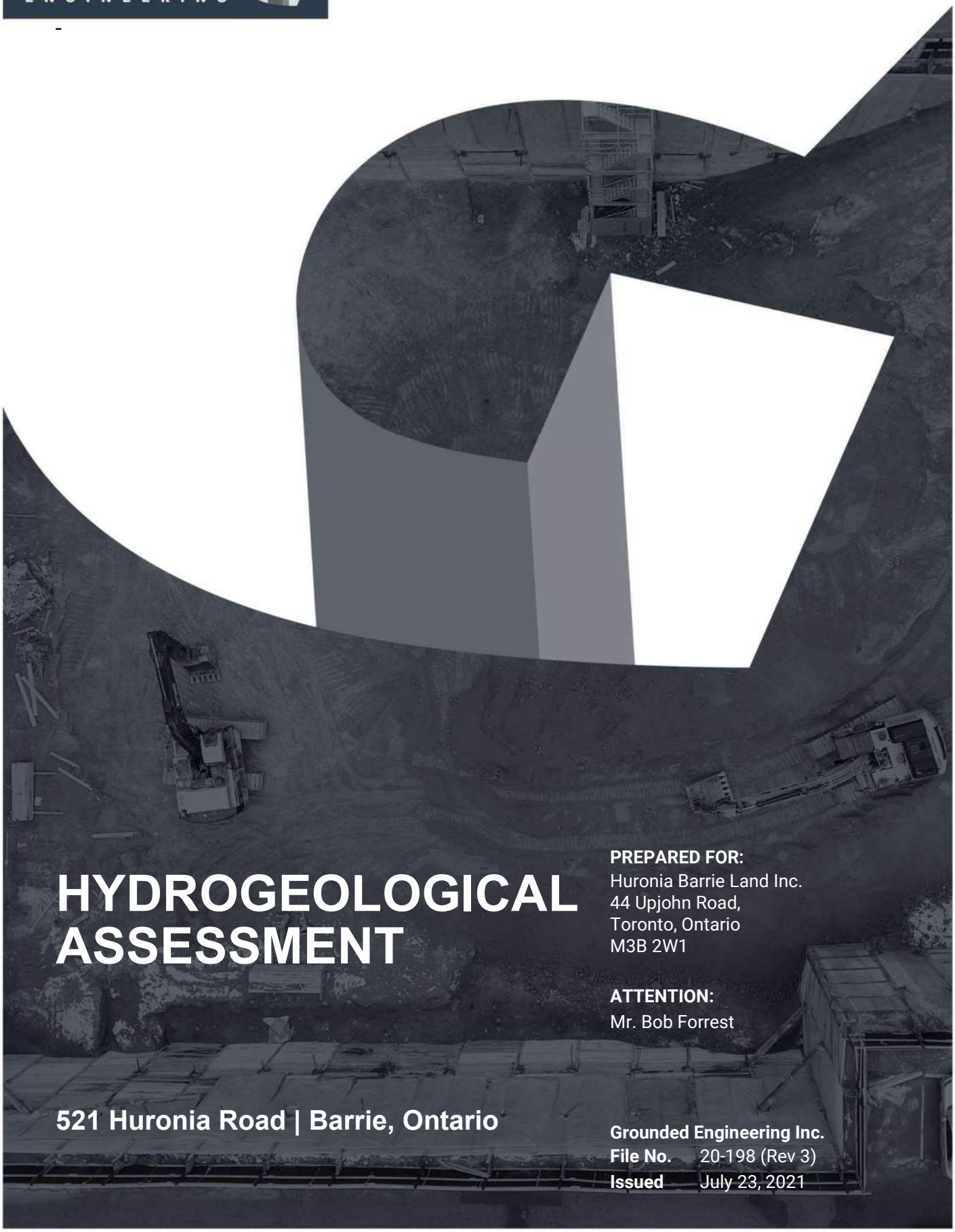
-



HYDROGEOLOGICAL ASSESSMENT

PREPARED FOR:
Huronia Barrie Land Inc.
44 Upjohn Road,
Toronto, Ontario
M3B 2W1

ATTENTION:
Mr. Bob Forrest

521 Huronia Road | Barrie, Ontario

Grounded Engineering Inc.
File No. 20-198 (Rev 3)
Issued July 23, 2021

TABLE OF CONTENTS

FIGURES

APPENDICES

1 Introduction

1.1 Background

Huronia Barrie Land Inc. retained Grounded Engineering Inc. (Grounded), to complete a Hydrogeological Assessment for the property located at the municipal address of 521 Huronia Road, Barrie, Ontario (the Property). The site location is presented in Figure 1.

It is understood that the Property will be developed with new townhouse buildings, with associated internal roads and servicing. The proposed project includes constructing new townhouse blocks (Blocks 1 through 7) consisting of a number of 3-storey townhouses, resting at-grade (i.e., no basement). Block details, including the proposed Finished Floor Elevations (FFE), are summarized below:

Block	Unit Type	Number of Units	Number of Storeys	Proposed FFE (m)
1	Townhomes	Six (6)	Three (3)	251.1 to 252.1
2	Townhomes	Five (5)	Three (3)	251.1 to 250.2
3	Townhomes	Three (3)	Three (3)	250.2 to 249.8
4	Townhomes	Four (4)	Three (3)	249.4
5	Townhomes	Eighteen (18)	Three (3)	248.4 to 247.6
6	Townhomes	Six (6)	Three (3)	248.3 to 247.7
7	Townhomes	Ten (10)	Three (3)	248.1 to 247.5

The hydrogeological assessment has been prepared for the purpose of Official Plan Amendment (OPA) and Rezoning applications as per the requirement of the Lake Simcoe Region Conservation Authority (LSRCA). A Survey Plan for the Property is provided in Appendix A. The hydrogeological assessment was undertaken to evaluate hydrogeological conditions of the proposed development on the Property and to develop a plan to manage risk of potential impacts associated with activities related to the proposed development.

1.2 Scope of Work

A summary of the scope of work is provided below:

- Background Information Review: Review of available background geologic and hydrogeological information for the Property and surrounding areas. This included a review of the Ministry of the Environment, Conservation and Parks (MECP) well records, watershed information by the Lake Simcoe Region Conservation Authority (LSRCA), and results of previous studies and subsurface investigations.

- Private Well Survey: A well survey was conducted for properties within 500 m of the Property.
- Groundwater Level Monitoring: Groundwater level monitoring was conducted in order to assess the groundwater flow conditions.
- Hydraulic Conductivity Test: In-situ hydraulic conductivity tests were conducted in select monitoring wells to assess hydraulic conductivity of the strata. The underlying soils were assessed in order to determine potential dewatering requirements.
- Infiltration Tests: In-situ infiltration tests were conducted using a Guelph Permeameter in select areas across the site to assess the infiltration/percolation rates of the strata. The underlying soils were assessed in order to determine the feasibility of Low Impact Development (LID) measures.
- Water Balance: A water balance and assessment of infiltration rates for existing (pre-development) and post development conditions was completed to determine the feasibility of the proposed development.

2 Site Information

2.1 Site Location and Description

The Property is located directly east of Huronia Road in Barrie, Ontario, bounded by residential properties and Loon Avenue to the north, vacant land to the east, and residential and agricultural properties to the south.

The Property is roughly rectangular in shape, with a total area of approximately 6.18 hectares (15 acres). The Property is currently undeveloped, consisting of woodland and wetland areas. A tributary of Lovers Creek transverses the southwestern portion of the Property in a generally northwest-southeast direction. It is understood that the Property will be developed with conventional and back-to-back townhouse buildings, with associated internal roads and servicing. The proposed project includes constructing new townhouse blocks (Blocks 1 through 7) consisting of a number of 3-storey townhouses, resting at-grade (i.e., no basement). The general site features are presented in Figures 2.

The conventional and back-to-back townhouses will be serviced with municipal piped water and sewer supply. The surrounding area is currently provided with municipal piped water and sewer supply. The surrounding properties are predominantly residential and commercial. There is however agricultural land in the south portion of the assessment area.

The Property information is provided below:

Municipal Address	521 Huronia Road, Barrie, Ontario
Area	6.18 hectares
Legal Description	Part of West Half Lot 11, Concession 12, Geographic Township of Innisfil, City of Barrie, Country of Simcoe
UTM Coordinates	17T 4911216 m N, 606612 m E
Current Land Use	Agricultural or Other (Undeveloped)
Property Owner Information	Huronia Barrie Land Inc. 44 Upjohn Road, Toronto, Ontario M3B 2W1
Person who has engaged the Qualified Person to conduct the assessment	Mr. Bob Forrest

2.2 Topography & Drainage

The Ministry of Natural Resources and Forestry (MNRF) and Ministry of Energy, Northern Development and Mines (MENDM) database were searched to obtain topographic and geological maps of Ontario for review. The maps are provided in Appendix B and the information obtained are summarized below:

Topographic Maps	The approximate elevation of the Property ranges from 245 to 254 masl and is sloping towards the south-southeast.
Hydrology	The nearest waterbody is a tributary of Lovers Creek which transverses the southwest portion of the Property. Lake Simcoe is located approximately 3 km to the northeast. Regionally, groundwater and surface water are expected to flow to the north/northeast towards Lake Simcoe. Locally, groundwater and surface water are expected flow to the east/southeast towards the tributary of Lovers Creek, which ultimately drains into Kempenfelt Bay, a western arm of Lake Simcoe.
Run-Off	It is expected that the majority of storm water run-off will follow site topography and flow to the southeast towards the onsite wetlands and Lovers Creek, which ultimately drains into Kempenfelt Bay, a western arm of Lake Simcoe.

2.3 Regional Physiography

From a regional perspective, the Property is situated within a physiographic feature known as the Till Plains characterized by ice-contact and coarse-textured glaciolacustrine deposits consisting of sand, gravel, minor silt and clay ranging to stone-poor, sandy silt to silty sand textured glacial till.

The Property is situated within the Lake Simcoe and Couchiching/Black River Source Protection Area and more specifically within the Lovers Creek Subwatershed which covers an area of approximately 59.9 km^2. The subwatershed has a total watercourse length (including all

branches) of 93.1 km which drain into Kempenfelt Bay, a western arm of Lake Simcoe located roughly 3 km north of the Property and is approximately 37.8 km^2 in size.

The watershed maps are presented in Appendix C.

2.4 Regional Geology and Soils

Based on the published information, the regional geology is described as below. The information is presented in Appendix D.

Geological Maps	Overburden: • The northwest portion of the Property is situated within ice contact stratified deposits (6), characterized by sand and gravel, minor silt, clay and till as well as in stone-poor, sandy silt to silty sand-textured till (5b). The southeastern portion of the Property is situated within coarse-textured glaciolacustrine deposits characterized by sand, gravel, minor silt and clay (9c). Bedrock: • Limestone, dolostone, shale, arkose, sandstone of the Ottawa Group; Simcoe Group; Shadow Lake Formation Depth to Bedrock: • Approximately 100 mbgs

It should be noted that the subsurface soil and rock conditions described above represent generalized conditions only and should not be considered site specific.

2.5 Regional Hydrogeology

The LSRCA has summarized the regional hydrogeologic conditions present within the Barrie Creeks Sub-watershed in the Barrie Creeks, Lovers Creek, and Hewitt's Creek Sub-Watershed Plan (LSRCA, 2012). As per LSRCA (2012), there are four (4) regionally extensive overburden confined aquifers within the sub-watershed (A1-A4). The regional stratigraphy also includes an upper confining layer, three (3) lower confining layers (C1-C3).

Based on the information, the below significant hydrostratigraphic units were defined in the vicinity of the Property.

<u>Upper Confining Layer - UC (Aquitard):</u>

The upper confining layer is comprised of coarse-grained lacustrine deposits which are part of a regionally extensive sand plain extending west from the City of Barrie to the Town of Angus.

<u>Aquifer 1 – A1 (Aquifer):</u>

The A1 Aquifer is composed of fine to medium grained sand with occasional occurrences of gravel. The A1 aquifer is commonly associated with upland areas. Detailed logging of this unit in the northwest part of the City of Barrie indicates that the A1 aquifer consists of a number of coarsening upward sequences of lacustrine sand with only minor occurrences of silt (LSRCA 2012).

Confining Layer 1 – C1 (Aquitard):

The C1 layer has been cored within the City of Barrie and is described as varved clay and silt.

Aquifer 2 – A2 (Aquifer):

The A2 aquifer is found in the elevation range of approximately 175 to 230 masl within lowland areas but the stratigraphic equivalent extends up to approximately 250 masl to the northeast, under the Oro Moraine. The A2 aquifer can generally be described as being composed of sand, with some clast rich portions. The aquifer is interpreted to extend under Kempenfelt Bay and to the north (towards Midhurst). The lower elevation of the aquifer in the vicinity of Kempenfelt Bay corresponds with the deeper channelized aquifer and suggests that it may represent in-filled former river channels in this area. The A2 aquifer ranges in thickness from approximately 10 to 30 m in most areas. It is regionally extensive but does pinch out in some areas. The aquifer is complex in the central core of Barrie, where it consists of inter-layered sand and silt/clay materials. The eastern part of the A2 aquifer is interpreted to be in direct contact with Kempenfelt Bay, based on the base elevation of the bay and the interpreted aquifer extents near its shores (LRSCA 2012).

2.6 Regional Climate

The Property is located in the climatic region of Southern Ontario known as the Simcoe and Kawartha Lakes region. The following general climate data was obtained from Lake Simcoe Climate Data for the Lovers Creek Sub-Watershed, dated April 2017 (Appendix E).

Mean annual precipitation (mm/yr.)	914 mm
Mean annual evapotranspiration	545 mm
Mean annual water surplus	369 mm

The precipitation data was based on Lake Simcoe Climate Data. It is noted that the above are average values, which are representative in a regional context. There will be seasonal and annual variations in these values. However, the average values will govern long-term groundwater recharge and discharge rates. Therefore, average values are appropriate for assessment of hydrogeologic conditions at the Property.

2.7 Groundwater Resources

Private well records from the MECP well record database was reviewed for wells located within 500 m radius of the Property. A total of seven (7) well records were retrieved from the well record database. The MECP well record is presented in Appendix F. A summary of the data obtained is presented in the following table.

Total Number of Wells	**7**
Wells completed in Overburden	7 (100%)
Bedrock	0 (0%)
Unknown	0 (0%)
Depth Ranges	
50 ft. or less	3 (43%)
51 ft. to 100 ft.	0 (0%)
101 to 200 ft.	1 (14%)
201 to 300 ft.	0 (0%)
301 to 400 ft.	2 (29%)
Unknown Depth	1 (14%)

Water Use	
Monitoring/Test Holes	2 (29%)
Commercial/Industrial	0 (0%)
Water Supply (domestic/public/livestock)	2 (29%)
Municipal (Test Hole)	2 (29%)
Unknown/Not Used/Abandoned	1 (14%)

The wells are generally used as test holes or for groundwater monitoring purposes. There were no records of wells used for domestic water supply. The well records with available construction and installation data indicate that the majority of wells in the Study Area were 50 ft deep or less or greater than 300 ft.

2.8 Private Well Survey

An initial door-to-door water well survey within 500 m of the Property was completed by others (Terraprobe Inc.) on December 9, 2019 to characterize the groundwater condition. Based on the private well survey, it was concluded that no sites within a 500 m radius of the Property were on private well water and previous private wells were not found. A follow-up inspection was completed by Grounded on September 29, 2020. The results of this inspection are as follows:

- Fire hydrants were observed along Huronia Road to the west and Loon Avenue to the north.

- Residents within residential subdivisions were using municipally supplied water as evidenced by water curb stops in lawns and driveways.
- The two (2) domestic wells identified during the MECP well record search was not located during the inspection.
- No domestic water wells were observed at the Property or within the Study Area

The Property is located in a developed area of the City of Barrie, and all properties are municipally serviced. The location of the wells identified within the MECP Well Record Search are presented on Figure 4. A cross section of the wells identified within the search are presented on Figure 6.

2.9 Subsurface Investigation

Four (4) boreholes/monitoring wells (T-BH1 to T-BH4) were advanced at the Property as part of a previous preliminary geotechnical and hydrogeological investigation completed by Terraprobe Inc. in September 2019. Five (5) additional boreholes/monitoring wells (BH101 to BH105) were advanced at the Property by Grounded in September 2020 for detailed design purposes. Borehole logs and Grain Size Analysis data are presented in Appendix G and Appendix H respectively. The locations of the boreholes are shown on Figures 2 and 3. A cross section of the boreholes are depicted in Figure 7.

Boreholes	T-BH1 to T-BH4 BH101 to BH105
Monitoring Wells	T-BH1 to T-BH4 BH101 to BH105
Well Depth (mbgs)	T-BH1 to T-BH4: • Approximately 8–12 m BH101 to BH105: • Approximately 4 m

The stratigraphy beneath the investigated areas of the Property generally consists of the following:

Topsoil	All boreholes (Boreholes T-BH1-4, 101-105) encountered a surficial layer of topsoil at grade (Elev. 245.8 to 252.0 ± m) ranging in thickness from 100 mm to 455 mm and extending to elevations of approximately 251.8 to 245.6 ± m. The topsoil consisted of organics and rootlets, was dark brown in colour, and had a strong organic odour.
Earth Fill	Earth fill was encountered in Boreholes T-BH1 and 2 underlying the topsoil at Elev. 251.6 to 251.8 ± m and extending to elevations of 250.8 to 251.2 ± m. The earth fill consisted of sand to silty sand, with trace amounts of gravel, organics and rootlets. The earth fill was typically brown and moist.

Upper Sands	All boreholes encountered an upper unit of cohesionless deposits underlying the topsoil/earth fill at depths of 0.2 to 0.9 m below grade (Elev. 244.6 to 251.2 ± m) and extended to depths varying from 0.8 to 3.0 m below grade (Elev. 243.9 to 249.0 ± m). The unit generally consisted of sand to silty sand, with trace amounts of gravel, rootlets, and organics. The deposit was typically brown to grey, and moist becoming wet with depth. Zones of gravelly sand interbedded within the deposit were noted in BH103 at Elev. 244.9 to 244.6 ± m.
Silty Clay Till	Underlying the upper cohesionless unit, all boreholes encountered a cohesive deposit of silty clay glacial till, with trace to some sand, and trace gravel. The silty clay was encountered at depths varying from 0.3 to 3.0 m below grade (Elev. 244.6 to 249.0 ± m) and extended to depths of 4.3 to 9.1 m below grade (Elev. 241.8 to 244.4 ± m). Boreholes 101 to 105 were terminated in this strata. The silty clay till ranged in colour from brownish-grey to grey. Like the overlying sand deposit, the silty clay till transitioned from moist to wet with depth.
Lower Sands	Boreholes 1 to 4 all encountered a lower cohesionless deposit described by others as a sand to sand glacial till. The lower sand unit was not encountered in Grounded's Boreholes 101 to 105. The lower sand unit was encountered at depths of 7.6 to 9.1 m below grade (Elev. 241.7 to 244.4 ± m) and extended beyond the vertical depth of investigation at 12.6 to 12.8 m below grade (Elev. 236.5 to 239.4 ± m). The lower cohesionless unit ranged in composition from sand to silty sand with trace to some clay, and trace gravel. The sand was consistently very dense, greyish-brown to grey in colour, and transitioned from moist to wet with depth.
Bedrock	Although not encountered within the boreholes, the area is underlain by bedrock of the Lindsay Formation consisting of nodular to black laminated limestone. The surface of the bedrock formation is anticipated at a depth of about 100 ± m below existing grade, based on drift thickness mapping for the area.

2.10 Groundwater Level Monitoring

Four (4) monitoring wells were installed on the Property as part of the preliminary Geotechnical and Hydrogeological investigation completed by Terraprobe Inc. in September 2019. Grounded subsequently advanced five (5) monitoring wells in September 2020 as part of this updated Hydrogeological Assessment. Groundwater level measurements were taken on various dates from September 2019 to June 2021 in all nine (9) wells as part of this and previous investigations.

Observations pertaining to the depth of the water level and caving were made in the open boreholes immediately after completion of drilling and are reported on the borehole logs. The measured water level along with other boreholes detailed are presented in Appendix G and on Figure 5. Groundwater levels are summarized in the tables found in Appendix M.

The groundwater table at the Property ranges from approximately Elev. 250 ± m in the northwest to approximately Elev. 245 ± m in the northeast side of the Property. Groundwater at the Property generally flows east/southeast towards Lovers Creek.

As shown in Appendix M, groundwater levels may be influenced by climatic variations, seasonal fluctuations and presence of underground services and structures.

For design purposes, and to account for seasonal fluctuations in the groundwater table within each of the development areas, the following **design water table elevations** should be assumed:

Block	Relevant Monitoring Wells	Design Groundwater Table (masl)
1	T-BH1, T-BH2	West Side - 250.4 East Side - 250.1
2	T-BH2, T-BH3	West Side - 250.1 East Side - 248.1
3	T-BH3, T-BH4	West Side - 248.1 East Side - 246.4
4	T-BH4	246.4
5	BH102	246.4
6	BH103, BH104, BH105	West Side - 246.5 Central – 246.1 East Side – 245.6
7	BH101	246.6

2.11 Hydraulic Conductivity

2.11.1 In Situ Permeability Test (Single Well Response Test)

In situ single well response tests (SWRT) were conducted on all nine (9) monitoring wells at the Property to assess the hydraulic conductivity of the underlying soils. The Terraprobe Inc. monitoring wells (T-BH1 to T-BH4) were installed predominantly in the Lower Sands units. The Grounded wells (BH101 to BH105) were installed within the Upper Sands and Silty Clay Till units. The tests were conducted by drawing down the water levels within each of the wells and recording the recovery over a prescribed length of time (rising head test).

Data from the SWRTs was analyzed using the Bouwer and Rice method (1976). The table below summarized the results of the hydraulic conductivity testing by Grounded and by others. The analysis graphs of the tests are presented in Appendix I.

Monitoring Well	Hydraulic Conductivity (m/s)	Infiltration Rate* (mm/hr)	Factored Infiltration Rate** (mm/hr)	Well Screen Strata
T-BH1	2.76×10^{-6}	61	24	Lower Sand Glacial Till
T-BH2	2.14×10^{-7}	31	12	Lower Sand Glacial Till
T-BH3	5.59×10^{-7}	40	16	Lower Sand Glacial Till
T-BH4	2.11×10^{-7}	31	12	Lower Sand Glacial Till

Monitoring Well	Hydraulic Conductivity (m/s)	Infiltration Rate* (mm/hr)	Factored Infiltration Rate** (mm/hr)	Well Screen Strata
BH101	1.13×10^{-7}	26	10	Silty Clay
BH102	1.41×10^{-8}	15	6	Silty Clay
BH103	2.02×10^{-6}	56	12	Upper Sands & Silty Clay
BH104	7.58×10^{-8}	23	9	Silty Clay
BH105	1.69×10^{-7}	29	6	Upper Sand & Silty Clay

*Calculated using relationship between infiltration rate and hydraulic conductivity (Figure C11) as defined in the TRCA's Stormwater Management Criteria, Appendix C: Water Balance and Recharge (August 2012)
**Calculated using Table C3: Safety correction factors for calculating design infiltration rates as defined in the TRCA's Stormwater Management Criteria, Appendix C: Water Balance and Recharge (August 2012). Hydraulic conductivity of underlying soil (silty clay till) determined from geomean of SWRTs as per below.

Based on the SWRT analysis, the geometric mean of the hydraulic conductivities for each of the strata are as follows:

- Upper Sands: 2.0×10^{-6} m/s
- Silty Clay Till: 4.9×10^{-8} m/s
- Lower Sands: 5.1×10^{-7} m/s

According to Freeze and Cherry (1979), the typical hydraulic conductivity of the strata investigated at the Property are:

- Sands to Sandy Silt: 1×10^{-5} to 1×10^{-7} m/s
- Silty Clay: 1×10^{-7} to 1×10^{-9} m/s
- Glacial Till: 1×10^{-6} to 1×10^{-12} m/s

The hydraulic conductivity field results are relatively consistent with the published values associated with the geological materials which were tested. Based on the in-situ testing, the Property is consisted of moderate to low permeability soils and is not considered to be significant in terms of groundwater recharge.

Given the approximate hydraulic conductivity of each of the strata and the resultant calculated infiltration rates (TRCA, 2012), the recommended "safety correction factor" to calculate the design infiltration rate is:

- Upper Sands → Silty Clay Till: 4.5
- Silty Clay Till → Lower Sands: 2.5

2.12 Surface Water Features

A site inspection was conducted to assess the presence of surface water features on/or bounding the Property. The inspection includes the following:

- Inspection of surface and groundwater interactions and associated features
- Inspection of areas of actual and potential groundwater discharge
- Inspection of swales and drainage courses
- Evidence of phreatophytic vegetation, which may indicate seasonally high groundwater levels and/or groundwater discharge and seepage.

The site inspection was conducted on September 28, 2020 to assess the presence of any natural environmental features. The topography across the Property is variable and notable features are summarized as follows:

- Steeply sloped ground from northwest and to south-southeast sides of Property
- Entire Property was heavily forested with walking trails throughout
- Wetland present on the south-southeast side of the Property
- Tributary of Lovers Creek transverses the southwest portion of the Property in a generally northwest-southeast direction

During the site visit, the ground surface was covered by natural vegetation including grass, trees, and shrubs. Phreatophytic vegetation (i.e. bulrushes) was also present in areas of lower elevation (south side of the Property) and zones of water ponding, especially in the wetland area located on the southern portion of the Property. Given the sloping topography of the Property, the direction of surface runoff is to the southeast.

