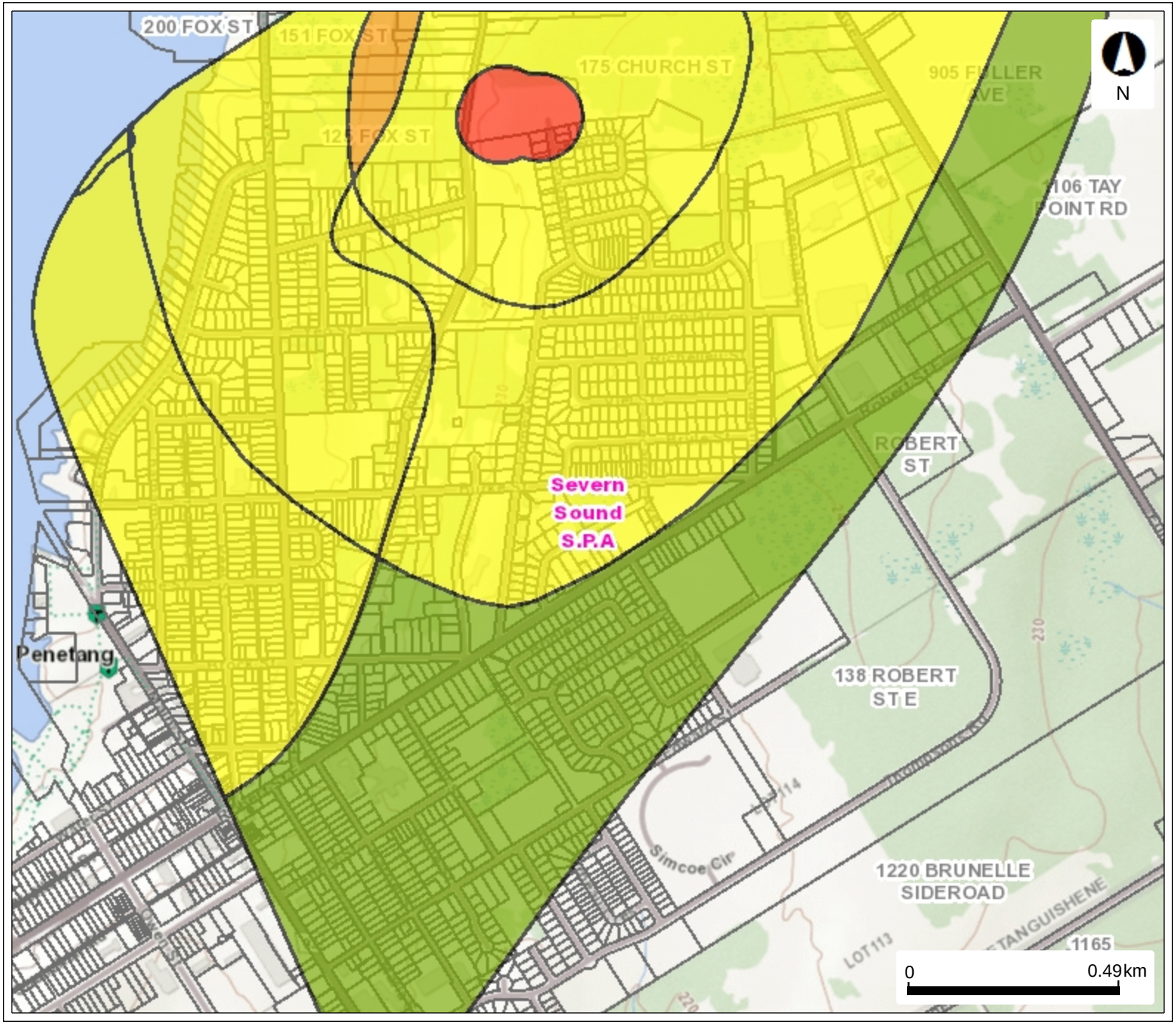
- Source Protection Areas
- Wellhead Protection Area
  - A
  - B
  - C
  - C1
  - D
  - F
- Assessment Parcel with Addre

This map should not be relied on as a precise indicator of routes or locations, nor as a guide to navigation. The Ontario Ministry of Environment, Conservation and Parks (MECP) shall not be liable in any way for the use or any information on this map. of, or reliance upon, this map.

Ontario

Map Created: 8/11/2022
Map Center: 44.775 N, -79.92337 W

Payette Wellhead Protection Area Vulnerability Scores



Legend

- Source Protection Areas
- Vulnerable Scoring Area - Groundwater
  - 2
  - 4
  - 6
  - 8
  - 10
- Assessment Parcel with Addre