2.13 Review of Current Regulatory Requirements

Current regulatory requirements associated with water supply and hydrogeology in connection with the proposed development were reviewed. This includes the review of the Lake Simcoe Region Conservation Authority and Lake Simcoe Protection Plan. Relevant information is provided below and presented in Appendix J.

2.13.1 Ministry of Natural Resources and Forestry

The Property is not located within the Niagara Escarpment Plan Area, Oak Ridges Moraine Plan Area, the Greenbelt Protection Act Area, and Natural Heritage Area.

The Property does however consist of a woodland and Provincially Significant Evaluated Wetland.

2.13.2 Lake Simcoe Region Conservation Authority

According to the Lake Simcoe Region Conservation Authority (LSRCA) website, the Property is located within an LSRCA regulated area as there are wetlands, watercourses, and slopes to be regulated by the Conservation Authority.

2.13.3 Wellhead Protection Areas and Aquifer Vulnerability

Wellhead Protection Area: The Property is **not** located within a Wellhead Source Protection Area.

***Intake Protection Zone*:** The Property does **not** fall within an Intake Protection Area.

***Significant Groundwater Recharge Area*:** The southwest corner of the Property(0.03 ha) falls within a Category 2 Significant Groundwater Recharge Area.

***Highly Vulnerable Aquifers*:** A portion along the east side of the Property (0.43 ha) **is** located in a highly vulnerable aquifer area.

Vulnerable Scoring Area – Groundwater: The Property is **not** located within a Vulnerable Groundwater Scoring Area.

***Vulnerable Scoring Area – Groundwater Under Direct Influence*:** The Property is **not** located within a Vulnerable Groundwater Under Direct Influence Scoring Area.

***Vulnerable Scoring Area – Surface Water*:** The entire Property falls within Vulnerable Surface Water Scoring Area, Category 4 - 7.9.

3 Discussion and Analysis

3.1 Proposed Development Plan

It is understood that the Property will be developed with new townhouse buildings, with associated internal roads and servicing. The proposed project includes constructing new townhome blocks (Blocks 1 through 7) consisting of a number of 3-storey townhomes, resting at-grade (i.e., no basement). Block details, including the proposed Finished Floor Elevation (FFE), summarized below:

Block	Unit Type	Number of Units	Number of Storeys	Proposed FFE (m)
1	Townhomes	Six (6)	Three (3)	251.1 to 252.1
2	Townhomes	Five (5)	Three (3)	251.1 to 250.2
3	Townhomes	Three (3)	Three (3)	250.2 to 249.8
4	Townhomes	Four (4)	Three (3)	249.4

Block	Unit Type	Number of Units	Number of Storeys	Proposed FFE (m)
5	Townhomes	Eighteen (18)	Three (3)	248.4 to 247.6
6	Townhomes	Six (6)	Three (3)	248.3 to 247.7
7	Townhomes	Ten (10)	Three (3)	248.1 to 247.5

The hydrogeological assessment has been prepared for the purpose of Official Plan Amendment (OPA) and Rezoning applications as per the requirement of the Lake Simcoe Region Conservation Authority. The proposed development concept plan is presented on Figure 3.

The following summarizes the proposed land coverage areas for the development. It is noted that the developable area only comprises the north portion of the Property. Analysis was completed for the developable area only. The remaining portion of the Property will remain untouched/undeveloped and is comprised of wooded wetland areas.

Land Coverage Type	Area (ha)
Building Envelope	0.2731
Hard Surface Paving	0.3750
Landscape areas for infiltration	0.4611
Total Area	**1.1092**

3.2 Summary of Hydrogeologic Conditions

Based on the review of the available site information, the hydrogeologic conditions of the Property is summarized as follows:

- The Property is characterized by surficial deposits of topsoil underlain by native cohesionless sand to silty sand deposits, overlying a cohesive silty clay glacial till deposit. Below the glacial till, boreholes observed an additional deposit of cohesionless sands and sand tills. These deposits are of moderate to low permeability and provide for low recharge capability and groundwater movement.
- Groundwater was observed at approximately 0 - 4.1 m depth (Elev. 250.4 to 245.3 masl) within the monitoring wells. The groundwater table has been observed at ground surface elevation as noted in MW103 on April 30, 2021. The general direction of groundwater flow at the Property is to the east/southeast.

- Based on the low to moderate permeability of the soils, groundwater transmission is expected to be moderate. A wetland and tributary of Lovers Creek are present on the Property.
- The Property is not located within a Wellhead Protection Area according to the Lake Simcoe Region Conservation Authority and Lake Simcoe Protection Plan.
- The entire Property falls within a Zone 3 Intake Protection Area. The southwest corner of the Property (0.03 ha) falls within a Category 2 Significant Groundwater Recharge Area and a portion along the east side of the Property (0.43 ha) **is** located in a highly vulnerable aquifer area. The entire Property falls within Vulnerable Surface Water Scoring Area, Category 4 - 7.9.
- MECP well records for wells completed in the vicinity of the Property show that there were seven (7) wells within 500 m of the Property used for test holes, monitoring, and domestic purposes. The two (2) domestic wells identified during the MECP well record search were not located during the inspection. Well records with available construction method data show that the wells were installed within 15 to 345 ft below grade.

The above hydrogeologic features and functions were considered in assessing the potential impact of the proposed development. This information was used to provide mitigating measures to ensure that hydrogeologic function is not adversely affected during the proposed development.

3.3 Infiltration Rates – Guelph Permeameter Tests

A total of five (5) Guelph Permeameter infiltration tests were completed by Grounded on September 30, 2020. The infiltration tests were completed in each of the respective potential LID areas on the Property (see Figure 3) to assess their feasibility. The results of the infiltration tests are presented in Appendix K and summarized below:

Infiltration Location	Approximate Test Depth (mbgs/masl)	Soil Type	Field Saturated K-Value (m/s)	Infiltration Rate* (mm/hr)	Factored Infiltration Rate** (mm/hr)
GP1	0.3 / 250.7	Silty Sand	8.79 x10^{-5} m/s	153	34
GP2	0.3 / 249.9	Silty Sand	2.87X10^{-6} m/s	61	14
GP3	0.6 / 245.9	Silty Sand	NA – Unsuccessful tests due to high groundwater table and saturated conditions within the native silty sand material		
GP4	0.6 / 245.5	Silty Sand			
GP5	0.6 / 245.1	Silty Sand			

*Calculated using relationship between infiltration rate and hydraulic conductivity (Figure C11) as defined in the TRCA's Stormwater Management Criteria, Appendix C: Water Balance and Recharge (August 2012)
**Calculated using Table C3: Safety correction factors for calculating design infiltration rates as defined in the TRCA's Stormwater Management Criteria, Appendix C: Water Balance and Recharge (August 2012). Hydraulic conductivity of underlying soil (silty clay till) determined from geomean of SWRTs as per below.

A high groundwater table was observed during the Guelph Permeameter Testing conducted in the southeastern area of the proposed development. The native soils were saturated below grade during the time of testing and on other inspections in dry-weather conditions. The testing in this area was therefore unsuccessful and an infiltration rate for the silty sands could not be determined. Furthermore, the infiltration rate of the underlying silty clay till also could not be tested due to these saturated conditions. The infiltration rate of the underlying strata was calculated using hydraulic conductivities from the in situ single well response tests conducted in the monitoring wells.

Based on the results of the Guelph Permeameter Testing in the northern portion and the record of the borehole logs for T-BHs 1 to 4, the strata within 1.5 m of the tested layer is the underlying silty clay glacial till. Given the approximate hydraulic conductivity of this strata (5.9×10^{-7} m/s) and the resultant infiltration rates, the recommended "safety correction factor" to calculate the design infiltration rate is 4.5 (TRCA, 2012). The mean factored infiltration rate obtained in the Guelph Permeameter tests in the northern portion of the Property was 31 mm/hr.

Note that it was observed that the northern portions appeared to have less saturated conditions. Saturation of the soils increased significantly towards the south end of each area with increased proximity to the wetlands. Infiltration testing was also attempted in the southern portions of the proposed development and was unsuccessful. If an LID is proposed in the southern portion of the Property, the grade will have to be raised to accommodate.

3.4 Water Balance Analysis

A water balance model was prepared for the Property to assess the distribution of rainfall run-off and infiltration for existing (pre- and post-development) conditions (Appendix L). The model is based on Lake Simcoe Weather Data presented in Section 2.6. The water balance for pre-and post-development conditions is summarized below. It is noted that the developable area only comprises the north portion of the Property. Analysis was completed for the developable area only. The remaining portion of the Property will remain untouched/undeveloped and is comprised of wooded wetland areas.

Pre-Development Water Balance

Pre-Development	Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-Off (m^3)
Landscaped Area	11,092	10,138	6,045	1,387	2,706

The post-development water balance accounts for hard surfaced areas created by buildings and pavements and uses the proposed land use statistic information provided by Counterpoint Engineering.

Post-Development Water Balance

Post-Development	Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-Off (m^3)
Building Envelope	2,731	2,496	-	-	2,496
Hard Surface Paving	3,750	3,428	-	-	3,428
Landscaped Area	4,611	4,214	2,513	576	1,125

Water Balance Totals

Development Phase	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-Off (m^3)
Pre-Development	10,138	6,045	1,387	2,706
Post-Development	10, 138	2,513	576	1,125

The volume of surface water run-off available from residential roof tops was calculated to be 2,496 m^3, as noted in the above table. This volume of water will be available as a resource, to maintain groundwater recharge and function. The volume of roof run-off available is compared to the difference in infiltration volume between pre-development and post-development, as noted below:

Potential Post-Development Infiltration Deficit (m^3)	Volume of Roof Run-off Available (m^3)
811	2,496

Approximately 32% of roof run-off would be required to match pre-development infiltration rates.

3.5 Groundwater Control Requirements

The conventional and back-to-back townhomes are to rest on grade with no basement level with an approximate proposed Finished Floor Elevation (FFE) as noted in the table below. The footings for the Blocks 1, 2, 5 and 7 will extend into the groundwater table at the Property. As such, it will be necessary to positively dewater the Property to a minimum of 1.2 m below proposed excavation elevation prior to excavation to preserve the integrity of the native soils during construction. The design considerations for each of the townhouse blocks is as follows:

Block	Boreholes	Approx. Area (m^2)	Borehole Elevations (masl)	Proposed Net Grade Change (m)	Proposed FFE (masl)	Proposed Footing Elev. (masl)	Design Groundwater Table Elev. (masl)	Footing Depth Below GWT (m)
1	T-BH1, T-BH2	550	252.0, 251.7	-0.6 to +0.1	252.1 to 251.1	250.6 to 249.6	West Side - 250.4 East Side - 250.1	0.2 – 0.8
2	T-BH2, T-BH3	615	251.7, 250.5	-0.6 to -0.3	251.1 to 250.2	249.6 to 248.7	West Side - 250.1 East Side - 248.1	0.5 – 1.4
3	T-BH3, T-BH4	300	250.5, 249.3	-0.3 to +0.5	250.2 to 249.8	248.7 to 248.3	West Side - 248.1 East Side - 246.4	n/a*
4	T-BH4	410	249.3	+0.5	249.4	247.9	246.4	n/a*
5	BH 102	1,820	247.2 to 245.6	+1.2 to +1.9	248.4 to 247.6	246.9 to 246.1	246.4	0.5
6	BH 103, 104, 105	615	246.6 to 245.8	+1.6 to +1.9	248.3 to 247.7	246.8 to 246.2	West Side - 246.5 Central – 246.1 East Side – 245.6	n/a*
7	BH 101	1,200	246.9 to 245.6	+1.0 to +1.9	248.1 to 247.5	246.6 to 246.0	246.6	0.6

*n/a indicates that the footings will not extend below the groundwater table.

Groundwater seepage estimates were conducted for both short-term and long-term dewatering scenarios. The modeling was conducted using an equivalent well radius approximation. The Excel-based calculation for groundwater seepage indicates the short-term (construction) and long-term (permanent) dewatering requirements as provided below.

The groundwater seepage estimates, which have been provided, represent the steady state groundwater seepage. There will be an initial drawdown of the groundwater before a steady state condition is reached. The rate of the initial drawdown, and therefore discharge, is dependent on the dewatering contractor and how the groundwater is being dealt with at the Property. An estimate initial volume of stored groundwater which will require removal before steady state is reached has been provided below.

Please note that if excavation is exposed to the elements, storm water will have to be managed. The short-term control of groundwater should consider stormwater management from rainfall events. A dewatering system should be designed to consider the removal of rainfall from excavation. A design storm of 32 mm has been used in the quantity estimates.

As required by Ontario Regulation 63/16, a plan for discharge must consider the conveyance of storm water from a 100-year storm. The additional volume that will be generated in the occurrence of a 100-year storm event (94 mm) is approximately 428,000 L.

Short Term (Construction) Groundwater Quantity – Safety Factor of 1.5 Used						
Block	**Groundwater Seepage**		**Design Rainfall Event (32 mm)**		**Total Daily Water Takings**	
	L/day	**L/min**	**L/day**	**L/min**	**L/day**	**L/min**
1	34,500	24	17,600	12.2	52,100	36
2	8,400	5.8	20,200	14	28,600	20
3	0	0	9,500	6.6	9,500	7
4	0	0	13,500	9.4	13,500	9
5	3,600	2.5	58,500	40.6	62,100	43
6	0	0	19,400	13.5	19,400	13
7	8,000	5.6	38,400	26.7	46,400	32
Total	**54,500**	**37.8**	**177,100**	**123.0**	**231,600**	**160.8**

The groundwater control system is required to be designed by a dewatering contractor. The groundwater must be dewatered prior to excavation in order to maintain a stable working base in the excavation. Mitigation measures based on dewatering and infiltration requirements as per the MECP are discussed in Section 3.6.

The long-term discharge estimates were calculated as follows.

Long Term (Permanent) Groundwater Quantity – Safety Factor of 1.5 Used						
Block	**Groundwater Seepage**		**Infiltration Design Rainfall Event (32 mm)****		**Total Daily Water Takings**	
	L/day	**L/min**	**L/day**	**L/min**	**L/day**	**L/min**
1	0	0	2,100	1.5	2,100	1.5
2	5,100	3.5	2,000	1.4	7,100	4.9
3	0	0	1,400	1.0	1,400	1.0
4	0	0	1,600	1.1	1,600	1.1
5	0	0	3,600	2.5	3,600	2.5

Long Term (Permanent) Groundwater Quantity – Safety Factor of 1.5 Used						
Block	**Groundwater Seepage**		**Infiltration Design Rainfall Event (32 mm)****		**Total Daily Water Takings**	
	L/day	**L/min**	**L/day**	**L/min**	**L/day**	**L/min**
6	0	0	2,000	1.4	2,000	1.4
7	0	0	2,900	2.0	2,900	2.0
Total	**5,100**	**3.5**	**15,600**	**10.8**	**20,700**	**14.4**
*** To be considered only if perimeter drainage is required*						

The final grading and building configurations have not been advanced to detailed design. To eliminate the requirement for long term discharge due to groundwater seepage, it is recommended that any below grade structures extending into the water table should be waterproofed. In the event that the finished floor elevations for the townhomes are less than 200 mm above final grade, perimeter drainage may be required (refer to geotechnical report) and the long-term discharge estimates will include infiltration seepage during storm events.

It is noted that permits are required to be submitted for the entire developable area not individual townhouse blocks. The summary below is based on total groundwater takings required, not the groundwater taking required for individual blocks.

Regulatory Requirements	
Environmental Activity and Sector Registry (EASR) Posting	Required
Short Term Permit to Take Water (PTTW)	Not Required
Long Term Permit to Take Water (PTTW)	Not Required

Long-term discharge into the City of Barrie's municipal sewer system is prohibited. Overland discharge of groundwater and surface water is proposed for the Property.

3.6 Assessment of Potential Impact

It is understood that the Property will be developed with conventional and back-to-back townhouse buildings, with associated internal roads and servicing. The proposed project includes constructing new townhouse blocks (Blocks 1 through 7) consisting of a number of 3-storey townhomes, resting at-grade (i.e., no basement).

The Property will be serviced with municipal piped water, storm, and sanitary sewers. The proposed nature of the development does not pose any significant concern with respect to potential impact to groundwater quality in the area.

3.6.1 Short Term Discharge (Construction Dewatering)

Groundwater takings of approximately 37.8 L/min to 160.8 L/min is possible. The flow of water from the dewatering system must be treated to meet Provincial Water Quality Standards prior to overland discharge in order to meet regulation requirements. Sampling of the discharge water from the dewatering system is required during initial discharge and on-going basis as required by the Region during active dewatering activities. Visual monitoring of the dewatering discharge should be conducted daily. Adjustment to the dewatering system should be made if an increase in turbidity or sediment is noted.

3.6.2 Long Term Discharge (Post Construction)

A permanent dewatering system would be required if the buildings will be drained structures. Groundwater takings of approximately 3.5 L/min to 14.4 L/min are possible. The flow of water from the dewatering system must be treated to meet Provincial Water Quality Standards prior to overland discharge in order to meet regulation requirements. The permanent building drainage system must be properly installed and screened to ensure sediments and fines will not be removed, which is typically a primary cause of dewatering related settlement.

If long term overland discharge is not feasible, then the buildings must be waterproofed structures.

3.6.3 Zone of Influence (ZOI)

The Zone of Influence (ZOI) was calculated based on the estimated groundwater taking rate and the average hydraulic conductivity recorded at the Property. The stratigraphy of the relevant native soil (for dewatering purposes) located at the Property generally consists of a cohesionless upper sand deposit underlain by a tight silty clay till. The ZOI calculated for each of the townhouse blocks is as follows:

Equation:

$R_0 = 3000*dH*K^{0.5}$ Where R_0 = Radius of Influence (Zone of Influence)

dH = dewatering thickness (m)

K = hydraulic conductivity (m/s)

The representative hydraulic conductivity of the soils used for the ZOI calculations varied by block as follows:

Block	Hydraulic Conductivity (m/s)
1	$2.76x10^{-6}$
2	$2.14x10^{-7}$
3	$5.59 x10^{-7}$
4	$2.11x10^{-7}$
5	$1.41x10^{-8}$
6	$2.02x10^{-6}$
7	$1.13x10^{-7}$

ZOI Calculations:

Block	Short Term		Long Term	
	dH (m)	ZOI (m)	dH (m)	ZOI (m)
1	2.0	**10.0**	1.3	**0**
2	2.6	**3.6**	0.4	**0.6**
3	0	**0**	0	**0**
4	0	**0**	0	**0**
5	1.5	**0.5**	0	**0**
6	0	**0**	0	**0**
7	1.8	**1.8**	0	**0**

The ZOI may reach up to 10± m during construction dewatering and 0.6± m in the long term if a drained structure is used. Based on these ZOI distances, there are no dewatering induced impacts on the surrounding environment and infrastructure as this radius of impact remains within the area of development and away from watercourses and wetlands.

3.6.4 Geotechnical Considerations

The Property is bound by residential properties to the north, Huronia Road to the west, vacant woodland & wetland to the east, and residential and agricultural properties to the south. The groundwater table is generally located within the Upper Sands Unit.

Changes in the groundwater table have the potential to cause settlement based on the change in effective stress. Within the zone of influence, changes in groundwater level have the potential to cause settlement base on the change in effective stresses that will result from dewatering and draining soil. Consideration should be given to implement a monitoring and mitigation program

during dewatering activities to confirm that there are not potential implications to existing structures on adjacent properties.

3.6.5 Surface Water, Wetlands and Natural Significance

A tributary of Lovers Creek and a Provincially Significant Evaluated Wetland are located on the Property. Groundwater and surface water is expected to flow towards Lovers Creek which eventually drains into Kempenfelt Bay (arm of Lake Simcoe) to the northeast.

3.6.6 Local Wells and Zone of Influence

The Property is in an area that is serviced by the City of Barrie. The conventional and back-to-back townhouses will eventually be serviced with municipal piped water and sewer supply. The surrounding area is currently provided with municipal piped water and sewer supply. The MECP well records were searched through the online Water Well Database for records located on the Property and within a 500 m radius.

Seven (7) wells were identified within the Study Area, whose uses range from test holes and monitoring wells to domestic. The domestic wells were not located during the Private Well Survey and surrounding inspection and have likely been decommissioned. Fire hydrants were present throughout the Study Area and the results of the Private Well Survey indicate that the Property and surrounding areas are supplied with water from municipal sources. Dewatering activities at the Property are unlikely to impact any of the wells identified in the Study Area.

3.6.7 Contamination Sources

The Property and immediately surrounding area currently consist mostly of residential and commercial occupants. These activities are not expected to provide an area of potential environmental concern for the Property.

3.7 Mitigation Measures to Maintain Hydrogeologic Functions

3.7.1 Maintenance of Groundwater Recharge

The existing groundwater recharge rates at the Property are approximately 125 mm/a. This recharge occurs in a broad diffuse manner over the entire Property. There are watercourses and wetlands within the boundaries of the Property. Mitigation measures are available to maintain recharge rates. As there is a surplus of water available following development, it is recommended to consider low-impact development (LID) techniques and/or other forms of groundwater control at the Property in order to maintain groundwater recharge and function across the site area.

Based on the results of the Guelph Permeameter testing, LID measures are not likely feasible due to the high groundwater table at the Property. Other forms of groundwater control will be required.

There is potential for direct surface runoff from the Property to the watercourses and wetlands. Intercepting overland flow water prior to discharging into these areas and thereby preserving groundwater recharge, groundwater flow pathways, and base flow contribution to existing watercourses must be a primary consideration.

The storm water management measures must specifically address the maintenance of groundwater recharge of the proposed development in order to preserve the tributary of Lovers Creek and wetland areas located on the Property.

3.7.2 Maintenance of Groundwater Transmission Pathways

As previously indicated, the soils present on the Property are of moderate to low permeabilities. No significant groundwater flow or transmission zones were encountered on the Property. However, the overall continuity of the groundwater flow at the Property should be maintained, where practical. Generally, the groundwater transmission pathways can be maintained through the following means:

- Bedding materials beneath underground services may serve as a subdrain to collect and convey groundwater. To prevent drainage of groundwater along bedding materials, clay trench plugs should be provided at all manhole locations in order to cut off the granular bedding.

- The excavation of any underground services or utilities across more permeable layers may interrupt the groundwater flow. It is recommended that trench backfilling be carried out with materials that are similar to the materials that have been excavated. The continuity of any sand or more permeable zones can be maintained by backfilling with the native sandy or more permeable zones as it excavated.

Groundwater flow may occur into the open shallow excavations if more permeable deposits (such as gravelly sand) are encountered. Based on the results of the subsurface investigation, active groundwater control (such as from wells or well points) is not anticipated during construction. Localized groundwater flow into shallow excavations can be controlled by utilizing localized sumps and pumps at the base of the excavations. In addition to this, it is recommended that any excavations should be staged or constructed in such a manner to avoid the collection of overland drainage.

3.8 Conclusions and Recommendations

- The Property is characterized by surficial deposits of fill material underlain by native sandy silt till deposits and a lower silty clay deposit. These deposits are of moderate to low permeability and provide for low recharge capability and groundwater movement.
- Groundwater was observed at approximately 0 - 4.1m depth (Elev. 250.4 to 245.3 masl) within the monitoring wells. The groundwater table has been observed at ground surface elevation as noted in MW103 on April 30, 2021. The general direction of groundwater flow at the Property is to the south/southeast.
- Based on the low to moderate permeability of the soils, groundwater transmission is expected to be moderate. A wetland and tributary of Lovers Creek are present on the Property.
- The Property is not located within a Wellhead Protection Area according to the Lake Simcoe Region Conservation Authority and Lake Simcoe Protection Plan.
- The entire Property falls within a Zone 3 Intake Protection Area. The southwest corner of the Property (0.03 ha) falls within a Category 2 Significant Groundwater Recharge Area and a portion along the east side of the Property (0.43 ha) **is** located in a highly vulnerable aquifer area. The entire Property falls within Vulnerable Surface Water Scoring Area, Category 4 - 7.9.
- MECP well records for wells completed in the vicinity of the Property show that there were seven (7) wells within 500 m of the Property used for test holes, monitoring, and domestic purposes. The two (2) domestic wells identified during the MECP well record search were not located during the inspection. Well records with available construction method data show that the wells were installed within 15 to 345 ft below grade.
- There will be a post-development infiltration deficit of approximately 811 m^3 for the Property.
- Based on the results of the Guelph Permeameter testing, LID measures are not likely feasible due to the high groundwater table at the Property.
- Construction or short-term groundwater control:
    - The footings for the Blocks 1, 2, 5 and 7 will extend into the groundwater table at the Property. As such, it will be necessary to positively dewater the Property to a minimum of 1.2 m below proposed excavation elevation prior to excavation to preserve the integrity of the native soils during construction.
    - Total short-term groundwater takings of approximately 2.7 L/sec (160.8L/min) are likely.
    - The flow of water from the dewatering system must be treated to meet Provincial Water Quality Standards prior to overland discharge in order to meet regulation requirements.

- An EASR and municipal discharge permits will be required prior to any discharge into the municipal sewers.

- Long-term groundwater control:
  - A permanent dewatering system would be required if the buildings will be drained structures. Total long-term groundwater takings of approximately 3.5 L/min to 14.4 L/min are likely.
  - Long-term discharge into the City of Barrie's municipal sewer system is prohibited.
  - Overland discharge of groundwater and surface water is proposed for the Property. If long term overland discharge is not feasible, then the buildings must be waterproofed structures.

3.9 Signatures

The Hydrogeological Assessment was conducted by Kim Pickett, C.E.T, LET, QP_{ESA} under the supervision of Suvish Melanta, P. Eng., QP_{ESA} and Matthew Bielaski, P.Eng., $QP_{RA\text{-}ESA}$.

We trust that this report meets your requirements at present.

For and on behalf of our team,

GROUNDED ENGINEERING

Kim Pickett. C.E.T, LET, QP_{ESA}
Senior Environmental Consultant

Mathew Bielaski, P.Eng., $QP_{RA\text{-}ESA}$
Principal

Suvish Melanta, P. Eng., QP_{ESA}
Associate

4 References

1. Armstrong, D.K. and Dodge, J.E.P. *Paleozoic Geology Map of Southern Ontario*. Ontario Geological Survey, Miscellaneous Release--Data 219.
2. Chapman, L.J. and Putnam, D.F. 2007. *The Physiography of Southern Ontario*. Ontario Geological Survey, Miscellaneous Release--Data 228.
3. Ontario Geological Survey 2010. *Surficial Geology of Southern Ontario.* Ontario Geological Survey, Miscellaneous Release--Data 128-REV. ISBN 978-1-4435-2483-7
4. Ontario Geological Survey 2006. *Bedrock Topography and Overburden Thickness Mapping, Southern Ontario.* Ontario Geological Survey, Miscellaneous Release—Data 207.
5. Lake Simcoe Region Conservation Authority 2017. *Lake Simcoe Climate Data: A Reference Document to Support the Completion of Water Balance Assessments*
6. Lake Simcoe Region Conservation Authority 2010. *The Barrie Creeks, Lovers Creek, and Hewitt's Creek Subwatershed Management Plan*
7. Ministry of Environment, Conservation and Parks (MECP). *Water Well Information System, Data Catalogue*. Retrieved from: https://data.ontario.ca/dataset/well-records
8. Ministry of Environment, Conservation and Parks (MECP). *Source Protection Information Atlas.* Retrieved from: https://www.gisapplication.lrc.gov.on.ca/SourceWaterProtection/Index.html?viewer=SourceWaterProtection.SWPViewer&locale=en-US
9. Lake Simcoe Region Conservation Authority. *Regulated Areas Map*. Retrieved from: https://maps.lsrca.on.ca/EH5Viewer/index.html?viewer=LSRCARegulations
10. Terraprobe Inc. *Hydrogeological Investigation 521 Huronia Road, Barrie, Ontario.* File No: 3-19-0101-46, February 14, 2020
11. Grounded Engineering, Geotechnical Engineering Report, 521 Huronia Road, Barrie, Ontario, File No. 20-198, January 27, 2021
12. Counterpoint Engineering, "Conceptual Grad Plan, 521 Huronia Road, Barrie"; Project No 19082, Figure 8, dated June 2021.
13. We Merchandise Space Inc. and Forrest Group Inc., "Concept Site Plan v3.3, Proposed Townhome Community 521 Huronia Road, Barrie, ON"; Project No 5214, Rev 12 dated June 29, 2021.
14. Terraprobe Inc., "Preliminary Geotechnical Investigation, Proposed Townhome Community, 521 Huronia Road, Barrie, Ontario"; File No 3-19-0101-02, dated March 2, 2020.
15. Rudy Mark Surveying Ltd., "Topographic Survey Plan of West Half Lot Concession 12, City of Barrie"; File No 13963, dated November 26, 2019.

5 Limitations and Restrictions

The assessment should not be considered a comprehensive investigation that eliminates all risks of encountering environmental problems. The information presented in this report is based on information collected during the completion of the Hydrogeological Assessment by Grounded Engineering Inc. It was based on the conditions on the Hydrogeological Assessment at the time of the site inspection supplemented by a review of historical information to assess the environmental conditions regarding the Property.

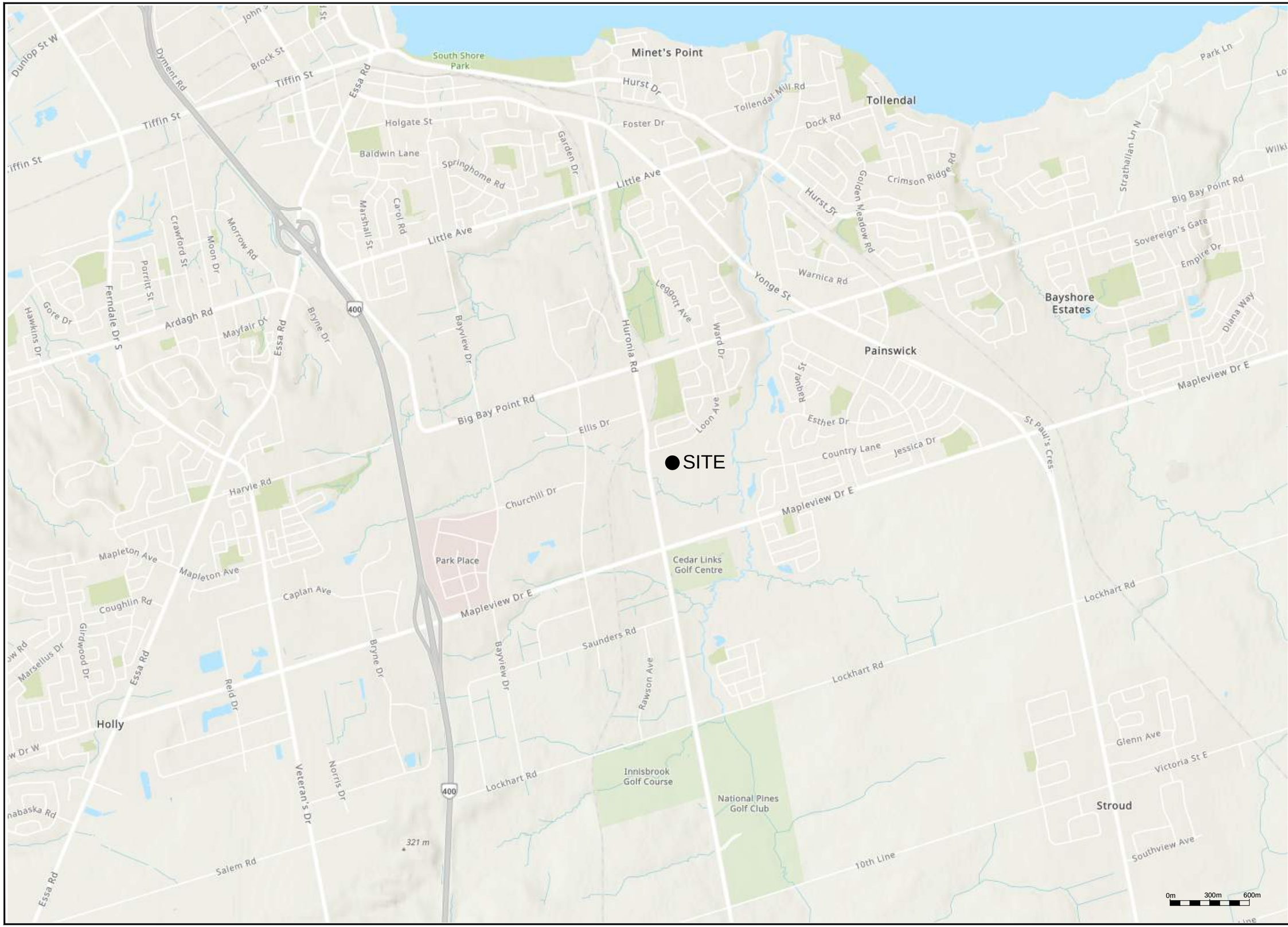
There is no warranty expressed or implied by this report regarding the hydrogeologic conditions of the Property. Professional judgement was exercised in gathering and analysing information collected by our staff, as well as that submitted by others. The conclusions presented are the product of professional care and competence and cannot be construed as an absolute guarantee.

If new information regarding the hydrogeological condition of the Property is identified during future work, or outstanding responses from regulatory agencies indicate outstanding issues on file with respect to the Property, Grounded Engineering Inc. should be notified so that we may re-evaluate the findings of this assessment and provide amendments.

5.1 Report Use

The authorized users of this report are Huronia Barrie Land Inc., for whom this report has been prepared. Grounded Engineering Inc. maintains the copyright and ownership of this document. Reproduction of this report in any format or medium requires explicit prior authorization from Grounded Engineering Inc.

FIGURES



GROUNDED ENGINEERING
12 Banigan Drive, Toronto, Ont., M4H 1E9
www.groundedeng.ca

LEGEND

● APPROXIMATE SITE LOCATION

Note

Reference
ArcGIS Streets Online
http://www.arcgis.com/home/webmap/viewer.html?webmap=55ebf90799fa4a3fa57562700a68c405

Project
HYDROGEOLOGICAL ASSESSMENT
521 HURONIA ROAD, BARRIE, ONTARIO

Figure Title
SITE LOCATION PLAN

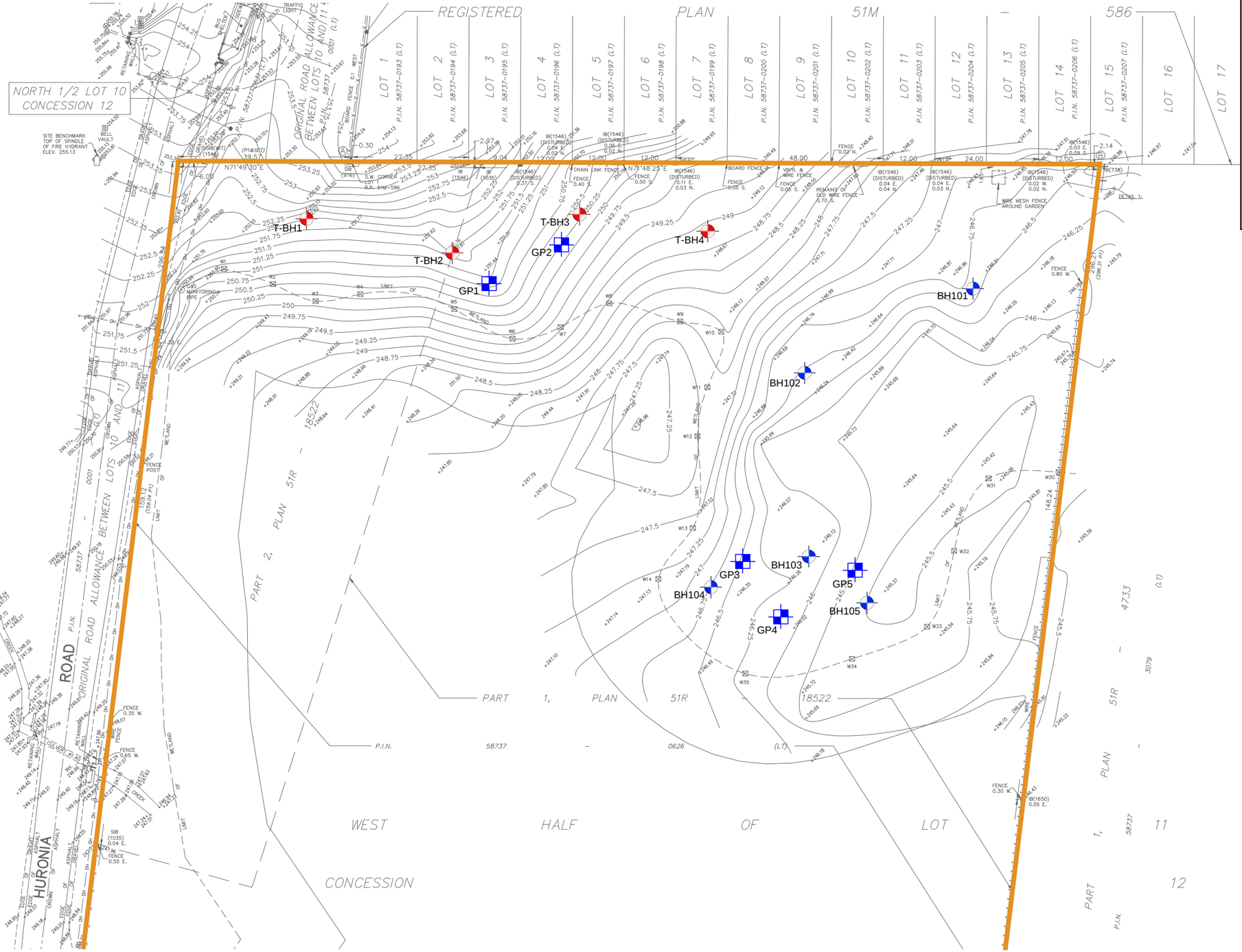
North
TRUE
PROJECT

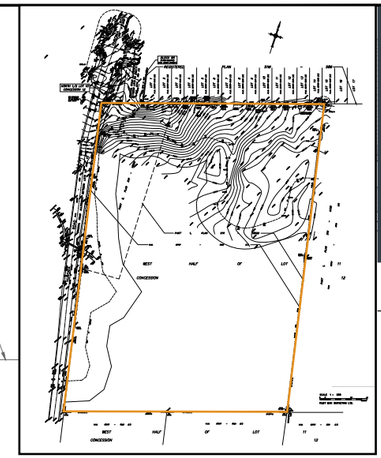
Date
OCTOBER 2020

Scale
AS INDICATED

Job No
20-198

Figure No
FIGURE 1





GROUNDED ENGINEERING

12 Banigan Drive, Toronto, Ont., M4H 1E9
www.groundedeng.ca

LEGEND

- APPROXIMATE PROPERTY BOUNDARY
- TERRAPROBE INC. BOREHOLE/MONITORING WELL LOCATION (2019)
- GROUNDED ENGINEERING BOREHOLE/MONITORING WELL LOCATION (2020)
- GUELPH PERMEAMETER INFILTRATION TEST

Note
Must be printed in colour

Reference
Topographic Survey Plan of West Half Lot Concession 12, City of Barrie, File No: 13963, Rudy Mak Surveying Ltd., November 26, 2019

Project
HYDROGEOLOGICAL ASSESSMENT

521 HURONIA ROAD, BARRIE, ONTARIO

Figure Title
BOREHOLE/MONITORING WELL LOCATION PLAN - EXISTING CONDITIONS

North
TRUE
PROJECT

Date
OCTOBER 2020

Scale
AS INDICATED

Job No
20-198

Figure No
FIGURE 2

ion 3.3
NCEPT SITE PLAN
IE (521 HURONIA RD.)
HURONIA BARRIE LAND INC.
21/06/29

0 25m 50m

GROUNDED ENGINEERING

12 Banigan Drive, Toronto, Ont., M4H 1E9
www.groundedeng.ca

LEGEND

- APPROXIMATE PROPERTY BOUNDARY
- TERRAPROBE INC. BOREHOLE/MONITORING WELL LOCATION (2019)
- GROUNDED ENGINEERING BOREHOLE/MONITORING WELL LOCATION (2020)
- GUELPH PERMEAMETER INFILTRATION TEST

Note

Proposed Development Planes with Finished Floor Elevations (FFE) and Conceptual Grading Plan.

Reference

Conceptual Grading Plan, 521 Huronia Road, Barrie, Project No: 19082, Figure 8, Counterpoint Engineering, June 2021

Project

521 HURONIA ROAD, BARRIE, ONTARIO

Figure Title

BOREHOLE LOCATION PLAN (PROPOSED DEVELOPMENT)

North

TRUE
PROJECT

Date

JULY 2021

Scale

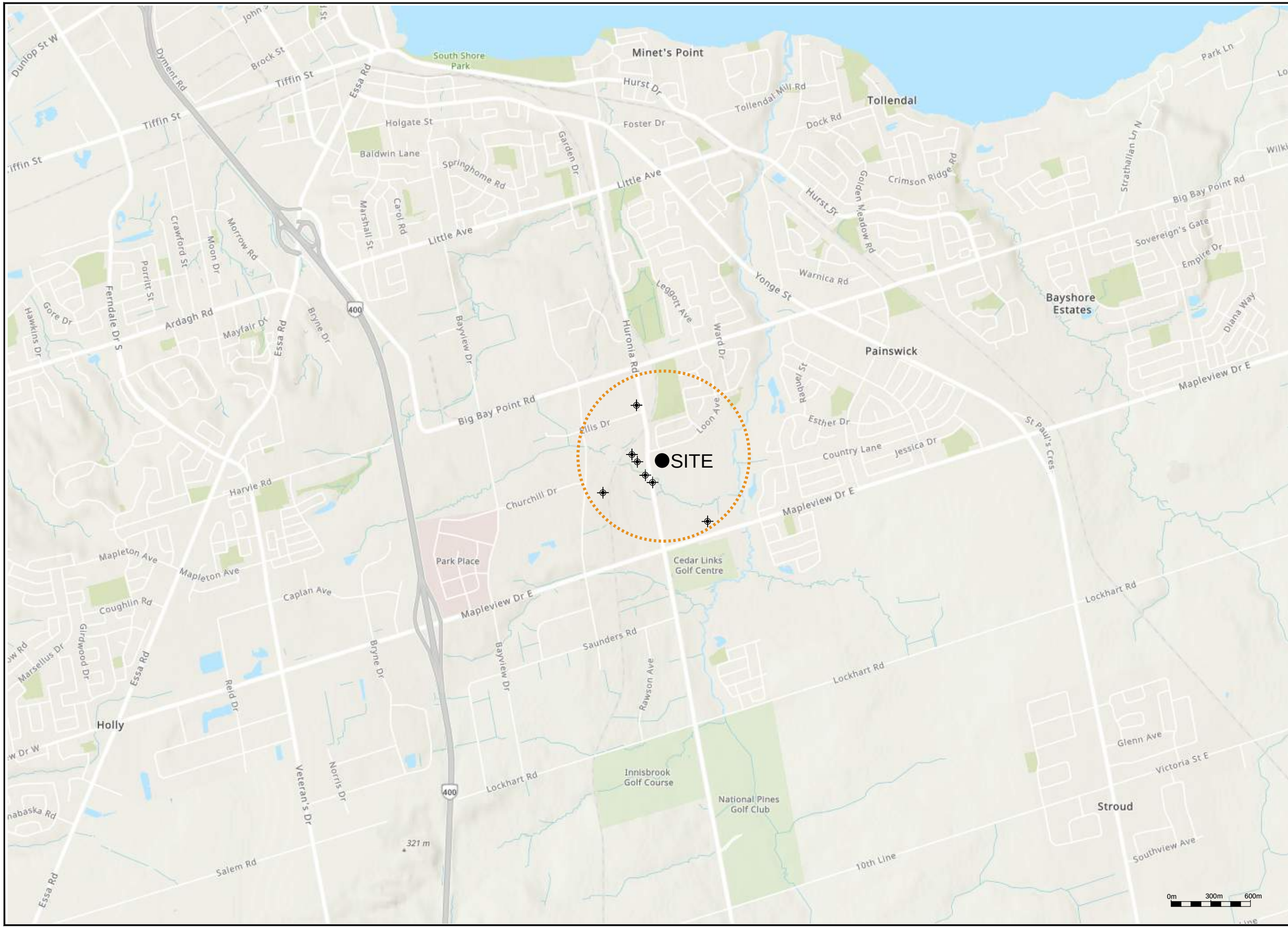
AS INDICATED

Job No

20-198

Figure No

FIGURE 3



GROUNDED ENGINEERING

12 Banigan Drive, Toronto, Ont., M4H 1E9
www.groundedeng.ca

LEGEND

- APPROXIMATE SITE LOCATION
- APPROXIMATE MECP WELL LOCATION (500 m RADIUS)

Note

Reference
ArcGIS Streets Online
http://www.arcgis.com/home/webmap/viewer.html?webmap=55ebf90799fa4a3fa57562700a68c405

Project
HYDROGEOLOGICAL ASSESSMENT

521 HURONIA ROAD, BARRIE, ONTARIO

Figure Title
MECP WELL LOCATION PLAN

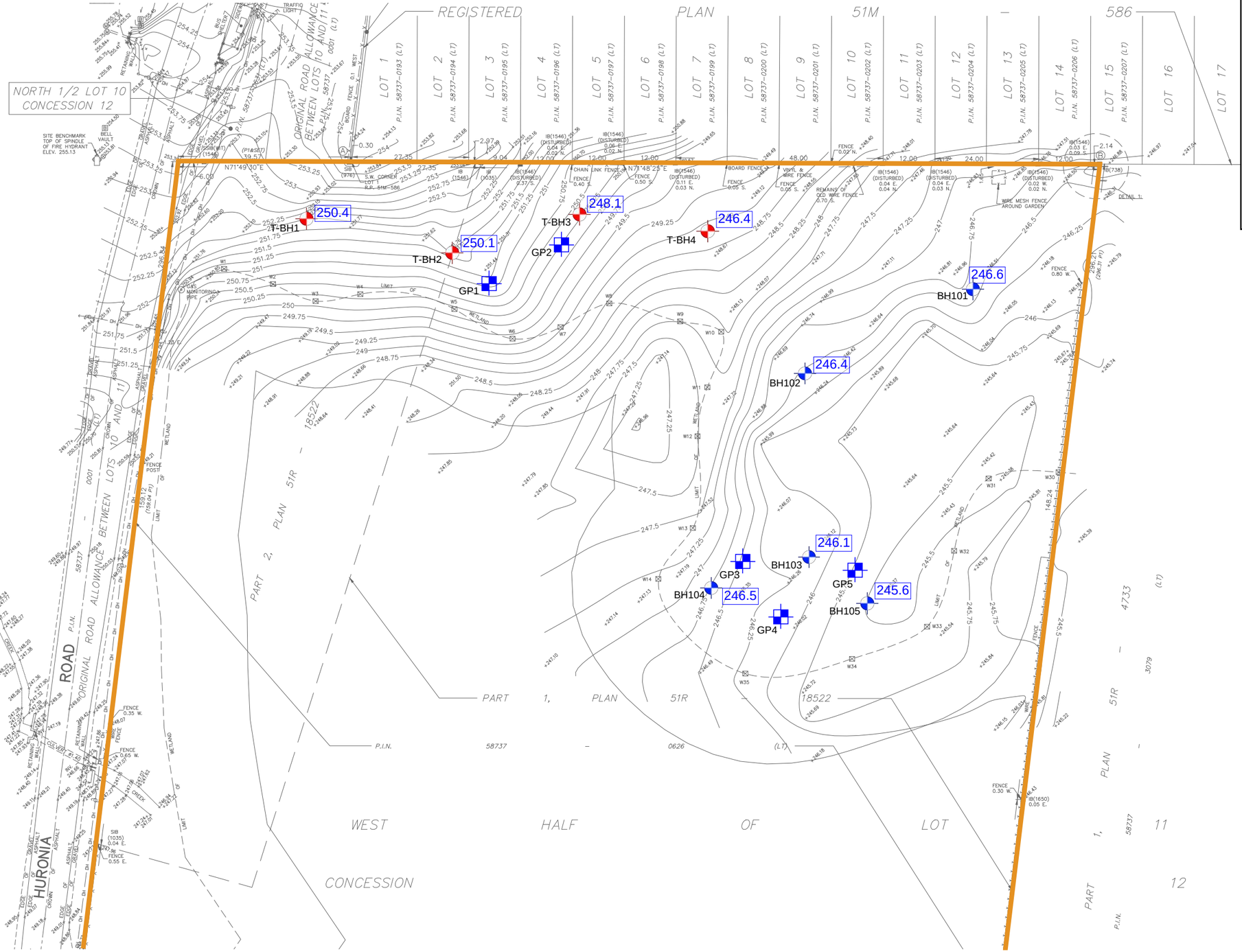
North
TRUE
PROJECT

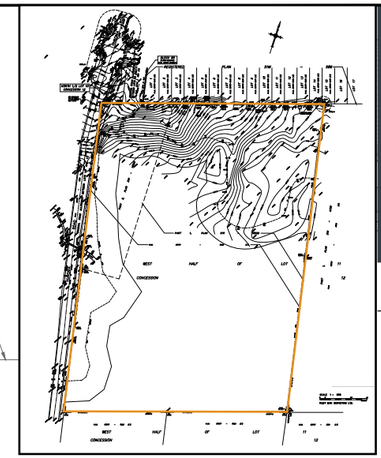
Date
OCTOBER 2020

Scale
AS INDICATED

Job No
20-198

Figure No
FIGURE 4





SCALE 1 : 500

5 0 25 40 metres

RUDY MAK SURVEYING LTD.