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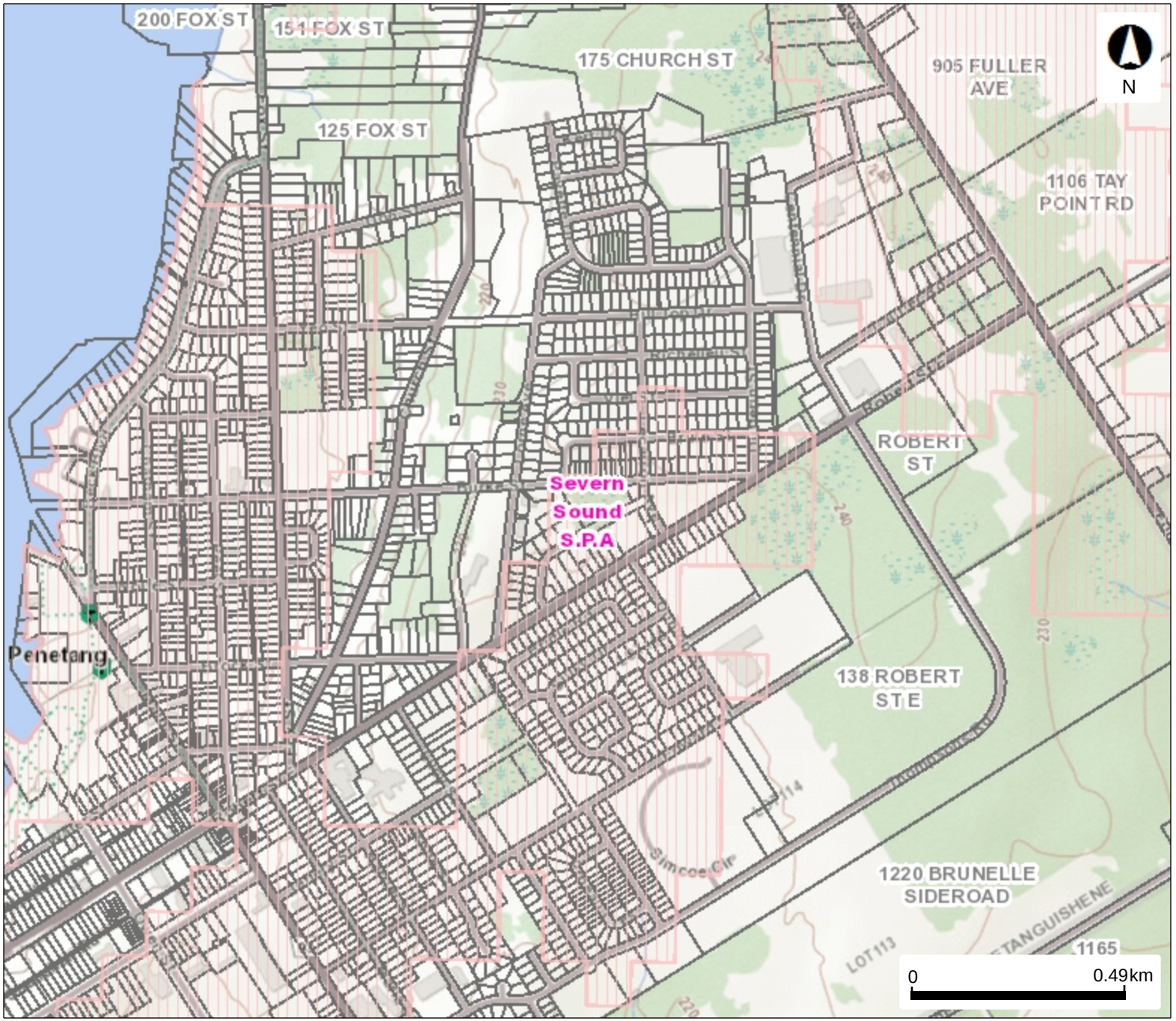
Ontario

Map Created: 8/11/2022
Map Center: 44.775 N, -79.92337 W

Highly Vulnerable Aquifer Areas



Legend

- Source Protection Areas
- Highly Vulnerable Aquifers
- Assessment Parcel with Addre

This map should not be relied on as a precise indicator of routes or locations, nor as a guide to navigation. The Ontario Ministry of Environment, Conservation and Parks (MECP) shall not be liable in any way for the use or any information on this map. of, or reliance upon, this map.

Ontario

Map Created: 8/11/2022
Map Center: 44.775 N, -79.92337 W

Appendix B

MECP Well Records

Water Well Records Summary Report

Produced by Cambium Inc. using MOECC Water Well Information System (WWIS)

Well ID: 5708926 **Con:** 02 **Lot:** 15 **UTM Zone:** 17 **Easting:** 586400 **Northing:** 4959013
Construction Date: 8/3/1972 **Positional Accuracy** margin of error : 300 m - 1 km

Final Status: Water Supply
Water Kind: FRESH
Primary Water Use: Domestic
Secondary Water Use:

Well Dept 48.77
Static Level (m) 43
Rec. Pump Rate: 41
Depth Water First Found 44.20

Formation
Drillers Description:
Layer 1: TOPSOIL
Layer 2: SAND
Layer 3: MEDIUM SAND

Well ID: 5710926 **Con:** 02 **Lot:** 15 **UTM Zone:** 17 **Easting:** 586503 **Northing:** 4958786
Construction Date: 5/6/1974 **Positional Accuracy** margin of error : 300 m - 1 km

Final Status: Water Supply
Water Kind: FRESH
Primary Water Use: Domestic
Secondary Water Use:

Well Dept 70.1
Static Level (m) 41
Rec. Pump Rate: 36
Depth Water First Found 49.38

Formation
Drillers Description:
Layer 1: SAND
Layer 2: CLAY
Layer 3: SAND

Well ID: 5710926 **Con:** 02 **Lot:** 15 **UTM Zone:** 17 **Easting:** 586503 **Northing:** 4958786
Construction Date: 5/6/1974 **Positional Accuracy** margin of error : 300 m - 1 km

Final Status: Water Supply
Water Kind: FRESH
Primary Water Use: Domestic
Secondary Water Use:

Well Dept 70.1
Static Level (m) 41
Rec. Pump Rate: 36
Depth Water First Found 60.96

Formation
Drillers Description:
Layer 1: SAND
Layer 2: CLAY
Layer 3: SAND

Well ID: 5715461 **Con:** 02 **Lot:** 15 **UTM Zone:** 17 **Easting:** 586414 **Northing:** 4958974
Construction Date: 8/22/1978 **Positional Accuracy** margin of error : 100 m - 300 m

Final Status: Water Supply
Water Kind: FRESH
Primary Water Use: Domestic
Secondary Water Use:

Well Dept 51.21
Static Level (m) 43
Rec. Pump Rate: 18
Depth Water First Found 42.67

Formation
Drillers Description:
Layer 1: SAND
Layer 2: GRAVEL
Layer 3: SAND

Well ID: 5715580 **Con:** 02 **Lot:** 15 **UTM Zone:** 17 **Easting:** 586464 **Northing:** 4958874
Construction Date: 11/9/1978 **Positional Accuracy** margin of error : 100 m - 300 m

Final Status: Water Supply
Water Kind: FRESH
Primary Water Use: Domestic
Secondary Water Use:

Well Dept 55.78
Static Level (m) 41
Rec. Pump Rate: 36
Depth Water First Found 51.21

Formation
Drillers Description:
Layer 1: SAND
Layer 2: SAND
Layer 3: SAND

Well ID: 5719375 **Con:** 02 **Lot:** 15 **UTM Zone:** 17 **Easting:** 586314 **Northing:** 4958924
Construction Date: 9/18/1984 **Positional Accuracy** margin of error : 100 m - 300 m

Final Status: Water Supply
Water Kind: FRESH
Primary Water Use: Domestic
Secondary Water Use:

Well Dept 48.77
Static Level (m) 43
Rec. Pump Rate: 68
Depth Water First Found 45.72

Formation
Drillers Description:
Layer 1: TOPSOIL
Layer 2: GRAVEL
Layer 3: SAND

Well ID: 5720267 **Con:** 01 **Lot:** 16 **UTM Zone:** 17 **Easting:** 585653 **Northing:** 4959141
Construction Date: 11/27/1985 **Positional Accuracy** margin of error : 10 - 30 m

Final Status: Water Supply
Water Kind: FRESH
Primary Water Use: Industrial
Secondary Water Use:

Well Dept 63.7
Static Level (m) 50
Rec. Pump Rate: 227
Depth Water First Found 50.29

Formation
Drillers Description:
Layer 1: TOPSOIL
Layer 2: SAND
Layer 3: SAND

Well ID: 5720267 **Con:** 01 **Lot:** 16 **UTM Zone:** 17 **Easting:** 585653 **Northing:** 4959141
Construction Date: 11/27/1985 **Positional Accuracy** margin of error : 10 - 30 m

Final Status: Water Supply
Water Kind: FRESH
Primary Water Use: Industrial
Secondary Water Use:

Well Dept 63.7
Static Level (m) 50
Rec. Pump Rate: 227
Depth Water First Found 62.18

Formation
Drillers Description:
Layer 1: TOPSOIL
Layer 2: SAND
Layer 3: SAND

Well ID: 5720974 **Con:** 02 **Lot:** 14 **UTM Zone:** 17 **Easting:** 586541 **Northing:** 4958537
Construction Date: 9/2/1986 **Positional Accuracy** margin of error : 10 - 30 m

Final Status: Water Supply
Water Kind: FRESH
Primary Water Use: Domestic
Secondary Water Use:

Well Dept 45.11
Static Level (m) 29
Rec. Pump Rate: 55
Depth Water First Found 45.11

Formation
Drillers Description:
Layer 1: TOPSOIL
Layer 2: CLAY
Layer 3: CLAY

Well ID: 5726430 **Con:** 02 **Lot:** 15 **UTM Zone:** 17 **Easting:** 586416 **Northing:** 4959088
Construction Date: 4/10/1990 **Positional Accuracy** margin of error : 10 - 30 m

Final Status: Water Supply
Water Kind: FRESH
Primary Water Use: Domestic
Secondary Water Use:

Well Dept 51.82
Static Level (m) 42
Rec. Pump Rate: 64
Depth Water First Found 51.51

Formation
Drillers Description:
Layer 1: GRAVEL
Layer 2: SAND
Layer 3: CLAY

Well ID: 7144589 **Con:** 01 **Lot:** 17 **UTM Zone:** 17 **Easting:** 585508 **Northing:** 4959126
Construction Date: 5/12/2010 **Positional Accuracy** margin of error : 100 m - 300 m

Final Status: Observation W
Water Kind: Untested
Primary Water Use: Monitoring
Secondary Water Use:

Well Dept 86
Static Level (m) 52
Rec. Pump Rate:
Depth Water First Found 83

Formation
Drillers Description:
Layer 1: CLAY
Layer 2: SAND
Layer 3: SAND

Well ID: 7261596 **Con:** **Lot:** **UTM Zone:** 17 **Easting:** 585399 **Northing:** 4959261
Construction Date: 4/19/2016 **Positional Accuracy** margin of error : 30 m - 100 m

Final Status: Observation W
Water Kind: Untested
Primary Water Use: Monitoring and Tes
Secondary Water Use:

Well Dept 4.57
Static Level (m)
Rec. Pump Rate:
Depth Water First Found 2.29

Formation
Drillers Description:
Layer 1: TOPSOIL
Layer 2: SAND
Layer 3: SILT

1. Core Material and Descriptive terms

Code	Description	Code	Description	Code	Description	Code	Description	Code	Description
BLDR	BOULDERS	FCRD	FRACTURED	IRFM	IRON FORMATION	PORS	POROUS	SOFT	SOFT
BSLT	BASALT	FGRD	FINE-GRAINED	LIMY	LIMY	PRDG	PREVIOUSLY DUG	SPST	SOAPSTONE
CGRD	COARSE-GRAINED	FGVL	FINE GRAVEL	LMSN	LIMESTONE	PRDR	PREV. DRILLED	STKY	STICKY
CGVL	COARSE GRAVEL	FILL	FILL	LOAM	TOPSOIL	QRTZ	QUARTZITE	STNS	STONES
CHRT	CHERT	FLDS	FELDSPAR	LOOS	LOOSE	QSND	QUICKSAND	STNY	STONEY
CLAY	CLAY	FLNT	FLINT	LTCL	LIGHT-COLOURED	QTZ	QUARTZ	THIK	THICK
CLN	CLEAN	FOSS	FOSILIFEROUS	LYRD	LAYERED	ROCK	ROCK	THIN	THIN
CLYY	CLAYEY	FSND	FINE SAND	MARL	MARL	SAND	SAND	TILL	TILL
CMTD	CEMENTED	GNIS	GNEISS	MGRD	MEDIUM-GRAINED	SHLE	SHALE	UNKN	UNKNOWN TYPE
CONG	CONGLOMERATE	GRNT	GRANITE	MGVL	MEDIUM GRAVEL	SHLY	SHALY	VERY	VERY
CRYS	CRYSTALLINE	GRSN	GREENSTONE	MRBL	MARBLE	SHRP	SHARP	WBRG	WATER-BEARING
CSND	COARSE SAND	GRVL	GRAVEL	MSND	MEDIUM SAND	SHST	SCHIST	WDFR	WOOD FRAGMENTS
DKCL	DARK-COLOURED	GRWK	GREYWACKE	MUCK	MUCK	SILT	SILT	WTHD	WEATHERED
DLMT	DOLOMITE	GVLY	GRAVELLY	OBDN	OVERBURDEN	SLTE	SLATE		
DNSE	DENSE	GYPS	GYPSUM	PCKD	PACKED	SLTY	SILTY		
DRTY	DIRTY	HARD	HARD	PEAT	PEAT	SNDS	SANDSTONE		
DRY	DRY	HPAN	HARDPAN	PGVL	PEA GRAVEL	SNDY	SANDYOAPSTONE		