GROUNDED ENGINEERING

12 Banigan Drive, Toronto, Ont., M4H 1E9
www.groundedeng.ca

LEGEND

- APPROXIMATE PROPERTY BOUNDARY
- TERRAPROBE INC. BOREHOLE/MONITORING WELL LOCATION (2019)
- GROUNDED ENGINEERING BOREHOLE/MONITORING WELL LOCATION (2020)
- GUELPH PERMEAMETER INFILTRATION TEST
- 245.9 MAXIMUM GROUNDWATER ELEVATIONS
- GROUNDWATER FLOW DIRECTION

Note
Must be printed in colour

Reference
Topographic Survey Plan of West Half Lot Concession 12, City of Barrie, File No: 13963, Rudy Mak Surveying Ltd., November 26, 2019

Project

HYDROGEOLOGICAL ASSESSMENT

521 HURONIA ROAD, BARRIE, ONTARIO

Figure Title

MAXIMUM GROUNDATER ELEVATIONS

North

TRUE

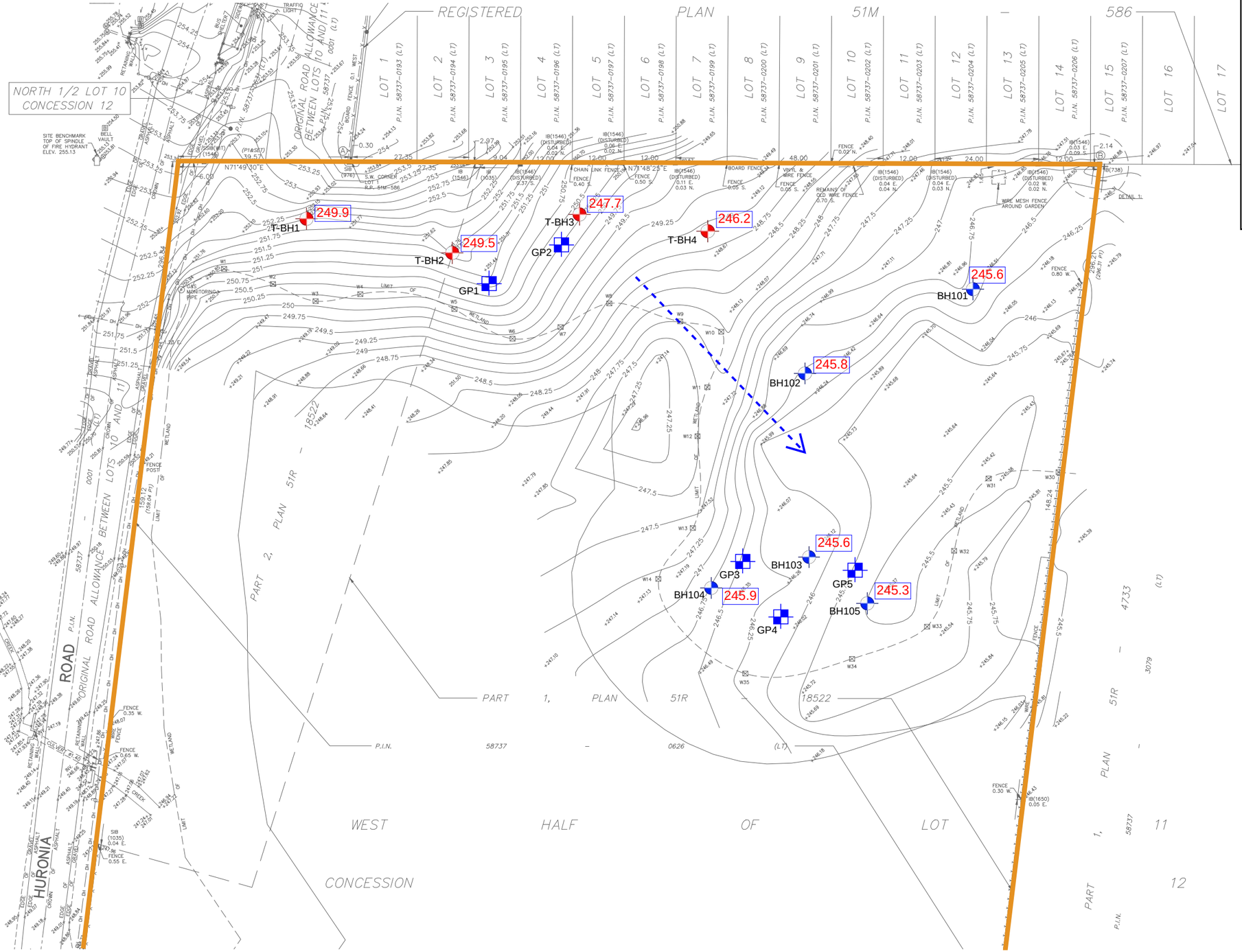
PROJECT

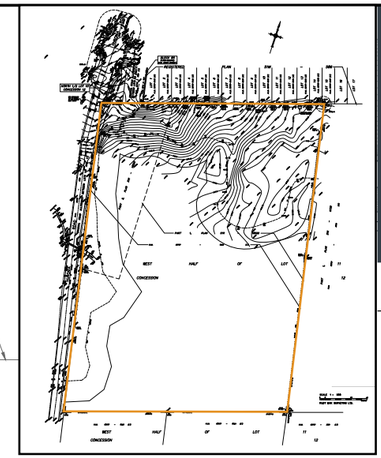
Date
June 2021

Scale
AS INDICATED

Job No
20-198-206

Figure No
FIGURE 5a





SCALE 1 : 500

5 0 25 40 metres

RUDY MAK SURVEYING LTD.

GROUNDED ENGINEERING

12 Banigan Drive, Toronto, Ont., M4H 1E9
www.groundedeng.ca

LEGEND

- APPROXIMATE PROPERTY BOUNDARY
- TERRAPROBE INC. BOREHOLE/MONITORING WELL LOCATION (2019)
- GROUNDED ENGINEERING BOREHOLE/MONITORING WELL LOCATION (2020)
- GUELPH PERMEAMETER INFILTRATION TEST
- 245.9 GROUNDWATER ELEVATION (MASL) - June 2021
- GROUNDWATER FLOW DIRECTION

Note
Must be printed in colour

Reference
Topographic Survey Plan of West Half Lot Concession 12, City of Barrie, File No: 13963, Rudy Mak Surveying Ltd., November 26, 2019

Project
HYDROGEOLOGICAL ASSESSMENT
521 HURONIA ROAD, BARRIE, ONTARIO

Figure Title
GROUNDATER ELEVATIONS AND FLOW DIRECTION

North
TRUE
PROJECT

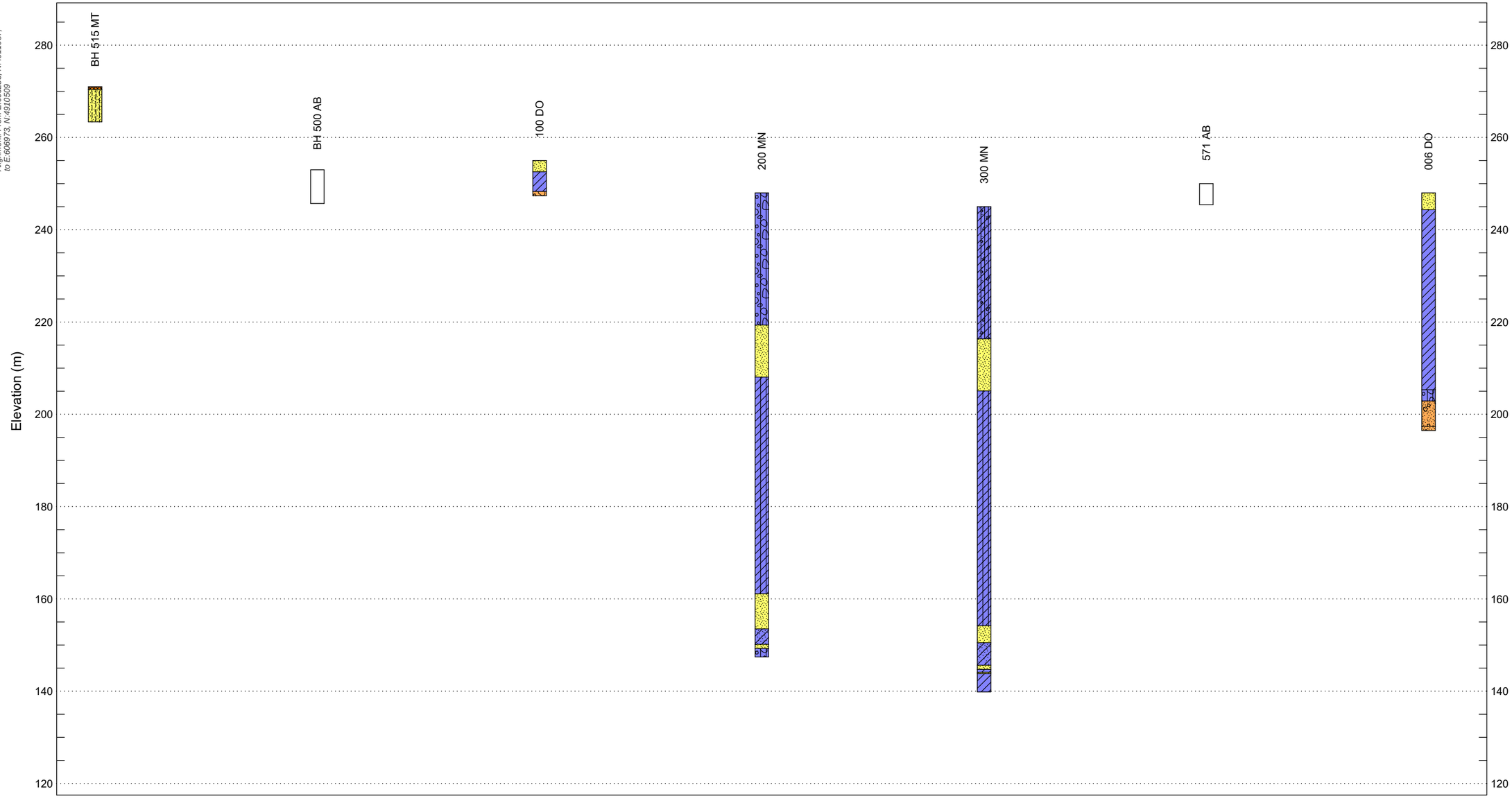
Date
June 2021

Scale
AS INDICATED

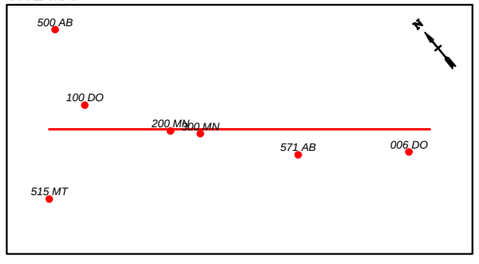
Job No
20-198-206

Figure No
FIGURE 5b

Alignment: From E:606283, N:4911087, to E:606973, N:4910509



SITE MAP



LITHOLOGY GRAPHIC LEGEND

- Sand
- Gravelly Sand
- Sandy Gravel and Clay and Silt
- Clay
- Gravel
- Blank
- Clay and Gravel
- Clay and Silt
- Fill
- Gravelly Sand Till
- Sandy Clay
- Silty Sand

Boreholes Equally Spaced

GROUNDED ENGINEERING

12 Banigan Drive, Toronto, Ont., M4H 1E9
www.groundedeng.ca

LEGEND

- FILL
- GRAVELS (gravel to gravelly sand)
- SILT TO SAND (not till)
- COHESIONLESS TILLS
- COHESIVE SOILS (clayey silt to clay, incl. tills)
- DISTURBED/REWORKED SOILS

- water level, unstabilized
- water level, stabilized

Reference

Terraprobe Inc. Hydrogeological Investigation 521 Huronia Road, Barrie, Ontario, Figure 4. File No: 3-19-0101-46. February 14, 2020

Project

HYDROGEOLOGICAL ASSESSMENT

521 HURONIA ROAD, BARRIE, ONTARIO

Figure Title

MECP WELL RECORD CROSS-SECTION A-A'

North

Date

OCTOBER 2020

Scale

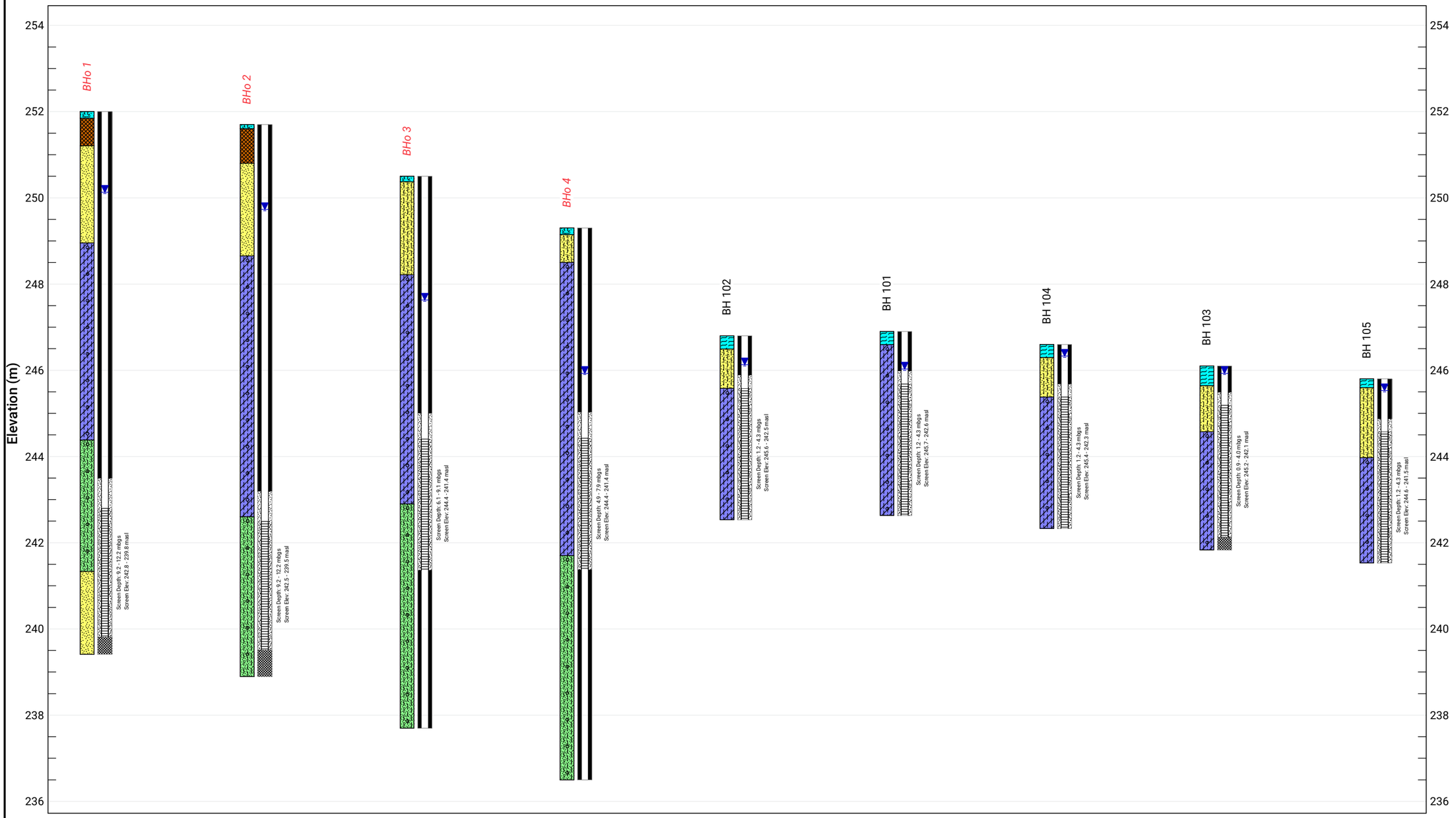
AS INDICATED

Job No

20-198

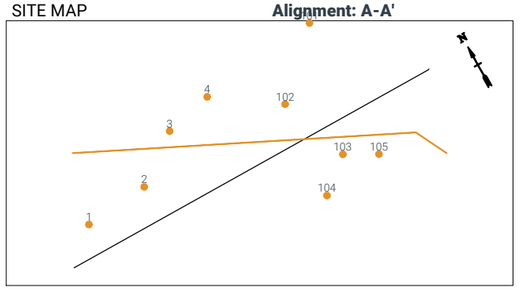
Figure No

FIGURE 6



SITE MAP

Alignment: A-A'



Boreholes Equally Spaced

LITHOLOGY GRAPHIC LEGEND

- Topsoil
- Fill
- Sand
- Silty Clay Till
- Silty Sand Till
- Silty Sand
- Organics/Topsoil

GROUNDED ENGINEERING
12 Banigan Drive, Toronto, Ont., M4H 1E9
www.groundedeng.ca

LEGEND

- FILL
- GRAVELS (gravel to gravelly sand)
- SILT TO SAND (not till)
- COHESIONLESS TILLS
- COHESIVE SOILS (clayey silt to clay, incl. tills)
- DISTURBED/REWORKED SOILS

- water level, unstabilized
- water level, stabilized

Project

HYDROGEOLOGICAL ASSESSMENT

521 HURONIA ROAD, BARRIE, ONTARIO

Figure Title

SUBSURFACE CROSS-SECTION

A-A'

Date

OCTOBER 2020

Scale

AS INDICATED

Job No

20-198

Figure No

FIGURE 7

APPENDIX A

TOPOGRAPHIC SURVEY OF

PART OF WEST HALF LOT 11
CONCESSION 12

GEOGRAPHIC TOWNSHIP OF INNISFIL

CITY OF BARRIE

COUNTY OF SIMCOE

SCALE 1 : 500

5 0 25 40 metres

RUDY MAK SURVEYING LTD.

DISTANCES

DISTANCES ARE GROUND AND CAN BE CONVERTED TO GRID BY MULTIPLYING BY THE COMBINED SCALE FACTOR OF 0.999706.

SPECIFIED CONTROL POINTS (SCPs): UTM ZONE 17, NAD 83 (ORIGINAL) COORDINATES TO URBAN ACCURACY PER SEC. 14 (2) OF O.REG. 216/10

POINT ID	NORTHING	EASTING
SCP 03120080004	4911722.231	606715.768
SCP 00119713848	4911611.018	606450.422
SCP 03120080054	4910878.123	607601.063
ORP A	4911278.504	606540.552
ORP B	4911332.744	606705.621

COORDINATES CANNOT, IN THEMSELVES, BE USED TO RE-ESTABLISH CORNERS OR BOUNDARIES SHOWN ON THE PLAN.

ELEVATION

ELEVATION ARE GEODETIC IN ORIGIN AND WERE DERIVED FROM OBSERVED REFERENCE POINTS (ORP) USING THE PRECISE POINT POSITIONING (PPP) SERVICE (2010 EPOCH) AND ARE REFERRED TO THE CGVD-1928:1978 DATUM.

BENCHMARK

SITE BENCHMARK IS THE TOP OF SPINDLE OF THE FIRE HYDRANT AT THE WEST SIDE OF HURONIA ROAD HAVING AN ELEVATION OF 255.13.

BEARING NOTE

BEARINGS ARE UTM GRID, DERIVED FROM SPECIFIED CONTROL POINTS 03120080004, 00119713848 AND 03120080054, UTM ZONE 17, NAD 83 (ORIGINAL).

FOR BEARING COMPARISONS, A ROTATION OF 00°46'35" COUNTER-CLOCKWISE WAS APPLIED TO BEARINGS ON PLAN 51R-18522.

NOTES:

THIS TOPOGRAPHIC SURVEY PLAN DELINEATES THE FEATURES AS SHOWN AND VISIBLE, GIVEN THE SITE CONDITIONS. CONSTRUCTION ACTIVITY, FROZEN GROUND, SNOW COVER, ETC. MAY HAVE HIDDEN FEATURES OTHERWISE VISIBLE. THE LOCATION OF UNDERGROUND SERVICES, IF SHOWN, WAS DERIVED FROM PLANS OBTAINED FROM OTHER AGENCIES. RUDY MAK SURVEYING CANNOT BE HELD RESPONSIBLE FOR THE LOCATION AND ACCURACY OF UNDERGROUND SERVICES. THE LOCATION OF ALL SERVICES MUST BE VERIFIED ON SITE. ONLY A SIGNED AND SEALED PAPER COPY OF THIS SURVEY IS AN ORIGINAL COPY. NO DIGITAL VERSION OF THIS PLAN IS TO BE CONSIDERED "ORIGINAL" AND MAY HAVE BEEN ALTERED BY OTHERS.

LEGEND

■	DENOTES FOUND SURVEY MONUMENT
□	DENOTES PLANTED SURVEY MONUMENT
SIB	DENOTES STANDARD IRON BAR
IB	DENOTES IRON BAR
-x-x-	DENOTES CHAIN LINK FENCE
(738)	DENOTES R.C. KIRKPATRICK, O.L.S.
(976)	DENOTES C.W.A. JONES, O.L.S.
(1035)	DENOTES R. WELSMAN, O.L.S.
(1546)	DENOTES RUDY MAK SURVEYING LTD.
(1650)	DENOTES DINO ASTRI, O.L.S.
(P1)	DENOTES PLAN 51R-18522
⊗	DENOTES MANHOLE
⊗	DENOTES WATER VALVE
▥	DENOTES BELL BOX
☼	DENOTES LIGHT STANDARD
○—	DENOTES UTILITY POLE
⟶	DENOTES GUY WIRE
	DENOTES OVERHEAD WIRES
	DENOTES FIRE HYDRANT
	DENOTES BOREHOLE

METRIC

DISTANCES AND COORDINATES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048.