2. Core Colour

Code	Description
WHIT	WHITE
GREY	GREY
BLUE	BLUE
GREN	GREEN
YLLW	YELLOW
BRWN	BROWN
RED	RED
BLCK	BLACK
BLGY	BLUE-GREY

Appendix C

Borehole Logs

Peterborough
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Log of Borehole: BH101-22

Client: Gerrits Engineering Ltd. **Project Name:** 138 Robert Street East, Penetanguishene **Project No.:** 14863-001

Contractor: Landshark Drilling **Method:** Hollow Stem Augers **Date Completed:** April 25, 2022

Location: 138 Robert Street East, Penetanguishene **UTM:** 17T, 4958535 m N, 585583 m E **Elevation:** 236.62 mASL

Elevation (m)	Depth	Description	Number	Type	% Recovery	SPT (N) / DCPT	Well Installation	Remarks
236	0	TOPSOIL: (~ 205 mm thick)	1A				Monument Cap	50 mm Diameter Monitoring Well with a 3.0 m screen. Groundwater level measured in monitoring well at a depth of about 5.86 mbgs on May 20, 2022 and 3.39 mbgs on June 15, 2022
		SILTY CLAY: (CL) - trace sand, trace gravel; brown, trace organic matter, reworked native; cohesive, w ~ PL, firm to stiff	1B	SS	100	8		
	1		2	SS	90	10	Holeplug PVC Standpipe	
235		CLAYEY SAND: (SC) - trace gravel; brown; non-cohesive, moist, loose	3	SS	85	7		
	2							
234		SAND TO SILTY SAND: (SP/SM) - trace gravel; light brown, (TILL); non-cohesive, moist, compact to very dense	4	SS	95	28		
	3		5	SS	100	50		GSA SS5: 6% Gravel 63% Sand 23% Silt 8% Clay
233								
	4						Sand PVC Screen	
232			6	SS	5	50/ 225 mm		
	5							
231								
	6						Cap	
230		SAND: (SP) - some silt, trace gravel; light brown (TILL); non-cohesive, moist, very dense	7	SS	75	50/ 275 mm		
	7	Borehole terminated at 6.7 mbgs due to target depth achieved						
229								

% Moisture: 25 50 75

SPT (N) / DCPT: 10 20 30 40

Logged By: Chris Malliaros **Input By:** Waleed El-Taweel

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Barrie
Oshawa
Kingston
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Log of Borehole: BH102-22

Client: Gerrits Engineering Ltd. **Project Name:** 138 Robert Street East, Penetanguishene **Project No.:** 14863-001

Contractor: Landshark Drilling **Method:** Solid Stem Augers **Date Completed:** April 25, 2022

Location: 138 Robert Street East, Penetanguishene **UTM:** 17T, 4958575 m N, 585771 m E **Elevation:** 239.57 mASL

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
239 / 0		TOPSOIL: (~ 125 mm thick)	1A							
		SAND: (SP) - trace gravel; brown; non-cohesive, moist, loose to compact	1B	SS	60	9				
239 / 1		-fine to medium, some fines at about 0.8 mbgs	2	SS	80	8				
238 / 2			3	SS	70	13				
237 / 3		SILTY SAND: (SM) - trace gravel; light brown (TILL); non-cohesive, moist, compact to very dense	4	SS	85	27				
236 / 4			5	SS	30	46				
235 / 5			6	SS	90	50				
234 / 6			7	SS	75	50/ 225 mm				
233 / 7		Borehole terminated at 6.6 mbgs due to target depth achieved								Borehole dry and open upon completion of drilling
232										

Logged By: Chris Malliaros **Input By:** Waleed El-Taweel

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Log of Borehole: BH103-22

Client: Gerrits Engineering Ltd. **Project Name:** 138 Robert Street East, Penetanguishene **Project No.:** 14863-001

Contractor: Landshark Drilling **Method:** Solid Stem Augers **Date Completed:** April 25, 2022

Location: 138 Robert Street East, Penetanguishene **UTM:** 17T, 4958321 m N, 585898 m E **Elevation:** 238.74 mASL

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
0 / 238		TOPSOIL: (~ 180 mm thick)	1A						Monument	50 mm Diameter Monitoring Well with a 3.0 m screen. Monitoring well was dry on May 20, 2022 and on June 15, 2022
		SAND to SILTY SAND: (SP-SM) - some fines, trace gravel; brown, reworked native, non-cohesive, moist, loose to compact	1B	SS	80	5			Cap	
1 / 237			2	SS	80	17			Holeplug	
		SILTY SAND: (SM) - trace gravel; brown (TILL); non-cohesive, moist, compact to very dense	3	SS	70	18			PVC Standpipe	GSA SS2: 5% Gravel 72% Sand 20% Silt 3% Clay
2 / 236			4	SS	80	36				
3 / 235			5	SS	85	50/ 250 mm				
4 / 234		SAND: (SP) - trace gravel; light brown (TILL); non-cohesive, moist, very dense	6	SS	80	50/ 275 mm			Sand	
5 / 233									PVC Screen	GSA SS6: 9% Gravel 77% Sand 14% Silt and Clay
6 / 232			7	SS	90	100			Cap	
7		Borehole terminated at 6.7 mbgs due to target depth achieved								

Logged By: Chris Malliaros **Input By:** Waleed El-Taweel

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Log of Borehole: BH104-22

Client: Gerrits Engineering Ltd. **Project Name:** 138 Robert Street East, Penetanguishene **Project No.:** 14863-001

Contractor: Landshark Drilling **Method:** Solid Stem Augers **Date Completed:** April 26, 2022

Location: 138 Robert Street East, Penetanguishene **UTM:** 17T, 4957884 m N, 585682 m E **Elevation:** 230.75 mASL

Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
230	0		TOPSOIL: (~ 205 mm thick)	1A						Monument	50 mm Diameter Monitoring Well with a 3.0 m screen. Groundwater level measured in monitoring well at a depth of about 6.06 mbgs on May 20, 2022 and was dry on June 15, 2022
			FILL: (SP) - SAND, trace fines; brown; non-cohesive, moist, loose to compact	1B	SS	70	10			Cap	
	1			2	SS	65	7				
			-trace gravel at 1.5 mbgs	3A							
229	2		SILTY SAND: (SM) - trace gravel; brown (TILL); non-cohesive, moist, loose to very dense	3B	SS	90	7			Holeplug	
			-some gravel at 2.3 mbgs	4A						PVC Standpipe	
228	3			4B	SS	75	100				
				5	SS	100	16				
227	4										
				6	SS	60	24			Sand	
226	5									PVC Screen	
225	6		SAND: (SP) - fine to medium; light brown (TILL); non-cohesive, moist, very dense	7	SS	90	100			Cap	
224	7		Borehole terminated at 6.7 mbgs due to target depth achieved								

Logged By: Chris Malliaros **Input By:** Waleed El-Taweel

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Log of Borehole: BH105-22

Client: Gerrits Engineering Ltd. **Project Name:** 138 Robert Street East, Penetanguishene **Project No.:** 14863-001

Contractor: Landshark Drilling **Method:** Solid Stem Augers **Date Completed:** April 26, 2022

Location: 138 Robert Street East, Penetanguishene **UTM:** 17T, 4958054 m N, 585591 m E **Elevation:** 231.86 mASL

Elevation (m)	Depth	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
231	0	TOPSOIL: (~ 180 mm thick)	1A							
		FILL: (SM) - SILTY SAND, trace to some gravel; brown; non-cohesive, moist, very loose to loose	1B	SS	95	4				
	1		2	SS	90	7				
230	2		3	SS	90	9				
		SILTY SAND: (SM) - trace gravel; light brown (TILL); non-cohesive, moist, compact to dense	4	SS	100	19				
229	3		5	SS	95	31				
228	4									
227	5		6	SS	95	23				
226	6		7	SS	85	36				
225	7	Borehole terminated at 6.7 mbgs due to target depth achieved								Borehole dry and open upon completion of drilling

Logged By: Chris Malliaros **Input By:** Waleed El-Taweel

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Log of Borehole: BH106-22

Client: Gerrits Engineering Ltd. **Project Name:** 138 Robert Street East, Penetanguishene **Project No.:** 14863-001

Contractor: Landshark Drilling **Method:** Solid Stem Augers **Date Completed:** April 26, 2022

Location: 138 Robert Street East, Penetanguishene **UTM:** 17T, 4958107 m N, 585966 m E **Elevation:** 238.76 mASL

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
0		TOPSOIL: (~ 125 mm thick)	1A							
		FILL: (SP) - SAND, some fines, trace gravel; brown; non-cohesive, moist, loose	1B	SS	40	6				
238 / 1		SAND: (SP) - some fines, some gravel to gravelly; brown; non-cohesive, moist, compact to dense	2	SS	60	33				
237 / 2			3	SS	80	14				
236 / 3		SILTY SAND: (SM) - some fines, trace gravel; brown; non-cohesive, moist, compact	4	SS	100	13				GSA SS4: 3% Gravel 67% Sand 24% Silt 6% Clay
235 / 4		SILTY SAND: (SM) - trace gravel; light brown (TILL); non-cohesive, moist, compact to very dense	5	SS	100	16				
234 / 5			6	SS	100	50/ 200 mm				
233 / 6		SAND: (SP) - trace silt, trace gravel; light brown (TILL); non-cohesive, moist, very dense	7	SS	75	86				
232 / 7		Borehole terminated at 6.7 mbgs due to target depth achieved								Borehole dry and open upon completion of drilling

Logged By: Chris Malliaros **Input By:** Waleed El-Taweel

Appendix D

Grain Size Distribution Analysis Results

Grain Size Distribution Chart

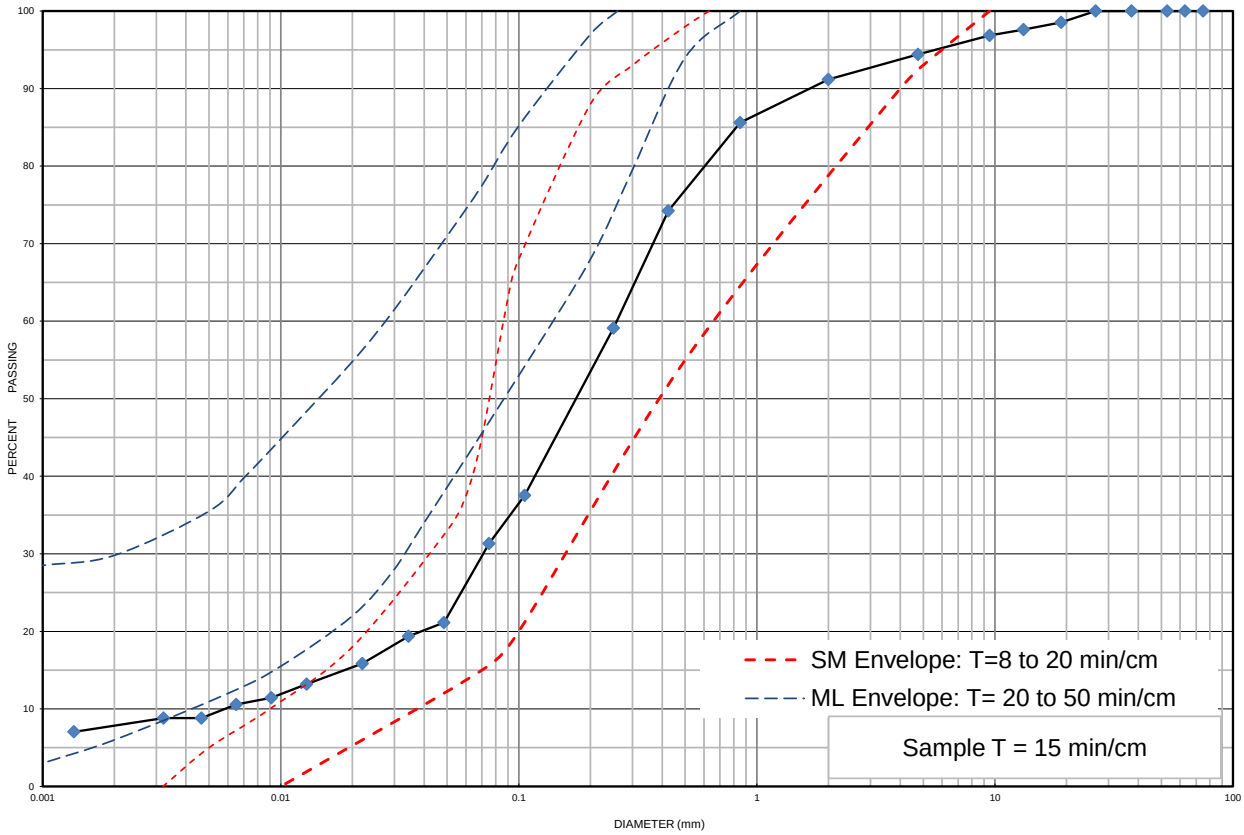
Project Number: *14863-001* **Client:** *138 Robert Street LP*

Project Name: *138 Robert Street, Penetanguishene*

Sample Date: *April 25, 2022* **Sampled By:** *Chris Malliaros - Cambium Inc.*

Location: *BH 101-22 SS 5* **Depth:** *3 m to 3.7 m* **Lab Sample No:** *S-22-0889*

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 101-22	SS 5	3 m to 3.7 m	6	63	23	8	8.3

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Silty Sand trace Clay trace Gravel	SM	0.2600	0.0710	0.0057	45.61	3.40

Additional information availabe upon request

Issued By: _____ *Date Issued:* *July 14, 2022*

(Senior Project Manager)

Cambium Inc. (Laboratory)
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Grain Size Distribution Chart

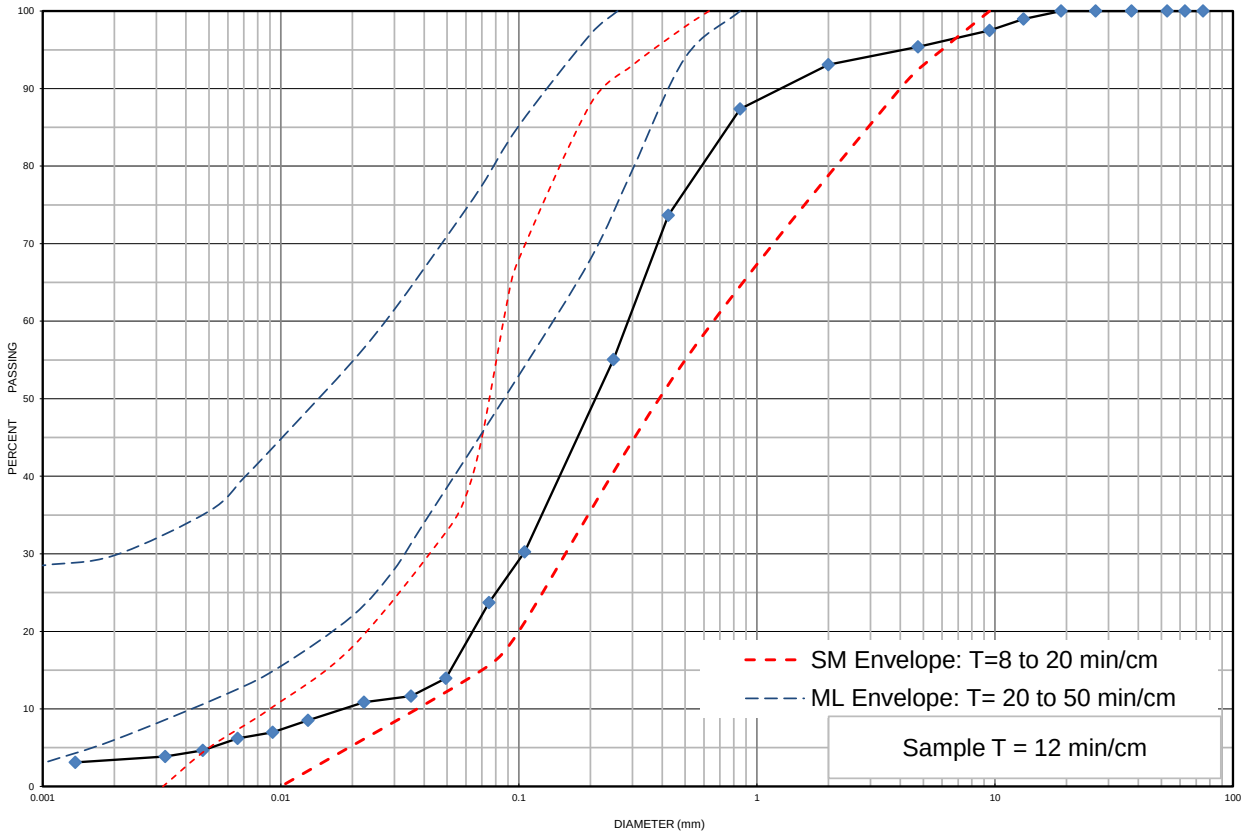
Project Number: *14863-001* **Client:** *138 Robert Street LP*

Project Name: *138 Robert Street, Penetanguishene*

Sample Date: *April 25, 2022* **Sampled By:** *Chris Malliaros - Cambium Inc.*

Location: *BH 103-22 SS 2* **Depth:** *0.8 m to 1.4 m* **Lab Sample No:** *S-22-0891*

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 103-22	SS 2	0.8 m to 1.4 m	5	72	20	3	10.1

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Silty Sand trace Gravel trace Clay	SM	0.290	0.110	0.018	16.11	2.32

Additional information availabe upon request

Issued By: _____ *Date Issued:* *July 14, 2022*

(Senior Project Manager)

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Grain Size Distribution Chart