REVISION	BY	DATE
FIRST ISSUE	HFD	OCT. 18/19
ADDED WETLAND BOUNDARY ALONG THE WEST LIMIT OF THE PROPERTY	HFD	NOV. 26/19

RUDY MAK SURVEYING LTD.
ONTARIO LAND SURVEYORS

89 BIG BAY POINT ROAD
BARRIE, ONTARIO L4N 8M5 (705) 722-3845
E-MAIL MAIL@MAKSURVEYING.COM

DRAWN BY: HFD | CHECK BY: | FILE No. 13963

APPENDIX B

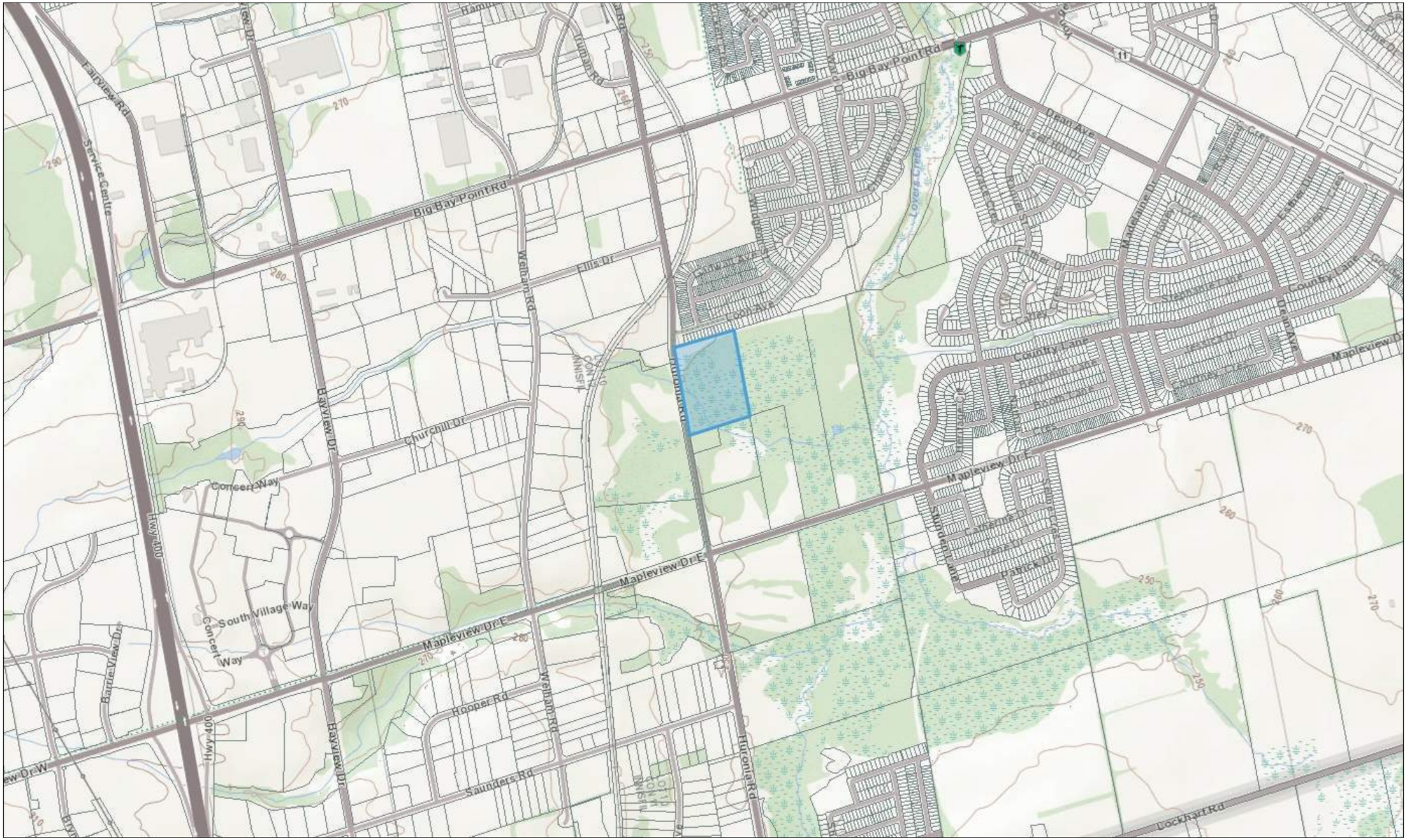
Ontario

MINISTRY OF NATURAL RESOURCES AND FORESTRY

Make a Topographic Map

Topographic Map

Notes: 521 Huronia Road, Barrie



Legend

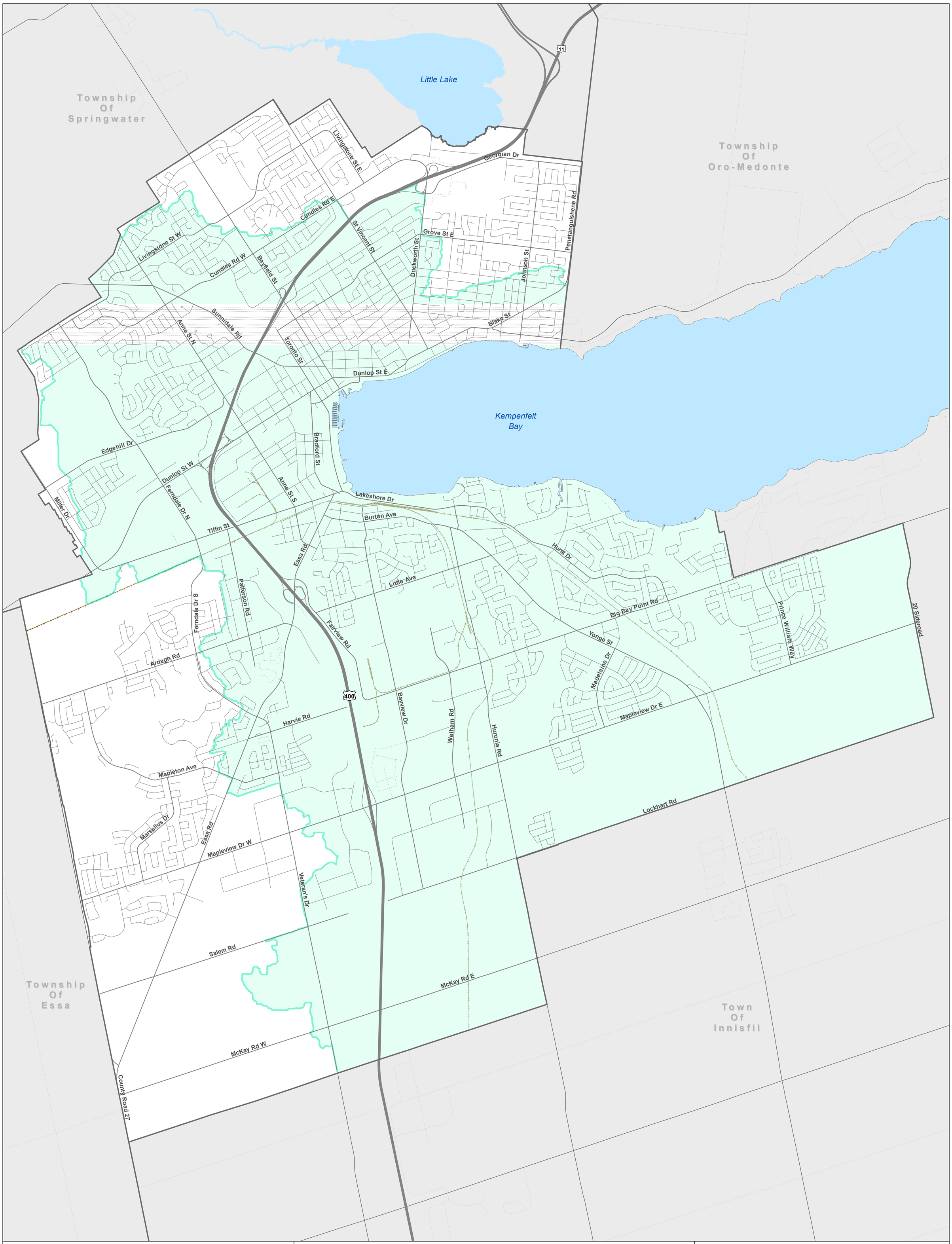
- Building as Symbol
- Building to Scale
- Airport
- Heliport \ Hospital Heliport
- Seaplane Base
- Ferry Route
- Trail Head \ Trail
- Railway \ Train Station
- Railway with Bridge
- Railway with Tunnel
- Road (Major → Minor)
- Winter Road
- Road with Bridge
- Road with Tunnel
- Primary, Kings or 400 Series Highway
- Secondary Highway
- Tertiary Highway
- District, County, Regional or Municipal Road
- Toll Highway
- One Way Road
- Road with Permanent Blocked Passage
- Road with Address Ranges
- Hydro Line, Communication Line or Unknown Transmission Line
- Natural Gas Pipeline, Water Pipeline or Unknown Pipeline
- Spot Height
- Index Contour
- Contour
- Wooded Area
- Wetland
- Waterbody
- Waterbody Elevation
- Watercourse
- Falls
- Rapids
- Rapids \ Falls
- Rapids
- Rocks
- Lock Gate
- Dam \ Hydro Wall
- Dam \ Hydro Wall
- Provincial \ State Boundary
- International Boundary
- Upper Tier \ District Municipal Boundary
- Lower Tier \ Single Tier Municipal Boundary
- Lot Line
- Indian Reserve
- Provincial Park
- National Park
- Conservation Reserve
- Military Lands

0 0.7 km

Projection: Web Mercator

N

APPENDIX C



OFFICIAL PLAN

Schedule J
Lake Simcoe Watershed

Office Consolidation
January 2018

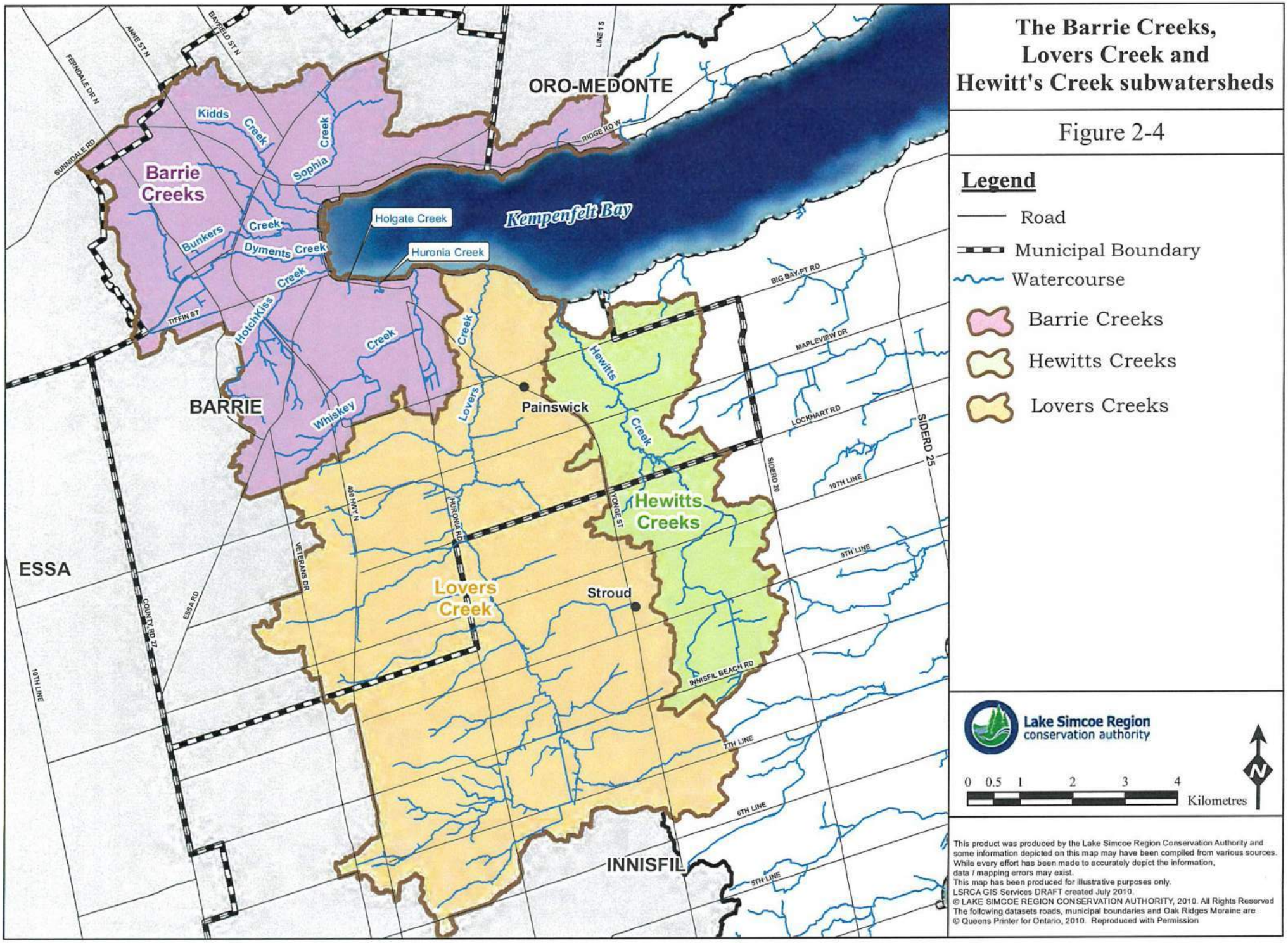
Lake Simcoe Watershed Boundary

1:20,000

0 0.5 1 2 km

N

GIS Branch 4/26/2018



The Barrie Creeks, Lovers Creek and Hewitt's Creek subwatersheds

Figure 2-4

Legend

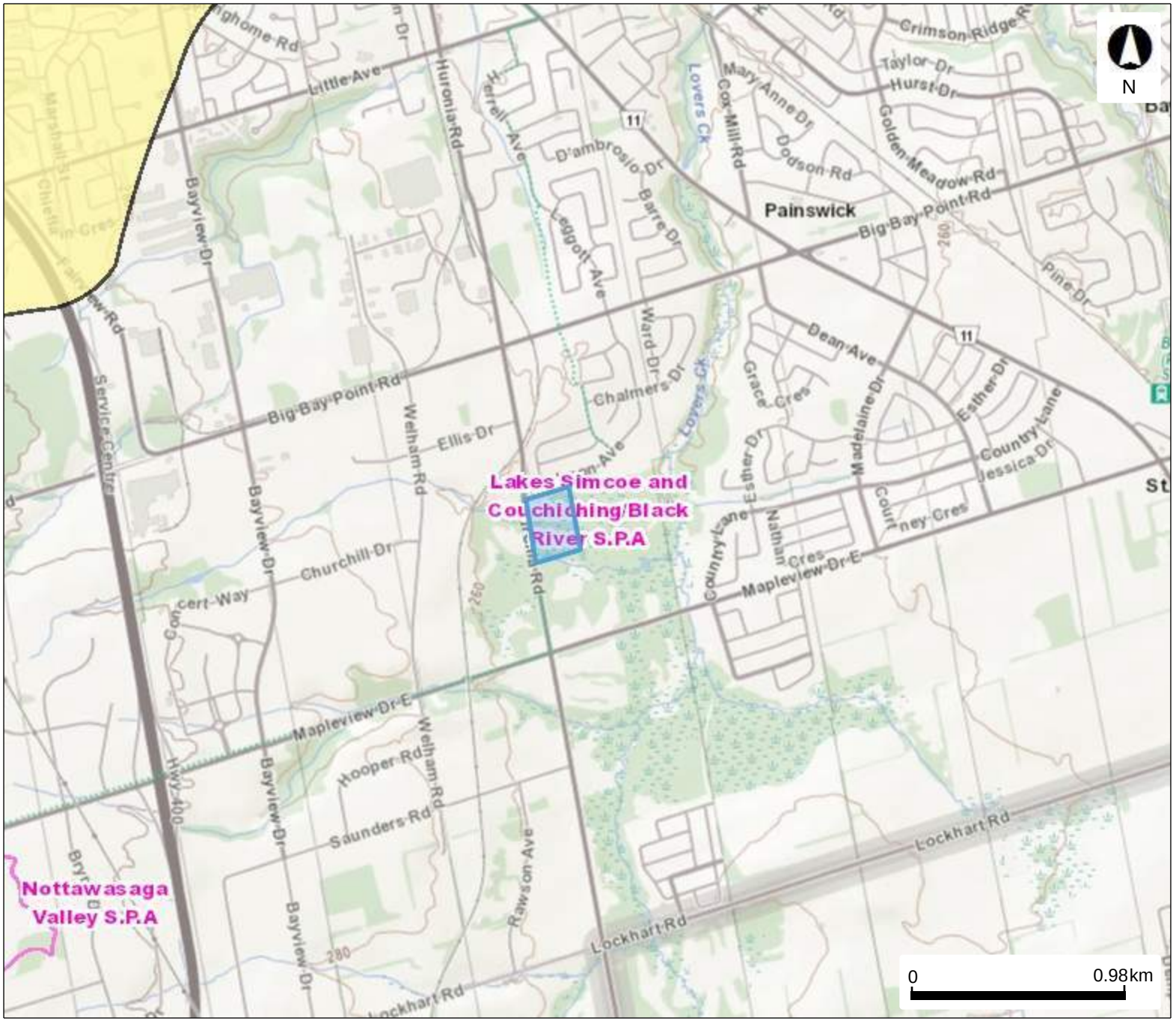
- Road
- Municipal Boundary
- Watercourse
- Barrie Creeks
- Hewitts Creeks
- Lovers Creeks

Lake Simcoe Region conservation authority

0 0.5 1 2 3 4 Kilometres

N

Source Water Protection Map



Legend

- Source Protection Areas
- WHPA Groundwater Under Direct Influence (WHPA-E)
- Wellhead Protection Area
  - A
  - B
  - C
  - C1
  - D
  - F
- Event Based Areas

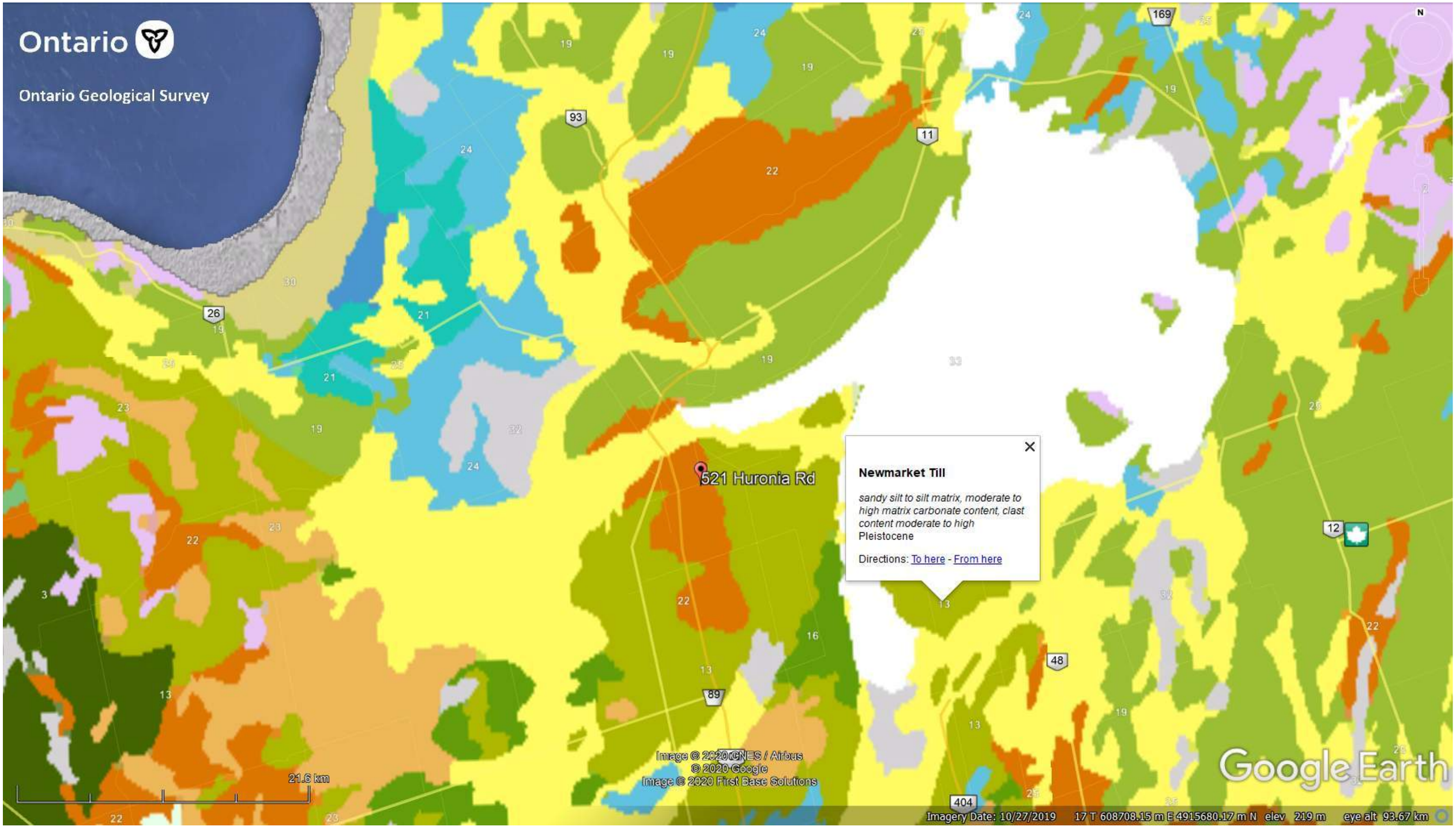
This map should not be relied on as a precise indicator of routes or locations, nor as a guide to navigation. The Ontario Ministry of Environment, Conservation and Parks (MECP) shall not be liable in any way for the use or any information on this map. of, or reliance upon, this map.

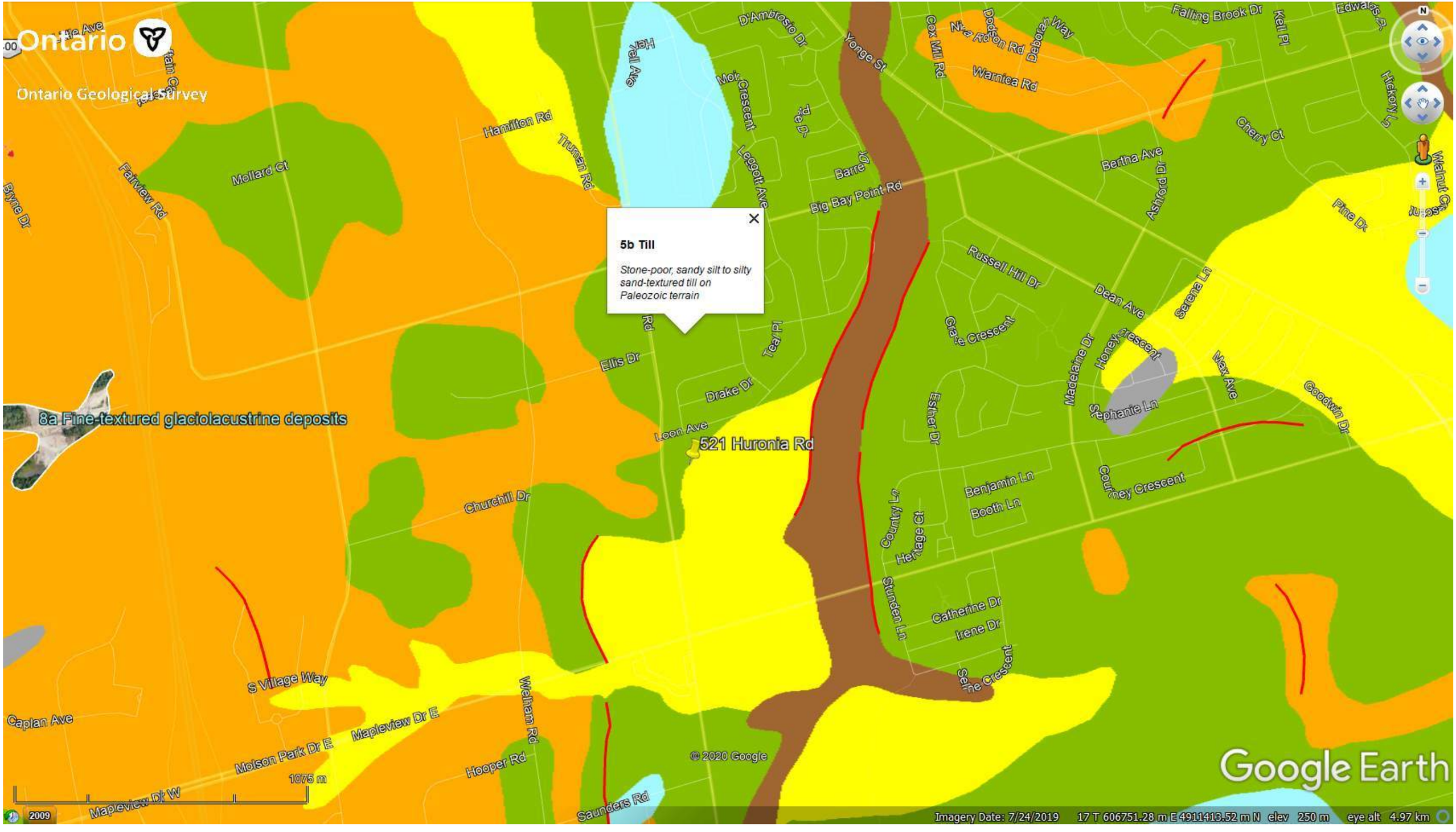
Ontario

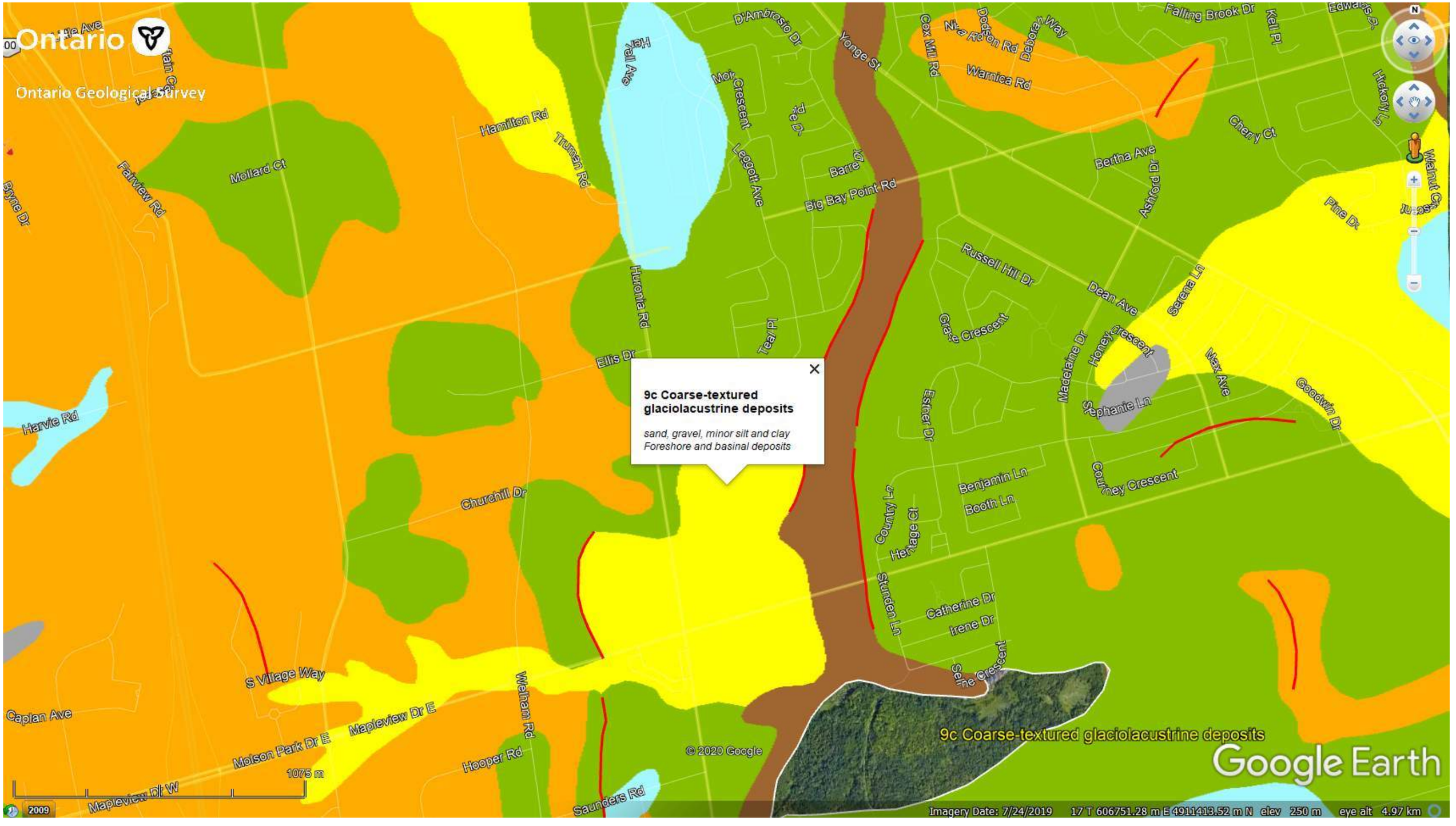
Map Created: 10/19/2020
Map Center: 44.34638 N, -79.66018 W