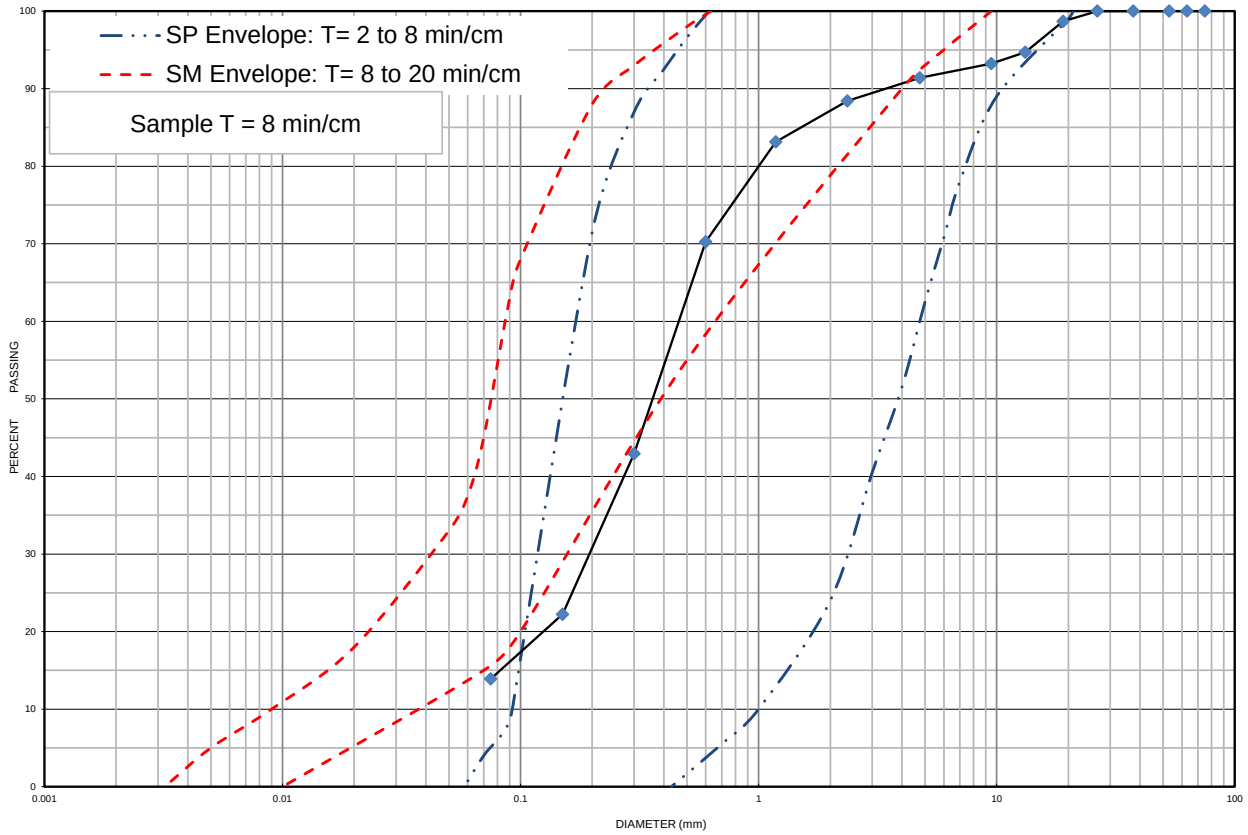
Project Number: *14863-001* **Client:** *138 Robert Street LP*

Project Name: *138 Robert Street, Penetanguishene*

Sample Date: *April 25, 2022* **Sampled By:** *Chris Malliaros - Cambium Inc.*

Location: *BH 103-22 SS 6* **Depth:** *4.6 m to 5.2 m* **Lab Sample No:** *S-22-0890*

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 103-22	SS 6	4.6 m to 5.2 m	9	77	14		5.2

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Sand some Silt trace Gravel	SM	0.460	0.195	-	-	-

Additional information available upon request

Issued By: _____ *Date Issued:* *July 14, 2022*

(Senior Project Manager)

Cambium Inc. (Laboratory)
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194 Sophia St. | Peterborough | ON | K9H 1E5

Grain Size Distribution Chart

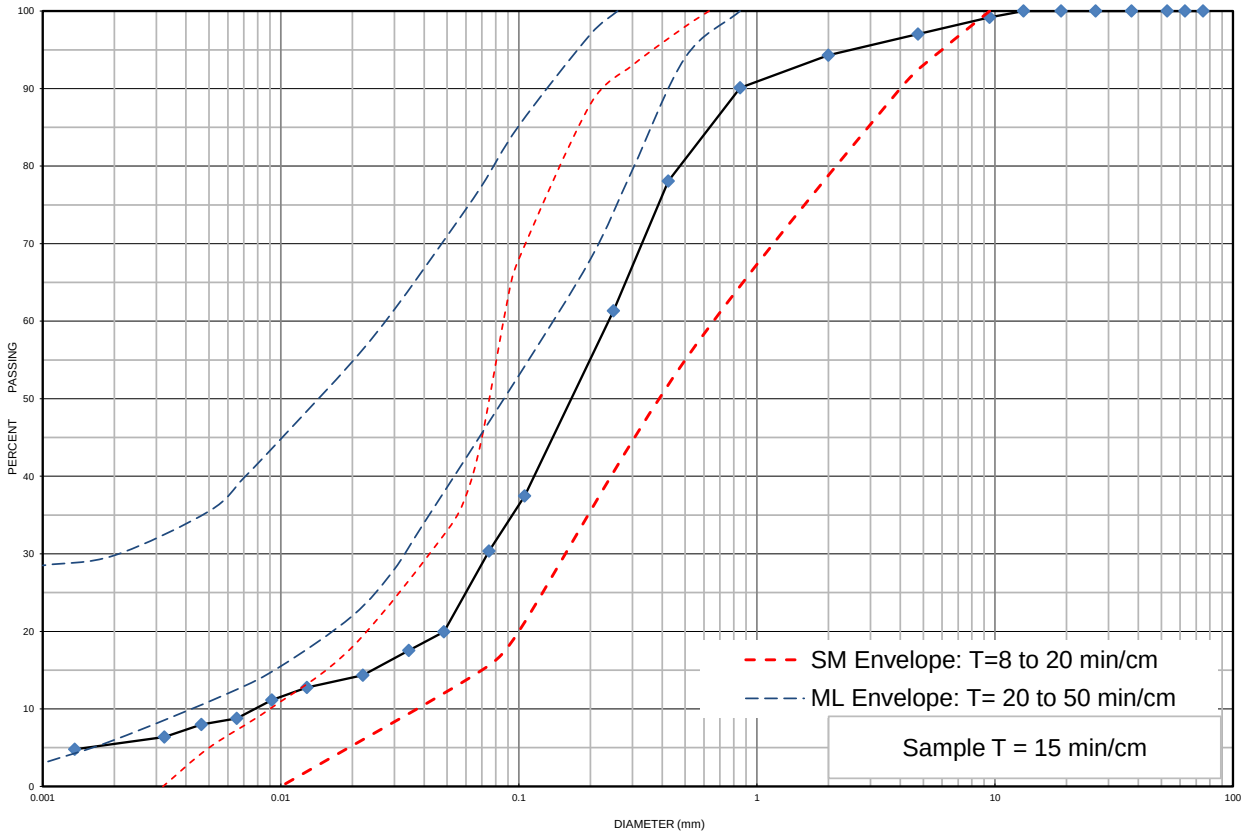
Project Number: *14863-001* **Client:** *138 Robert Street LP*

Project Name: *138 Robert Street, Penetanguishene*

Sample Date: *April 25, 2022* **Sampled By:** *Chris Malliaros - Cambium Inc.*

Location: *BH 106-22 SS 4* **Depth:** *2.3 m to 2.9 m* **Lab Sample No:** *S-22-0892*

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 106-22	SS 4	2.3 m to 2.9 m	3	67	24	6	10.7

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Silty Sand trace Clay trace Gravel	SM	0.2400	0.0740	0.0078	30.77	2.93

Additional information availabe upon request

Issued By: _____ *Date Issued:* *July 14, 2022*

(Senior Project Manager)

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Appendix E

Water Balance Calculations

Water Balance Calculations

138 Robert Street East, Penetanguishene, 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	501 mm/yr
Weather Station Location:	**Midland Water Pollution Plant**				**Latitude:**	**44.8**	**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	14.7	15.3	15.0	13.8	12.3	10.8	9.4	8.7	
Available Water Storage Capacity	0.10	m/m		**Root Depth**	1500	mm		**SOILmax**	150.0	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)	-8.5	-6.4	-1.9	5.8	12.2	18.1	20.8	19.9	15.9	9.3	3.2	-3.1	
PRECIPITATION (P)	109.8	69.9	65.7	65.1	92.8	89.5	72.7	77.9	99.1	90.1	103.6	104.4	1041
RAIN	21.5	20.9	36.1	59.3	92.8	89.5	72.7	77.9	99.1	88.0	74.8	27.5	760
SNOW	88	49	30	6	0	0	0	0	0	2	29	77	281
MELT FACTOR (F)	0.00	0.00	0.00	0.97	1.00	1.00	1.00	1.00	1.00	1.00	0.53	0.00	
PACK	179	228	257	9	0	0	0	0	0	0	13	90	
MELT	0	0	0	254	9	0	0	0	0	2	15	0	281
INPUT (W)	22	21	36	314	102	90	73	78	99	90	90	28	1041
POTENTIAL ET (PET)	0	0	0	39	68	98	116	102	69	41	23	0	557
NET INPUT (ΔW)	22	21	36	274	34	-9	-43	-24	30	49	67	28	
SOIL MOISTURE (SOIL)	150	150	150	150	150	142	106	91	121	150	150	150	
ΔSOIL	0	0	0	0	0	-8	-36	-15	30	29	0	0	0
ET	0	0	0	39	68	98	108	93	69	41	23	0	540
SURPLUS=W-ET-ΔSOIL	22	21	36	274	34	0	0	0	0	19	67	28	501

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

138 Robert Street West, Penetanguishene, ON

1 Climate Information

Precipitation	1041	mm/yr
Actual Evapotranspiration	540	mm/yr
Water Surplus	501	mm/yr

2 Infiltration Rates

Table 2 Approach - Infiltration factors		
Topography: Flat to Gently Sloping Land	0.3	
Soil Type: predominantly loam	0.3	
Cover: Open Land	0.1	
Total Infiltration Factor	**0.7**	
Infiltration (Water Surplus * Infiltration Factor)	**351**	mm/yr
Run-off (Water Surplus - Infiltration)	**150**	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	0.00	0
Total Roof Area	0.00	0
Total Landscape Area	31.62	316,220
Total	**31.62**	**316,220**

4 Post-Development Property Statistics	**ha**	**m^2**
Communal Paved Road Area	7.19	71,870
Communal Landcape Area	2.46	24,620
Developed Lots - Roof Area (219,732*0.5)	10.99	109,865
Developed Lots - Paved Area (219,732*0.1)	2.20	21,973
Developed Lots - Landcape Area (219,732*0.4)	8.79	87,892
Total Paved Area	9.38	93,843
Total Roof Area	10.99	109,865
Total Landscape Area	11.25	112,512
Total	**31.62**	**316,220**

Pre- and Post-Development Water Balance Calculations

138 Robert Street West, Penetanguishene, 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	-	-	-	-	-
	Roof Area	-	-	-	-	-
Pervious Areas	Landscape Area	316,220	329,185	170,759	110,898	47,528
	Totals	316,220	329,185	170,759	110,898	47,528
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	93,843	97,691	9,769	-	87,922
	Roof Area	109,865	114,369	11,437	-	102,933
Pervious Areas	Landscape Area	112,512	117,125	60,756	39,458	16,911
	Totals	316,220	329,185	81,962	39,458	207,765
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	329,185	170,759	110,898	47,528
Post-Development	329,185	81,962	39,458	207,765
Change in Volume	-	- 88,796	- 71,440	160,237
Change in %	-	- 52	- 64	337

8 Requirement for Infiltration of Roof Run-off

Volume of Pre-Development Infiltration (m^3/yr)	110,898
Volume of Post-Development Infiltration (m^3/yr)	39,458
Deficit from Pre to Post Development Infiltration (m^3/yr)	71,440
Percentage of Roof Runoff required to match the pre-development infiltration (%)	69