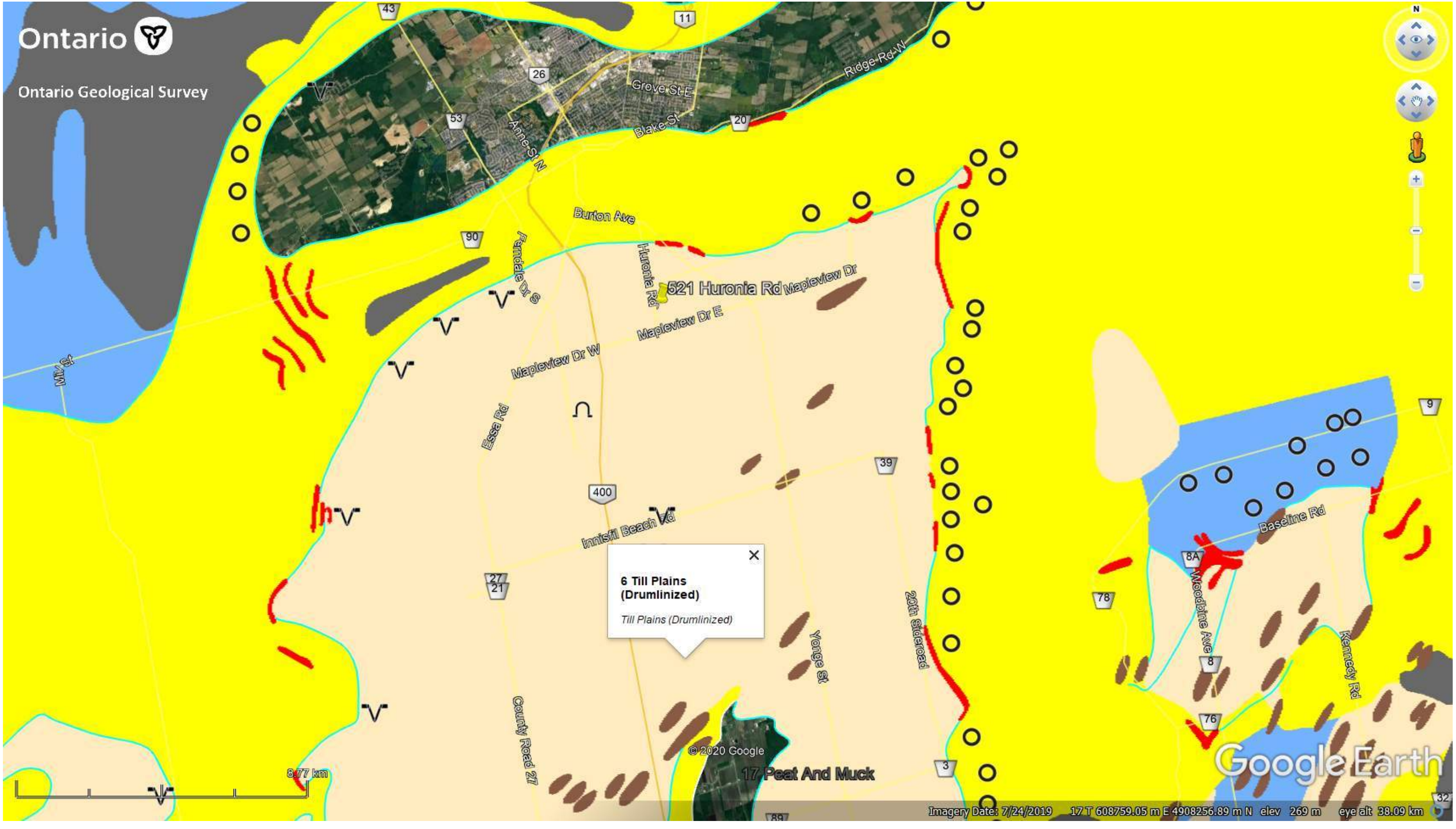
APPENDIX D


Ontario
Ontario Geological Survey
Glaciofluvial Ice
gravel and sand, minor till, includes esker, kame, end moraine, ice-marginal delta and subaqueous fan deposits
Pleistocene
Directions: To here - From here
521 Huronia Rd
93
11
169
26
89
48
12
404
N
21.6 km
Image © 2020 CNES / Airbus
© 2020 Google
Image © 2020 First Base Solutions
Google Earth
Imagery Date: 10/27/2019 17 T 608708.15 m E 4915680.17 m N elev 219 m eye alt 93.67 km

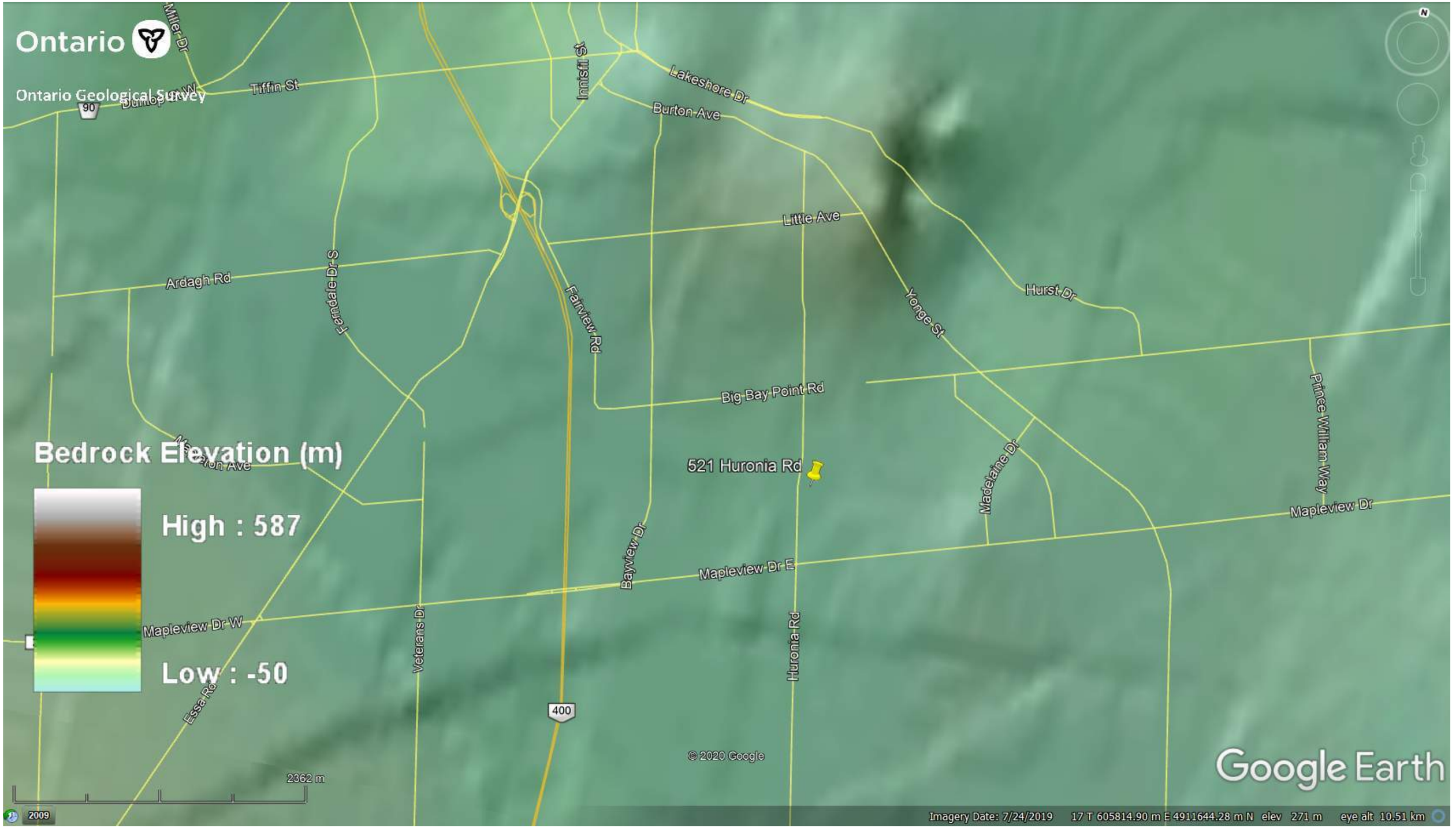

Ontario
Ontario Geological Survey
521 Huronia Rd
Newmarket Till
sandy silt to silt matrix, moderate to high matrix carbonate content, clast content moderate to high
Pleistocene
Directions: To here - From here
Image © 2020 CNES / Airbus
© 2020 Google
Image © 2020 First Base Solutions
21.6 km
Google Earth
Imagery Date: 10/27/2019 17 T 608708.15 m E 4915680.17 m N elev 219 m eye alt 93.67 km


Ontario
Ontario Geological Survey
5b Till
Stone-poor, sandy silt to silty sand-textured till on Paleozoic terrain
8a Fine-textured glaciolacustrine deposits
521 Huronia Rd
Hamilton Rd
Truman Rd
Mollard Ct
Fairview Rd
Byrne Dr
Big Bay Point Rd
Leggott Ave
Moir Crescent
Barrie Dr
Yonge St
Cox Mill Rd
Warnica Rd
Deborah Way
Falling Brook Dr
Kell Pl
Hickory Ln
Cherry Ct
Bertha Ave
Ashford Dr
Walnut Cres
Pine Dr
Russell Hill Dr
Dean Ave
Serena Ln
Grace Crescent
Honey Crescent
Madelaine Dr
Stephanie Ln
Mex Ave
Goodwin Dr
Esther Dr
Benjamin Ln
Booth Ln
Courtney Crescent
Country Ln
Heritage Ct
Stunden Ln
Catherine Dr
Irene Dr
Ellis Dr
Drake Dr
Loon Ave
Tear Pl
Churchill Dr
S Village Way
Caplan Ave
Moison Park Dr E
Mapleview Dr E
Mapleview Dr W
Welham Rd
Hooper Rd
Saunders Rd
1076 m
© 2020 Google
Google Earth
2009
Imagery Date: 7/24/2019 17 T 606751.28 m E 4911413.52 m N elev 250 m eye alt 4.97 km


Ontario
Ontario Geological Survey
9c Coarse-textured glaciolacustrine deposits
sand, gravel, minor silt and clay
Foreshore and basinal deposits
Hamilton Rd
Truman Rd
Mollard Ct
Fairview Rd
Byrne Dr
Harvie Rd
Yell Ave
Leggott Ave
Barrett Dr
Big Bay Point Rd
Yonge St
D'Ambrosio Dr
Cox Mill Rd
Dodson Rd
Deborah Way
Warnica Rd
Falling Brook Dr
Kell Pl
Hickory Ln
Cherry Ct
Bertha Ave
Ashford Dr
Pine Dr
Walnut Cr
Scenic
Huronia Rd
Ellis Dr
Tear Pl
Russell Hill Dr
Dean Ave
Serena Ln
Grape Crescent
Honey Crescent
Madelaine Dr
Esther Dr
Stephanie Ln
Max Ave
Goodwin Dr
Benjamin Ln
Booth Ln
Courtney Crescent
Country Ln
Heritage Ct
Stunden Ln
Catherine Dr
Irene Dr
Serine Crescent
Churchill Dr
S Village Way
Caplan Ave
Molson Park Dr E
Mapleview Dr E
Mapleview Dr W
Welham Rd
Hooper Rd
Saunders Rd
1075 m
2009
© 2020 Google
9c Coarse-textured glaciolacustrine deposits
Google Earth
Imagery Date: 7/24/2019 17 T 606751.28 m E 4911413.52 m N elev 250 m eye alt 4.97 km


Ontario
Ontario Geological Survey
43
11
26
Grove St E
Ridge Rd W
53
Anne St N
Blake St
20
Burton Ave
90
Ramdale Dr S
Huronia Rd
521 Huronia Rd
Mapleview Dr
Mapleview Dr E
Mapleview Dr W
Essa Rd
Mill St
400
39
9
Innisfil Beach Rd
27
21
6 Till Plains
(Drumlinized)
Till Plains (Drumlinized)
Yonge St
20th Sideroad
Baseline Rd
8A
78
Woodbine Ave
8
Kennedy Rd
76
3
County Road 27
© 2020 Google
17 Peat And Muck
8.77 km
Google Earth
Imagery Date: 7/24/2019 17 T 608759.05 m E 4908256.89 m N elev 269 m eye alt 38.09 km


Ontario
Ontario Geological Survey
54a
Limestone, dolostone, shale, arkose, sandstone
Ottawa Group; Simcoe Group; Shadow Lake Formation
521 Huronia Rd
16
169
121
11
49
48
36
26
7B
7
12
5
28
89
400
7A
3
2
35
57
401
10
9
6
404
407
27
42 km
© 2020 Google
Image Landsat / Copernicus
Image NOAA
Google Earth
17 T 614943.94 m E 4908456.17 m N elev 249 m eye alt 178.01 km


Ontario
Ontario Geological Survey
Bedrock Elevation (m)
High : 587
Low : -50
521 Huronia Rd
Miller Dr
Tiffin St
Dunlop St W
90
Innisfil St
Lakeshore Dr
Burton Ave
Little Ave
Ardagh Rd
Fernedale Dr S
Fairview Rd
Yonge St
Hurst Dr
Big Bay Point Rd
Prince William Way
Madelaine Dr
Mapleview Dr
Mapleview Dr E
Mapleview Dr W
Bayview Dr
Veterans Dr
Huronia Rd
Essa Rd
400
2362 m
© 2020 Google
Google Earth
2009
Imagery Date: 7/24/2019 17 T 605814.90 m E 4911644.28 m N elev 271 m eye alt 10.51 km

APPENDIX E

Lovers Creek Subwatershed

	Hydrologic Soil Group	Subwatershed Area (km^2)	Mean Annual Precipitation (mm/yr.)	Actual Evapotranspiration (mm/yr.)	Precipitation Surplus (mm/yr.)
Urban Lawns/Golf Courses					
Fine Sand	A	1.69	914	537	377
Fine Sandy Loam	B		914	571	343
Silt Loam	C		914	585	329
Clay	D		-	-	-
Forest					
Fine Sand	A	8.05	914	574	340
Fine Sandy Loam	B		914	557	357
Silt Loam	C		914	593	321
Clay	D		914	560	354
Pasture & Shrubs					
Fine Sand	A	1.66	914	566	348
Fine Sandy Loam	B		914	582	332
Silt Loam	C		914	658	256
Clay	D		-	-	-
Non-Intensive Agriculture (e.g. Hay)					
Fine Sand	A	3.89	914	571	343
Fine Sandy Loam	B		914	608	306
Silt Loam	C		914	650	264
Clay	D		-	-	-
Intensive Agriculture (e.g. Row crop)					
Fine Sand	A	16.20	914	589	325
Fine Sandy Loam	B		914	623	291
Silt Loam	C		914	646	268
Clay	D		914	523	391
Open Alvar					
Fine Sand	A	-	-	-	-
Fine Sandy Loam	B		-	-	-
Silt Loam	C		-	-	-
Clay	D		-	-	-
Aggregates					
Fine Sand	A	0.20	914	493	421
Fine Sandy Loam	B		914	529	385
Silt Loam	C		-	-	-
Clay	D		-	-	-
Mean Annual			**914**	**545**	**369**

Notes: Precipitation and Actual Evapotranspiration values are the AVERAGE ANNUAL estimates obtained from the Lake Simcoe PRMS model (Earthfx, 2010).

APPENDIX F

Water Well Records

October 19, 2020

6:37:58 AM

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
BARRIE CITY (INNISFI	17 606420 4911700 W	2016-09 7190	0.75	UT		MO	0010 5	7272826 (Z238664) A156794	BRWN SAND SILT 0015
INNISFIL TOWNSHIP	17 606177 4910961 W	2012-05 7241	1.25			MT	0015 10	7181772 (Z135039) A125735	GREY GRVL SAND LOOS 0002 GREY SAND SILT LOOS 0010 BRWN SAND SILT SOFT 0014 GREY SAND SILT DNSE 0025
INNISFIL TOWNSHIP	17 606445 4911259 W	1467						7158673 (Z94549) A082330 A	
INNISFIL TOWNSHIP CON 12 010	17 606398 4911300 W	1967-08 4608	30	FR 0013	13//2/:	DO		5701453 ()	MSND 0008 BRWN CLAY 0015 GREY CLAY 0022 GRVL 0025
INNISFIL TOWNSHIP CON 12 011	17 606914 4910723 W	1980-06 3203	6	FR 0146 FR 0166	/140/9/1:0	DO	0166 3	5717363 ()	BRWN SAND 0012 GREY CLAY 0140 GREY GRVL CLAY PCKD 0146 GREY GRVL LOOS 0148 GREY GRVL CLAY STNS 0166 GREY SAND GRVL 0169 GREY CLAY 0169
INNISFIL TOWNSHIP CON 12 011	17 606564 4911073 W	1974-07 4816	1	FR 0298	2/71//20:0	MN	0305 5	5711981 ()	CLAY SAND GRVL 0094 SAND CMTD 0131 CLAY SILT 0298 MSND FSND 0310 CLAY SAND LYRD 0326 SAND 0329 CLAY 0331 SAND 0332 CLAY DNSE 0345
INNISFIL TOWNSHIP CON 12 011	17 606514 4911123 W	1974-08 4816	2	UK 0285	10/70/37/20:0	MN		5711980 ()	CLAY GRVL 0094 SAND CMTD 0131 CLAY SILT 0285 FSND 0290 MSND 0301 CSND 0310 CLAY SAND LYRD 0321 SAND CMTD 0324 CLAY GRVL 0330

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION

Notes:
UTM: UTM in Zone, Easting, Northing and Datum is NAD83; L: UTM estimated from Centroid of Lot; W: UTM not from Lot Centroid
DATE CNTR: Date Work Completedand Well Contractor Licence Number
CASING DIA: .Casing diameter in inches
WATER: Unit of Depth in Fee. See Table 4 for Meaning of Code

PUMP TEST: Static Water Level in Feet / Water Level After Pumping in Feet / Pump Test Rate in GPM / Pump Test Duration in Hour : Minutes
WELL USE: See Table 3 for Meaning of Code
SCREEN: Screen Depth and Length in feet
WELL: WEL (AUDIT #) Well Tag . A: Abandonment; P: Partial Data Entry Only
FORMATION: See Table 1 and 2 for Meaning of Code

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 Color

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

3. Well Use

Code	Description	Code	Description
DO	Domestic	OT	Other
ST	Livestock	TH	Test Hole
IR	Irrigation	DE	Dewatering
IN	Industrial	MO	Monitoring
CO	Commercial	MT	Monitoring TestHole
MN	Municipal		
PS	Public		
AC	Cooling And A/C		
NU	Not Used		

4. Water Detail

Code	Description	Code	Description
FR	Fresh	GS	Gas
SA	Salty	IR	Iron
SU	Sulphur		
MN	Mineral		
UK	Unknown		

APPENDIX G

GROUNDED ENGINEERING

Date Started : Sep 28, 2020
Position : E: 606687, N: 4911298 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 101

File No. : 20-198 **Project** : 521 Huronia Rd, Barrie **Client** : Huronia Barrie Land Inc.

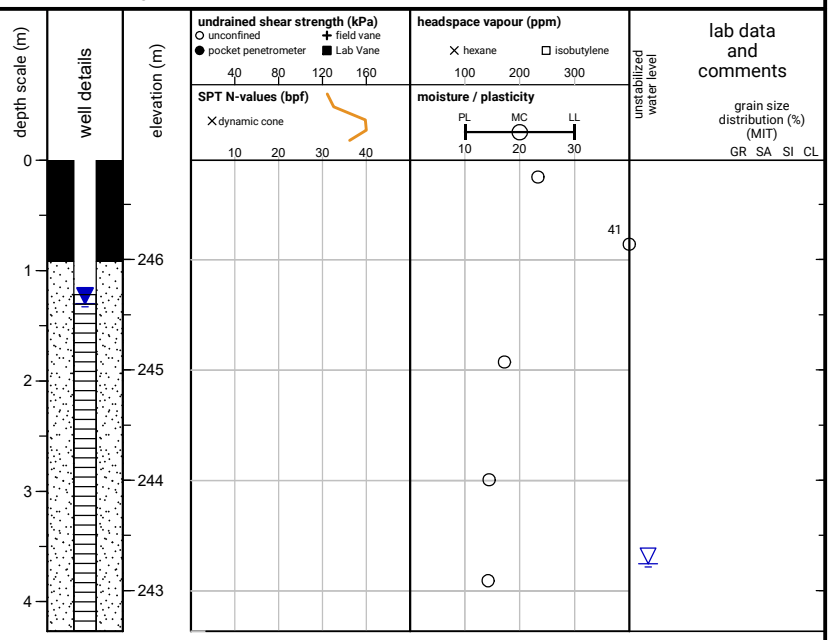
drill method : *MiniProbe*

Dual Tube Direct Push OD=50 mm

elev depth (m)	description	graphic log	sample number	sample type	SPT N-value
246.9	**GROUND SURFACE**				
246.6 / 0.3	305mm **TOPSOIL**		1A		
	SILTY CLAY, trace to some sand, trace gravel, trace organics, brown, moist		1B	DP	
	...at 1.2 m, greyish-brown		2	DP	
	...at 2.4 m, grey		3	DP	
			4	DP	
242.6 / 4.3					

depth scale (m) | well details | elevation (m)

undrained shear strength (kPa): unconfined, field vane, pocket penetrometer, Lab Vane (40, 80, 120, 160)
SPT N-values (bpf): dynamic cone (10, 20, 30, 40)
headspace vapour (ppm): hexane, isobutylene (100, 200, 300)
moisture / plasticity: PL, MC, LL (10, 20, 30)
unstabilized water level
lab data and comments
grain size distribution (%) (MIT): GR SA SI CL



END OF BOREHOLE

Unstabilized water level measured at 3.7 m below ground surface; open upon completion of drilling.

25 mm dia. monitoring well installed. No. 10 screen

GROUNDWATER LEVELS

Date	Water Depth (m)	Elevation (m)
Oct 9, 2020	0.9	246.0
Oct 13, 2020	0.9	246.0
Oct 23, 2020	0.8	246.1
Oct 30, 2020	0.7	246.2
Nov 6, 2020	0.7	246.2
Dec 17, 2020	0.3	246.6
Jan 25, 2021	0.7	246.2
Feb 27, 2021	0.8	246.1
Mar 31, 2021	0.4	246.5
Apr 30, 2021	0.5	246.4
May 18, 2021	0.7	246.2
Jun 14, 2021	1.3	245.6

file: 20-198.gpj

Tech : MC | **PM** : YQ | **Rev** : MD

GROUNDED ENGINEERING

Date Started : Sep 28, 2020
Position : E: 606655, N: 4911267 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 102

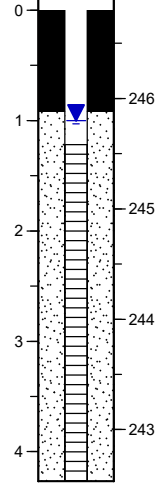
File No. : 20-198 **Project** : 521 Huronia Rd, Barrie **Client** : Huronia Barrie Land Inc.

drill method : *MiniProbe*

elev depth (m)	description	graphic log	samples: number	samples: type	samples: SPT N-value
246.8	**GROUND SURFACE**				
246.5 / 0.3	305mm **TOPSOIL**		1A	DP	
	SILTY SAND, trace gravel, trace organics, trace rootlets, dark brown, wet		1B	DP	
245.6 / 1.2	**SILTY CLAY**, trace to some sand, trace gravel, brownish grey, moist		2	DP	
			3	DP	
	...at 3.4 m, grey		4	DP	
242.5 / 4.3	**END OF BOREHOLE**				

Dual Tube Direct Push OD=50 mm

depth scale (m) / well details / elevation (m)



undrained shear strength (kPa)
○ unconfined + field vane
● pocket penetrometer ■ Lab Vane
40 80 120 160

SPT N-values (bpf)
× dynamic cone
10 20 30 40

headspace vapour (ppm)
× hexane □ isobutylene
100 200 300

moisture / plasticity
PL MC LL
10 20 30

unstabilized water level

lab data and comments
grain size distribution (%) (MIT)
GR SA SI CL

Unstabilized water level measured at 3.7 m below ground surface; open upon completion of drilling.

25 mm dia. monitoring well installed.
No. 10 screen

GROUNDWATER LEVELS

Date	Water Depth (m)	Elevation (m)
Oct 9, 2020	0.8	246.0
Oct 13, 2020	0.7	246.1
Oct 23, 2020	0.7	246.1
Oct 30, 2020	0.7	246.1
Nov 6, 2020	0.6	246.2
Dec 17, 2020	0.4	246.4
Jan 25, 2021	0.6	246.2
Feb 27, 2021	0.6	246.2
Mar 31, 2021	0.4	246.4
Apr 30, 2021	0.5	246.3
May 18, 2021	0.6	246.2
Jun 14, 2021	1.0	245.8

file: 20-198.gpj

Tech : MC | **PM** : YQ | **Rev** : MD

GROUNDED ENGINEERING

Date Started : Sep 28, 2020
Position : E: 606668, N: 4911229 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 103

File No. : 20-198 **Project** : 521 Huronia Rd, Barrie **Client** : Huronia Barrie Land Inc.

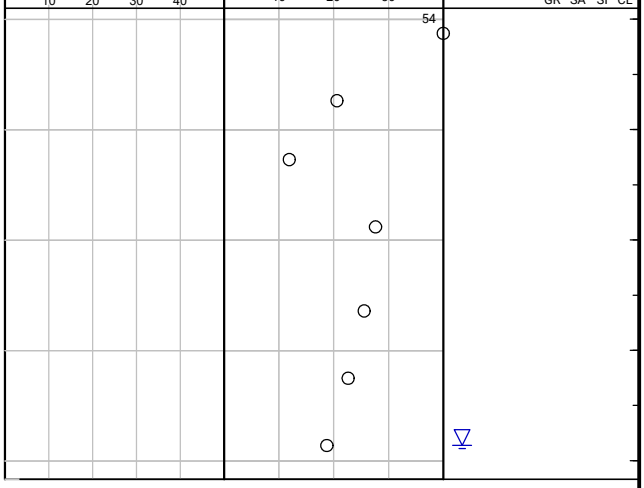
drill method : *MiniProbe*

elev / depth (m)	description	graphic log	sample number	sample type	SPT N-value
246.1	**GROUND SURFACE**				
245.6 / 0.5	455mm **TOPSOIL**		1A	DP	
	SILTY SAND, some gravel, trace organics, dark brown, wet		1B		
	...at 1.2 m, gravelly sand, greyish-brown		2A		
244.6 / 1.5	**SILTY CLAY**, trace sand, trace gravel, grey, moist		2B	DP	
			3	DP	
			4	DP	
			5	DP	
241.8 / 4.3					

Dual Tube Direct Push OD=50 mm

depth scale (m) | well details | elevation (m)

undrained shear strength (kPa): unconfined, pocket penetrometer, field vane, Lab Vane — 40 80 120 160
SPT N-values (bpf): dynamic cone — 10 20 30 40
headspace vapour (ppm): hexane, isobutylene — 100 200 300
moisture / plasticity: PL MC LL — 10 20 30
unstabilized water level
lab data and comments
grain size distribution (%) (MIT): GR SA SI CL



END OF BOREHOLE

Unstabilized water level measured at 4.0 m below ground surface; open upon completion of drilling.

25 mm dia. monitoring well installed. No. 10 screen

GROUNDWATER LEVELS

Date	Water Depth (m)	Elevation (m)
Oct 9, 2020	0.3	245.8
Oct 13, 2020	0.2	245.9
Oct 23, 2020	0.1	246.0
Oct 30, 2020	0.2	245.9
Nov 6, 2020	0.2	245.9
Dec 17, 2020	0.1	246.0
Jan 25, 2021	0.2	245.9
Feb 27, 2021	0.2	245.9
Mar 31, 2021	0.2	245.9
Apr 30, 2021	0.0	246.1
May 18, 2021	0.3	245.8
Jun 14, 2021	0.5	245.6

file: 20-198.gpj

Tech : MC | **PM** : YQ | **Rev** : MD

GROUNDED ENGINEERING

Date Started : Sep 28, 2020
Position : E: 606650, N: 4911214 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 104

File No. : 20-198 **Project** : 521 Huronia Rd, Barrie **Client** : Huronia Barrie Land Inc.

drill method : *MiniProbe*

elev depth (m)	description	graphic log	sample number	sample type	SPT N-value
246.6	**GROUND SURFACE**				
246.3 / 0.3	305mm **TOPSOIL**		1A	DP	
	SILTY SAND, some gravel, trace organics, orangey brown, wet		1B	DP	
245.4 / 1.2	**SILTY CLAY**, trace sand, trace gravel, grey, moist		2	DP	
			3	DP	
			4	DP	
			5	DP	
242.3 / 4.3					

Dual Tube Direct Push OD=50 mm

depth scale (m) 0 1 2 3 4

well details

elevation (m) 246 245 244 243

undrained shear strength (kPa)
○ unconfined + field vane
● pocket penetrometer ■ Lab Vane
40 80 120 160

SPT N-values (bpf)
× dynamic cone
10 20 30 40

headspace vapour (ppm)
× hexane □ isobutylene
100 200 300

moisture / plasticity
PL MC LL
10 20 30
LL=47.4

unstabilized water level

lab data and comments
grain size distribution (%) (MIT)
GR SA SI CL
1 3 27 69

END OF BOREHOLE

Unstabilized water level measured at 4.0 m below ground surface; open upon completion of drilling.

25 mm dia. monitoring well installed.
No. 10 screen

GROUNDWATER LEVELS

Date	Water Depth (m)	Elevation (m)
Oct 9, 2020	0.4	246.2
Oct 13, 2020	0.3	246.3
Oct 23, 2020	0.2	246.4
Oct 30, 2020	0.2	246.4
Nov 6, 2020	0.2	246.4
Dec 17, 2020	0.1	246.5
Jan 25, 2021	0.3	246.3
Feb 27, 2021	0.3	246.3
Mar 31, 2021	0.2	246.4
Apr 30, 2021	0.1	246.5
May 18, 2021	0.4	246.2
Jun 14, 2021	0.7	245.9

file: 20-198.gpj

Tech : MC | **PM** : YQ | **Rev** : MD

Date Started : Sep 28, 2020
Position : E: 606685, N: 4911220 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 105

File No. : 20-198 **Project** : 521 Huronia Rd, Barrie **Client** : Huronia Barrie Land Inc.

drill method : *MiniProbe*

elev depth (m)	description	graphic log	number	type	SPT N-value
245.8	**GROUND SURFACE**				
245.6	205mm **TOPSOIL**		1A		
0.2	**SILTY SAND**, some gravel, trace organics, orangey brown, wet		1B	DP	
	...at 1.2 m, gravelly sand, trace silt, trace clay		2A	DP	
244.0					
1.8	**SILTY CLAY**, trace sand, trace gravel, grey, moist		2B		
			3	DP	
			4	DP	
241.5					
4.3					

Dual Tube Direct Push OD=50 mm

depth scale (m): 0, 1, 2, 3, 4

well details

elevation (m): 245, 244, 243, 242

undrained shear strength (kPa)
○ unconfined + field vane
● pocket penetrometer ■ Lab Vane
40 80 120 160

SPT N-values (bpf)
× dynamic cone
10 20 30 40

headspace vapour (ppm)
× hexane □ isobutylene
100 200 300

moisture / plasticity
PL MC LL
10 20 30

unstabilized water level

lab data and comments

grain size distribution (%) (MIT)
GR SA SI CL
70
34 57 6 3

END OF BOREHOLE

Unstabilized water level measured at 3.0 m below ground surface; open upon completion of drilling.

25 mm dia. monitoring well installed.
No. 10 screen

GROUNDWATER LEVELS

Date	Water Depth (m)	Elevation (m)
Oct 9, 2020	0.3	245.5
Oct 13, 2020	0.3	245.5
Oct 23, 2020	0.2	245.6
Oct 30, 2020	0.2	245.6
Nov 6, 2020	0.2	245.6
Dec 17, 2020	0.2	245.6
Jan 25, 2021	0.2	245.6
Feb 27, 2021	0.2	245.6
Mar 31, 2021	0.2	245.6
Apr 30, 2021	0.2	245.6
May 18, 2021	0.3	245.5
Jun 14, 2021	0.5	245.3

file: 20-198.gpj

Tech : MC | **PM** : YQ | **Rev** : MD

LOG OF BH 1

Terraprobe

Project No. : 3-19-0101-01	Client : Huronia Barrie Land Inc.	Originated by : MC
Date started : September 23, 2019	Project : 521 Huronia Rd.	Compiled by : BH
Sheet No. : 1 of 1	Location : Barrie, Ontario	Checked by : SO

Position : E: 606534, N: 4911262 (UTM 17T) Elevation Datum : Geodetic (NAD83)

Rig type : B-57, track-mounted Drilling Method : Hollow stem augers

Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value	Elevation (m)	Penetration Test Values (Blows / 0.3m) / Undrained Shear Strength (kPa)	Moisture / Plasticity (PL, MC, LL)	Headspace Vapour (ppm)	Instrument Details	Lab Data and Comments
252.0	**GROUND SURFACE**					252					
251.8 / 0.2	150mm **TOPSOIL**		1	SS	8				PID: =5		SS1 Analysis: M&I
251.2 / 0.8	**FILL**, silty sand, trace gravel, trace organics, loose, brown, moist										
	SAND, trace to some gravel, trace silt, loose, brown, moist		2	SS	9	251			PID: <5		SS2 Analysis: PAH, PCB
			3	SS	9	250			PID: =10		SS3 Analysis: VOC, PHC
			4	SS	7				PID: =10		SS4 Analysis: M&I
249.0 / 3.0	**SILTY CLAY**, trace to some sand, trace gravel, firm, brown to grey, moist to wet		5	SS	5	249			PID: =5		SS5 Analysis: PAH, PCB
			6	SS	6	248			PID: <5		
			7	SS	6	247			PID: <5		
244.4 / 7.6	**SAND**, silty to some silt, trace to some clay, trace gravel, very dense, grey, moist (GLACIAL TILL)		8	SS	70	246			PID: =5		
			9A 9B	SS	66	245			PID: =5		
241.3 / 10.7	**SAND**, trace gravel, trace silt, very dense, greenish brown, wet to moist		10	SS	79	244			PID: =10		SS10 Analysis: VOC, PHC
239.4 / 12.6	**END OF BOREHOLE**		11	SS	89 / 250mm	243			PID: =10		
						242					
						241					
						240					

Penetration Test Values (Blows / 0.3m): Dynamic Cone (10, 20, 30, 40)

Undrained Shear Strength (kPa): Unconfined, Pocket Penetrometer, Field Vane, Lab Vane (40, 80, 120, 160)

Moisture / Plasticity: Plastic Limit, Natural Water Content, Liquid Limit (PL, MC, LL) (10, 20, 30)

Unstabilized Water Level

GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL

Unstabilized water level measured at 7.0 m below ground surface; borehole was open upon completion of drilling.

50 mm dia. monitoring well installed. 3m screen installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Sep 30, 2019	2.4	249.6

file: 3-19-0101-01, bh logs.gpj

LOG OF BH 2

Terraprobe

Project No. : 3-19-0101-01	Client : Huronia Barrie Land Inc.	Originated by : MC
Date started : September 23, 2019	Project : 521 Huronia Rd.	Compiled by : BH
Sheet No. : 1 of 1	Location : Barrie, Ontario	Checked by : SO

Position : E: 606569, N: 4911265 (UTM 17T) Elevation Datum : Geodetic (NAD83)

Rig type : B-57, track-mounted Drilling Method : Hollow stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
0	251.7	**GROUND SURFACE**				
		100mm **TOPSOIL**		1	SS	6
	250.8	**FILL**, sand, trace silt, trace gravel, trace organics, loose, brown, moist				
1	0.9	**SAND**, trace to some gravel, trace silt, loose, brown, moist		2	SS	6
2				3	SS	7
				4	SS	8
3	248.7					
	3.0	**SILTY CLAY**, trace to some sand, trace gravel, soft to firm, brown to grey, moist to wet		5	SS	6
4						
				6	SS	3
5						
6				7	SS	4
7						
				8	SS	6
8						
9	242.6					
	9.1	**SAND**, silty to some silt, trace to some clay, trace gravel, very dense to dense, grey, moist (GLACIAL TILL)		9	SS	48
10				10	SS	50 / 125mm
11				11	SS	46
12	238.9					
	12.8	**END OF BOREHOLE**				

Elevation Scale (m): 251, 250, 249, 248, 247, 246, 245, 244, 243, 242, 241, 240, 239

Penetration Test Values (Blows / 0.3m): Dynamic Cone 10 20 30 40

Undrained Shear Strength (kPa): Unconfined, Pocket Penetrometer, Field Vane, Lab Vane — 40 80 120 160

Moisture / Plasticity: Plastic Limit (PL) Natural Water Content (MC) Liquid Limit (LL) — 10 20 30

Headspace Vapour (ppm): PID: =5 | PID: =5 | PID: =5 | PID: =5 | PID: =5 | PID: <5 | PID: <5 | PID: <5 | PID: =5 | PID: =10 | PID: =10

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL

SS1 Analysis: PAH, PCB

SS2 Analysis: M&I, VOC, PHC

SS3 Analysis: M&I

SS4 Analysis: PAH, PCB

SS11 Analysis: VOC, PHC

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Sep 30, 2019	2.6	249.1

Unstabilized water level measured at 7.0 m below ground surface; borehole was open upon completion of drilling.

50 mm dia. monitoring well installed. 3m screen installed.

file: 3-19-0101-01, bh logs.gpj

LOG OF BH 3

Terraprobe

Project No. : 3-19-0101-01	Client : Huronia Barrie Land Inc.	Originated by : MC
Date started : September 24, 2019	Project : 521 Huronia Rd.	Compiled by : BH
Sheet No. : 1 of 1	Location : Barrie, Ontario	Checked by : SO

Position : E: 606595, N: 4911284 (UTM 17T) Elevation Datum : Geodetic (NAD83)

Rig type : B-57, track-mounted Drilling Method : Hollow stem augers

Depth (m)	Elev (m)	Description	Number	Type	SPT 'N' Value
0	250.5	**GROUND SURFACE**			
		130mm **TOPSOIL**	1	SS	8
		SILTY SAND, trace gravel, loose, brown, moist to wet	2	SS	7
2	248.2		3	SS	8
	2.3	**SILTY CLAY**, trace to some sand, trace gravel, stiff, brown to grey, moist	4	SS	10
			5	SS	10
			6	SS	10
			7	SS	12
	242.9				
	7.6	**SAND**, silty to some silt, trace to some clay, trace gravel, very dense, grey, moist (GLACIAL TILL)	8	SS	50 / 125mm
			9	SS	24
			10	SS	69
			11	SS	48
	237.7				
12	12.8	**END OF BOREHOLE**			

Penetration Test Values (Blows / 0.3m): Dynamic Cone 10 20 30 40

Undrained Shear Strength (kPa): Unconfined, Pocket Penetrometer, Field Vane, Lab Vane 40 80 120 160

Moisture / Plasticity: Plastic Limit (PL) Natural Water Content (MC) Liquid Limit (LL) 10 20 30

Elevation Scale (m): 250 249 248 247 246 245 244 243 242 241 240 239 238

Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL

SS1 Analysis: PAH, PCB

SS2 Analysis: M&I

SS3 Analysis: VOC, PHC

SS4 Analysis: M&I

SS5 Analysis: PAH, PCB

SS11 Analysis: VOC, PHC

Unstabilized water level measured at 7.3 m below ground surface; borehole was open upon completion of drilling.

50 mm dia. monitoring well installed. 3m screen installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Sep 30, 2019	3.7	246.9

file: 3-19-0101-01, bh logs.gpj

LOG OF BH 4

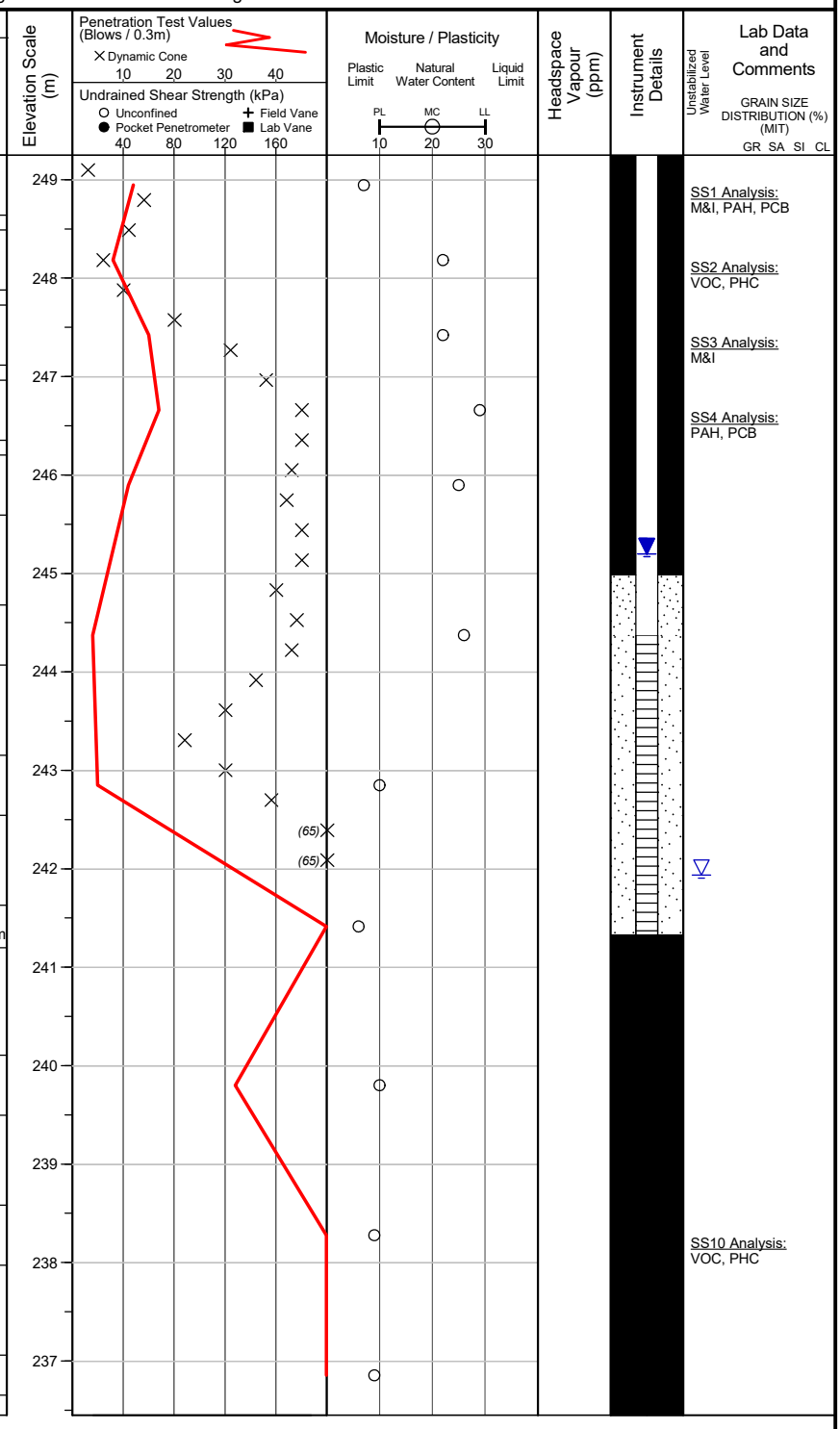
Terraprobe

Project No. : 3-19-0101-01	Client : Huronia Barrie Land Inc.	Originated by : MC
Date started : September 24, 2019	Project : 521 Huronia Rd.	Compiled by : BH
Sheet No. : 1 of 1	Location : Barrie, Ontario	Checked by : SO

Position : E: 606621, N: 4911290 (UTM 17T) Elevation Datum : Geodetic (NAD83)

Rig type : B-57, track-mounted Drilling Method : Hollow stem augers

Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
249.3	**GROUND SURFACE**				
249.1 / 0.2	150mm **TOPSOIL**				
248.5 / 0.8	**SILTY SAND**, trace gravel, compact to loose, brown, moist		1	SS	12
	SILTY CLAY, trace to some sand, trace gravel, very stiff to firm, brown to grey, moist to wet		2	SS	8
			3	SS	15
			4	SS	17
			5	SS	11
			6	SS	4
			7	SS	5
241.7 / 7.6	**SAND**, silty to some silt, trace to some clay, trace gravel, very dense, grey, moist to wet (GLACIAL TILL)		8	SS	86 / 275mm
			9	SS	32
			10	SS	58
			11	SS	61
236.5 / 12.8	**END OF BOREHOLE**				



WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Sep 30, 2019	4.1	245.2

Unstabilized water level measured at 7.3 m below ground surface; borehole was open upon completion of drilling.

50 mm dia. monitoring well installed. 3m screen installed.

file: 3-19-0101-01, bh logs.gpj

APPENDIX H

Terraprobe

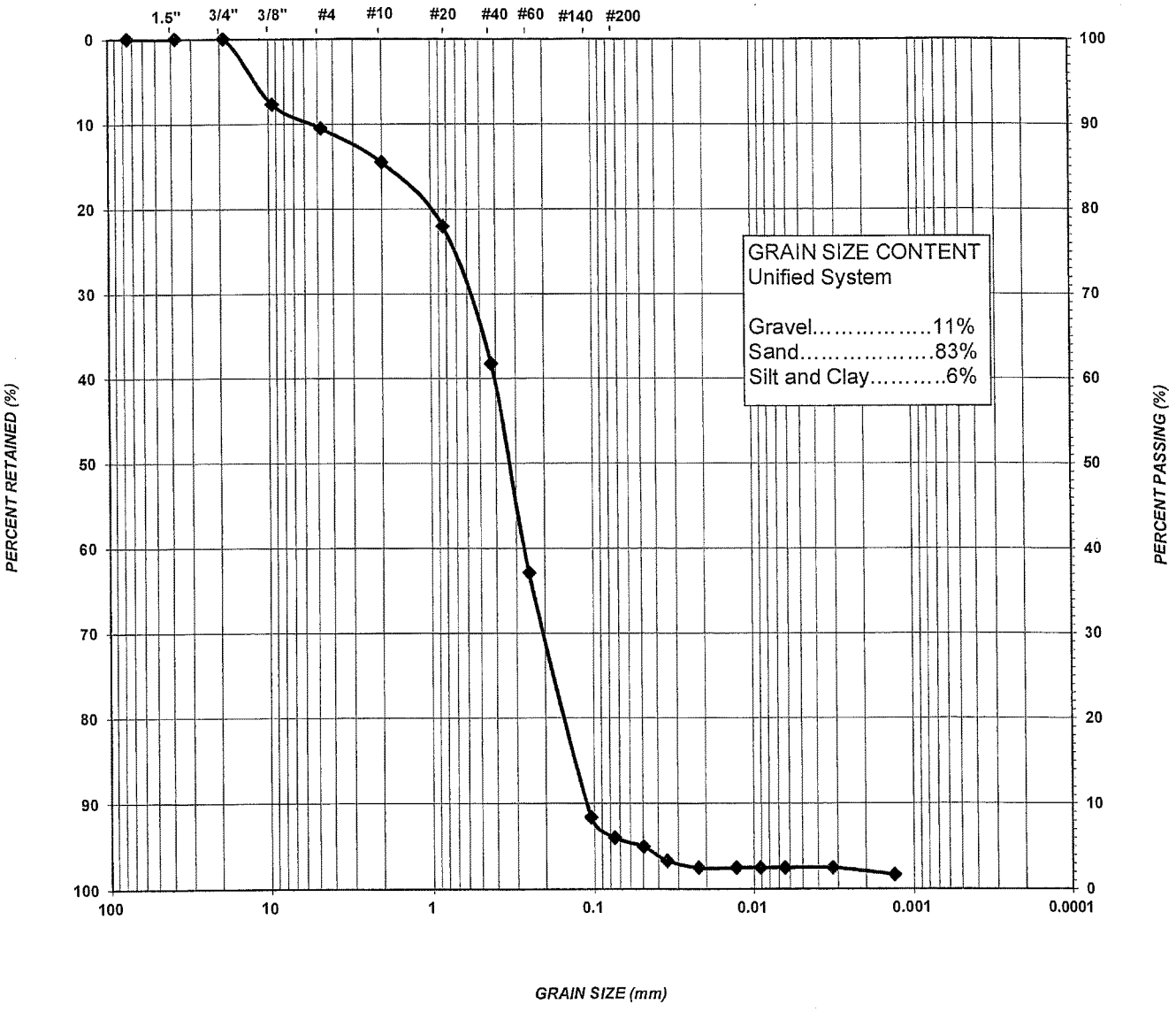
SIEVE AND HYDROMETER ANALYSIS TEST REPORT

PROJECT: **521 Huronia Road**
LOCATION: **Barrie, ON**
CLIENT: **Huronia Road Land Inc.**

FILE NO.: **3-19-0101**
LAB NO.: **1438a**
SAMPLE DATE: **Sept-25-19**
SAMPLED BY: **M.C.**

BOREHOLE NUMBER: **2** SAMPLE DEPTH: **5 to 7'**
SAMPLE NUMBER: **3**
SAMPLE LOCATION: **as above**
SAMPLE DESCRIPTION: **Sand, some gravel, trace silt, trace clay**

GRAIN SIZE DISTRIBUTION



MIT SYSTEM	GRAVEL	COARSE	MEDIUM	FINE	SILT	CLAY
		SAND				

UNIFIED SYSTEM	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY
	GRAVEL		SAND			

Terraprobe

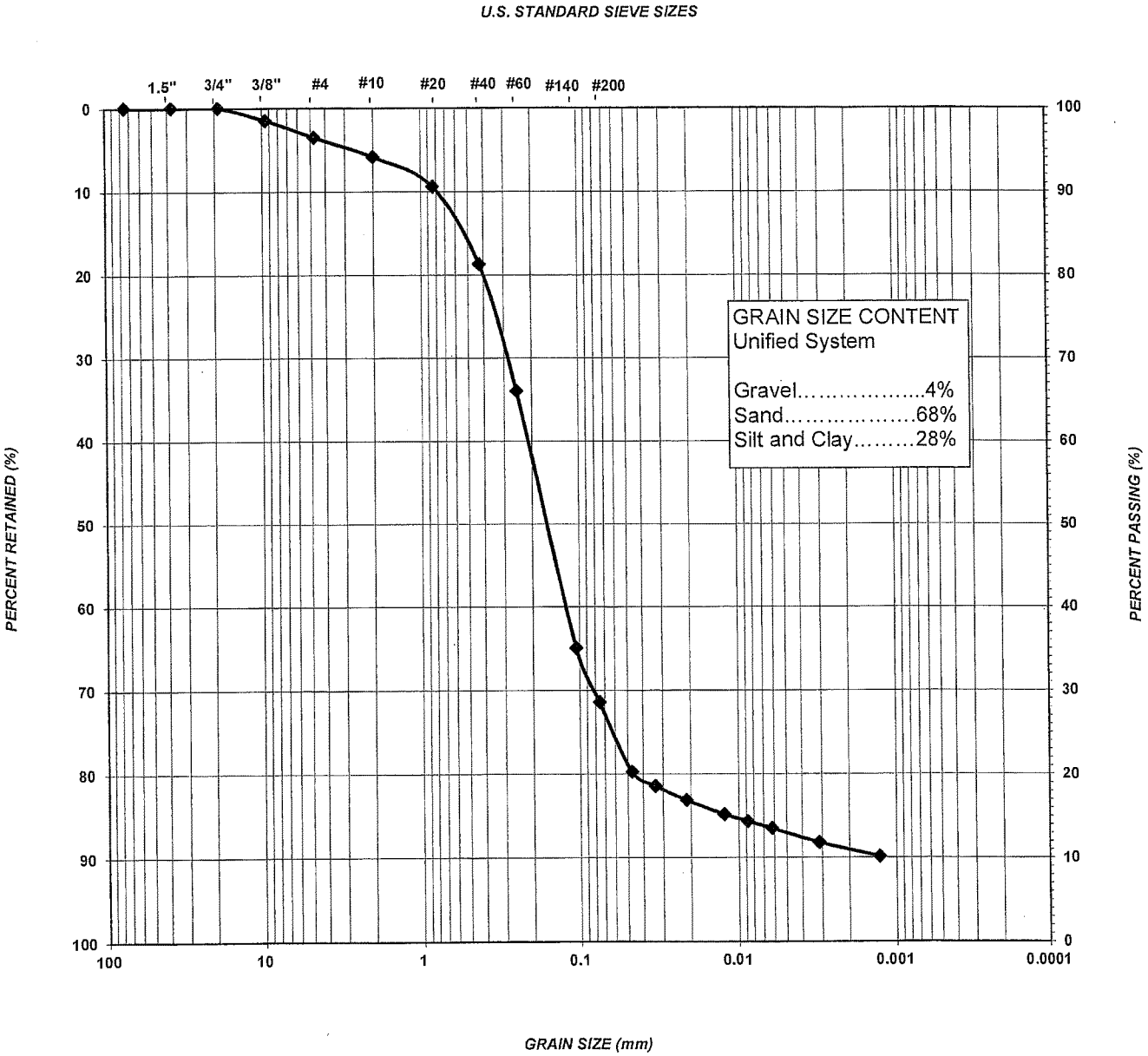
SIEVE AND HYDROMETER ANALYSIS TEST REPORT

PROJECT: **521 Huronia Road**
LOCATION: **Barrie, ON**
CLIENT: **Huronia Road Land Inc.**

FILE NO.: **3-19-0101**
LAB NO.: **1438b**
SAMPLE DATE: **Sept-25-19**
SAMPLED BY: **M.C.**

BOREHOLE NUMBER: **3** SAMPLE DEPTH: **30 to 32'**
SAMPLE NUMBER: **9**
SAMPLE LOCATION: **as above**
SAMPLE DESCRIPTION: **Sand, some silt, some clay, trace gravel**

GRAIN SIZE DISTRIBUTION



MIT SYSTEM	GRAVEL	COARSE	MEDIUM	FINE	SAND	SILT	CLAY

UNIFIED SYSTEM	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY
	GRAVEL		SAND			

Terraprobe

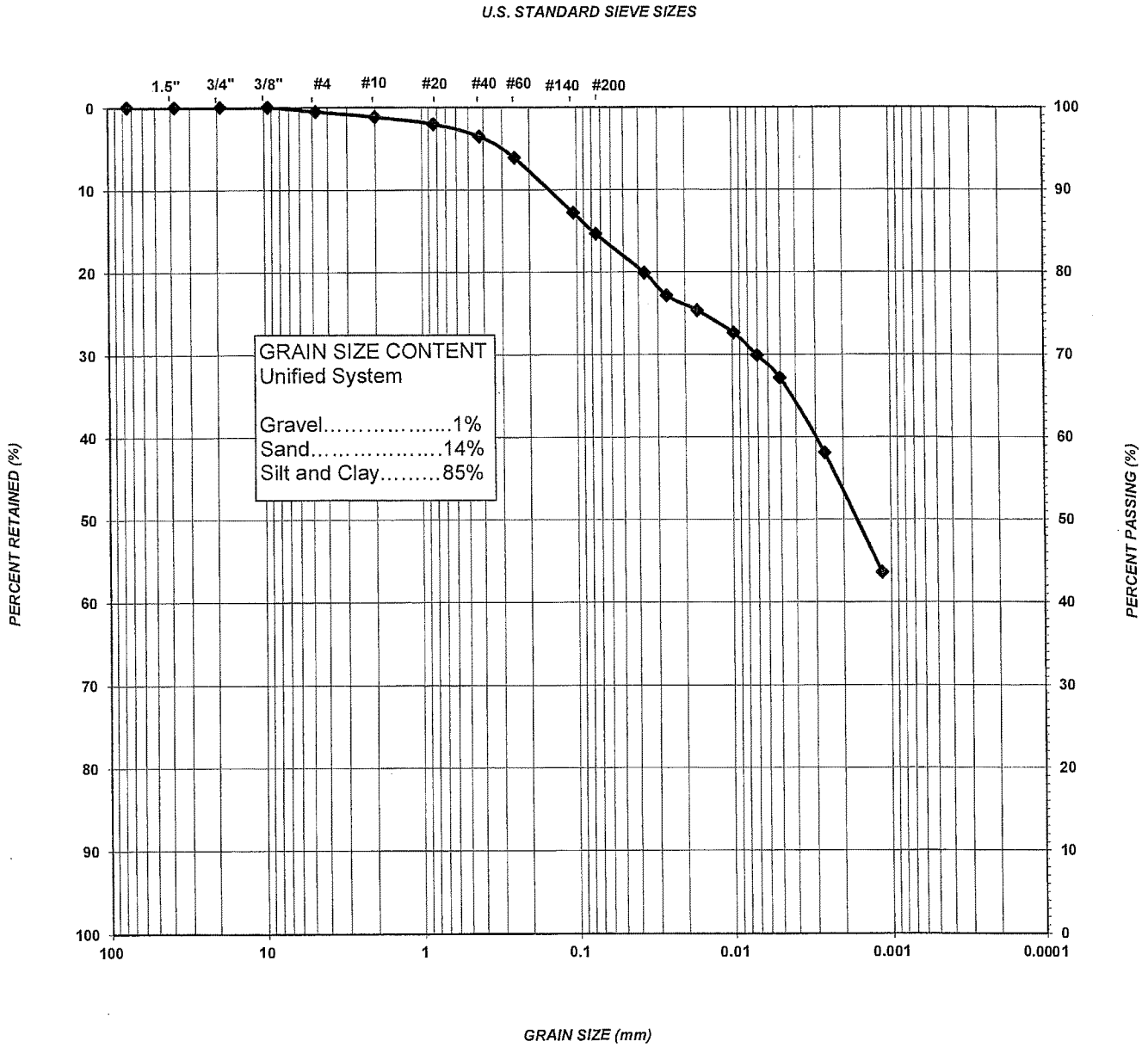
SIEVE AND HYDROMETER ANALYSIS TEST REPORT

PROJECT: **521 Huronia Road**
LOCATION: **Barrie, ON**
CLIENT: **Huronia Road Land Inc.**

FILE NO.: **3-19-0101**
LAB NO.: **1438c**
SAMPLE DATE: **Sept-25-19**
SAMPLED BY: **M.C.**

BOREHOLE NUMBER: **4** SAMPLE DEPTH: **10 to 12'**
SAMPLE NUMBER: **5**
SAMPLE LOCATION: **as above**
SAMPLE DESCRIPTION: **Silty clay, some sand, trace gravel**

GRAIN SIZE DISTRIBUTION



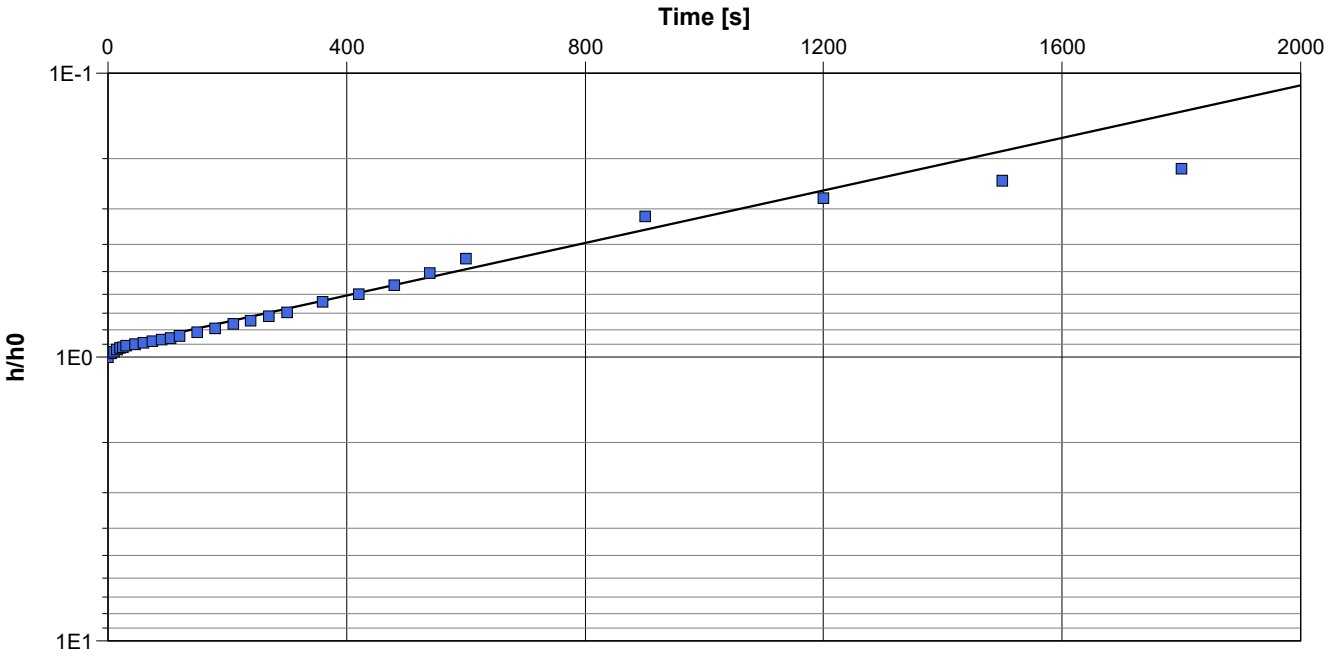
MIT SYSTEM	GRAVEL	COARSE	MEDIUM	FINE	SILT	CLAY
		SAND				

UNIFIED SYSTEM	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY
	GRAVEL		SAND			

APPENDIX I

GROUNDED ENGINEERING	**Slug Test Analysis Report**
	Project: 521 Huronia Road
	Number: 20-198
	Client: Huronia Barrie Land Inc.

Location: Barrie, ON	Slug Test: BH101	Test Well: BH101
Test Conducted by: MC		Test Date: 2020-10-13
Analysis Performed by: YQ	RHT 1	Analysis Date: 2020-10-14
Aquifer Thickness: 4.50 m		

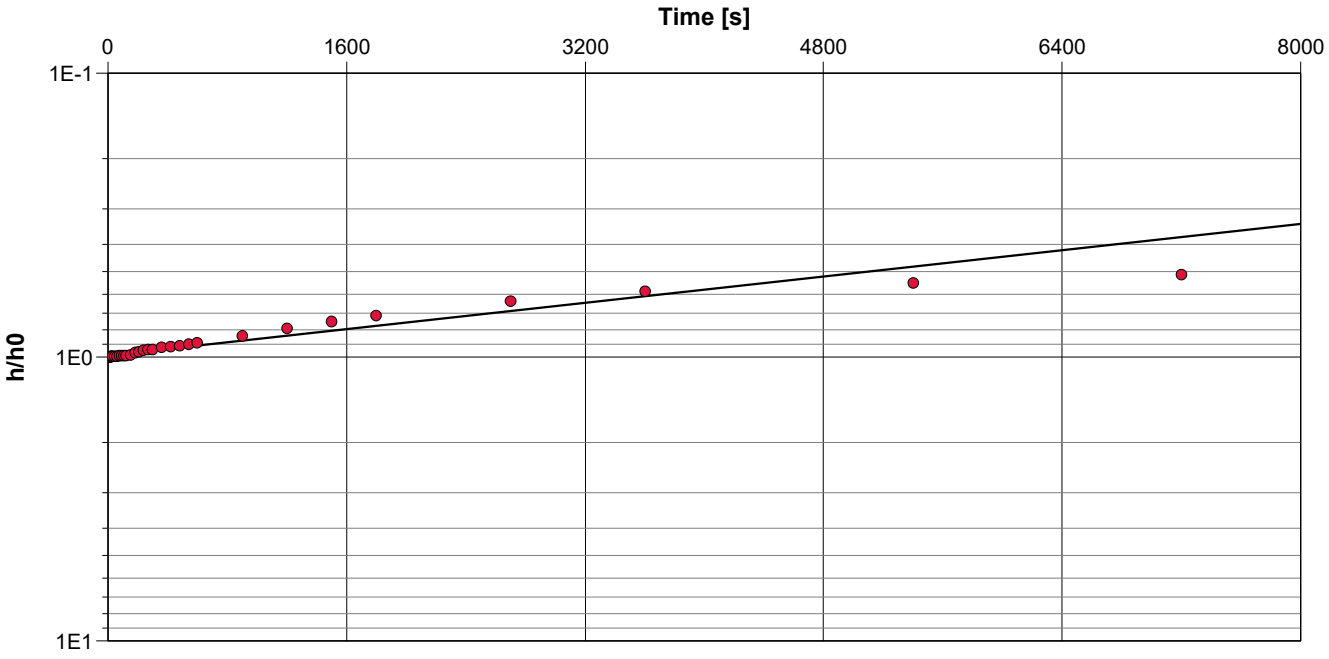


Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH101	1.13×10^{-7}	

GROUNDED ENGINEERING	**Slug Test Analysis Report**
	Project: 521 Huronia Road
	Number: 20-198
	Client: Huronia Barrie Land Inc.

Location: Barrie, ON	Slug Test: BH102	Test Well: BH102
Test Conducted by: MC		Test Date: 2020-10-13
Analysis Performed by: YQ	RHT 1	Analysis Date: 2020-10-14
Aquifer Thickness: 4.50 m		

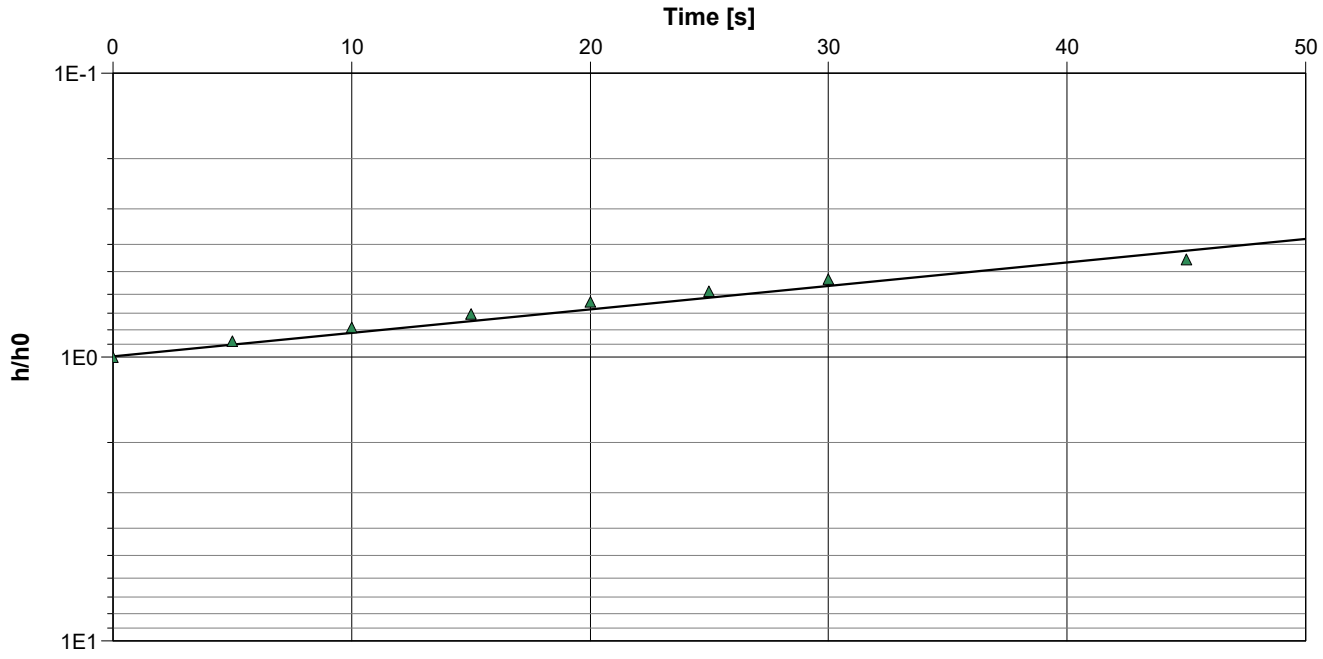


Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH102	1.41×10^{-8}	

GROUNDED ENGINEERING	**Slug Test Analysis Report**
	Project: 521 Huronia Road
	Number: 20-198
	Client: Huronia Barrie Land Inc.

Location: Barrie, ON	Slug Test: BH103	Test Well: BH103
Test Conducted by: MC		Test Date: 2020-10-13
Analysis Performed by: YQ	RHT 1	Analysis Date: 2020-10-14
Aquifer Thickness: 4.50 m		

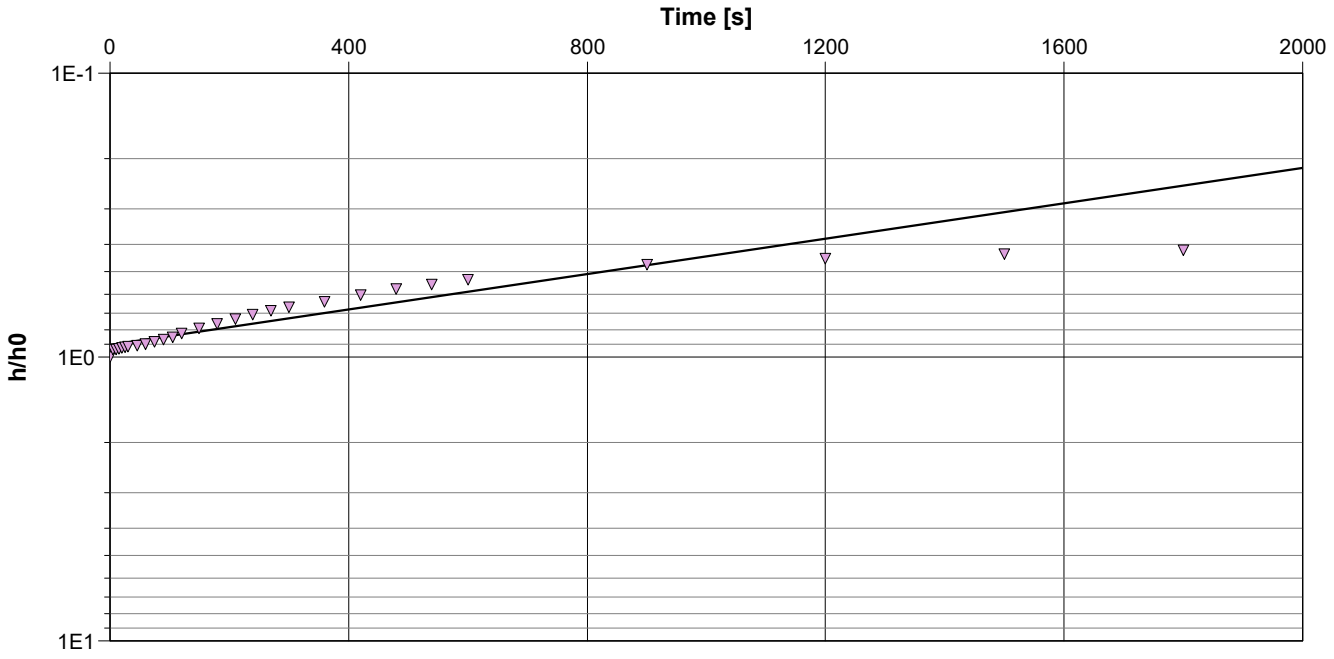


Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH103	2.02×10^{-6}	

GROUNDED ENGINEERING	**Slug Test Analysis Report**
	Project: 521 Huronia Road
	Number: 20-198
	Client: Huronia Barrie Land Inc.

Location: Barrie, ON	Slug Test: BH104	Test Well: BH104
Test Conducted by: MC		Test Date: 2020-10-13
Analysis Performed by: YQ	RHT 1	Analysis Date: 2020-10-14
Aquifer Thickness: 4.50 m		

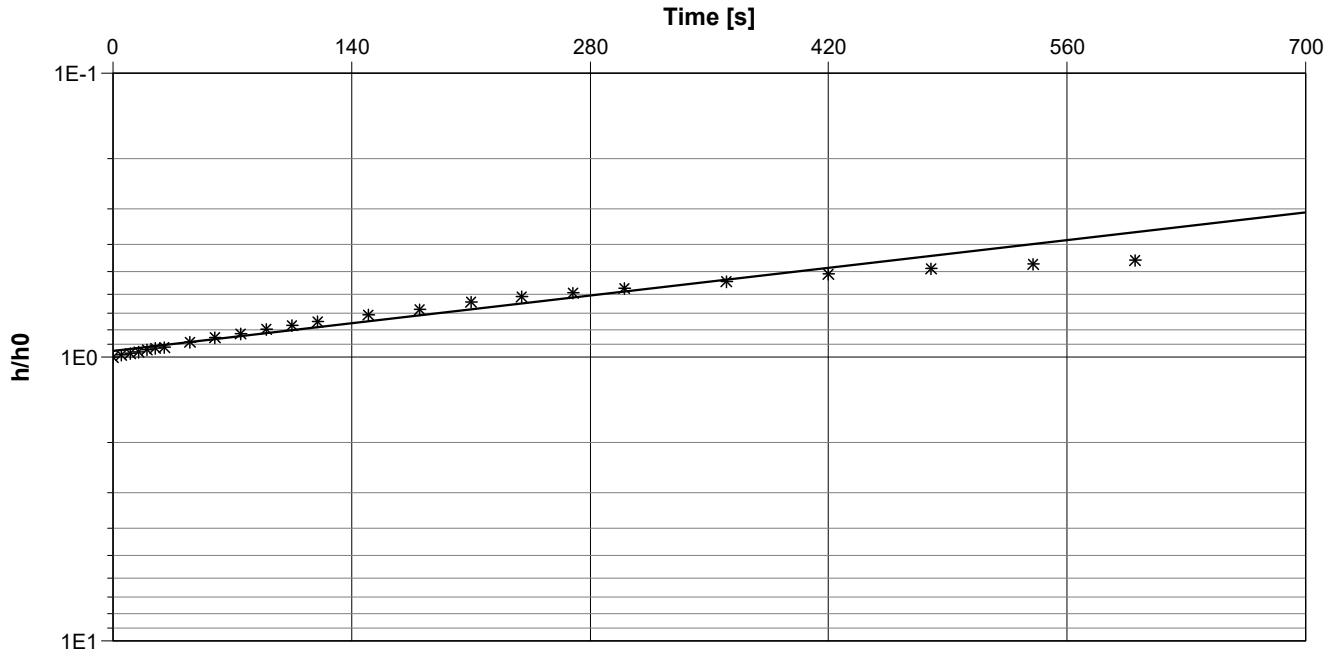


Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH104	7.58×10^{-8}	

GROUNDED ENGINEERING	**Slug Test Analysis Report**
	Project: 521 Huronia Road
	Number: 20-198
	Client: Huronia Barrie Land Inc.

Location: Barrie, ON	Slug Test: BH105	Test Well: BH105
Test Conducted by: MC		Test Date: 2020-10-13
Analysis Performed by: YQ	RHT 1	Analysis Date: 2020-10-14
Aquifer Thickness: 4.50 m		



Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH105	1.69×10^{-7}	

Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Engineering, Inspection & Testing

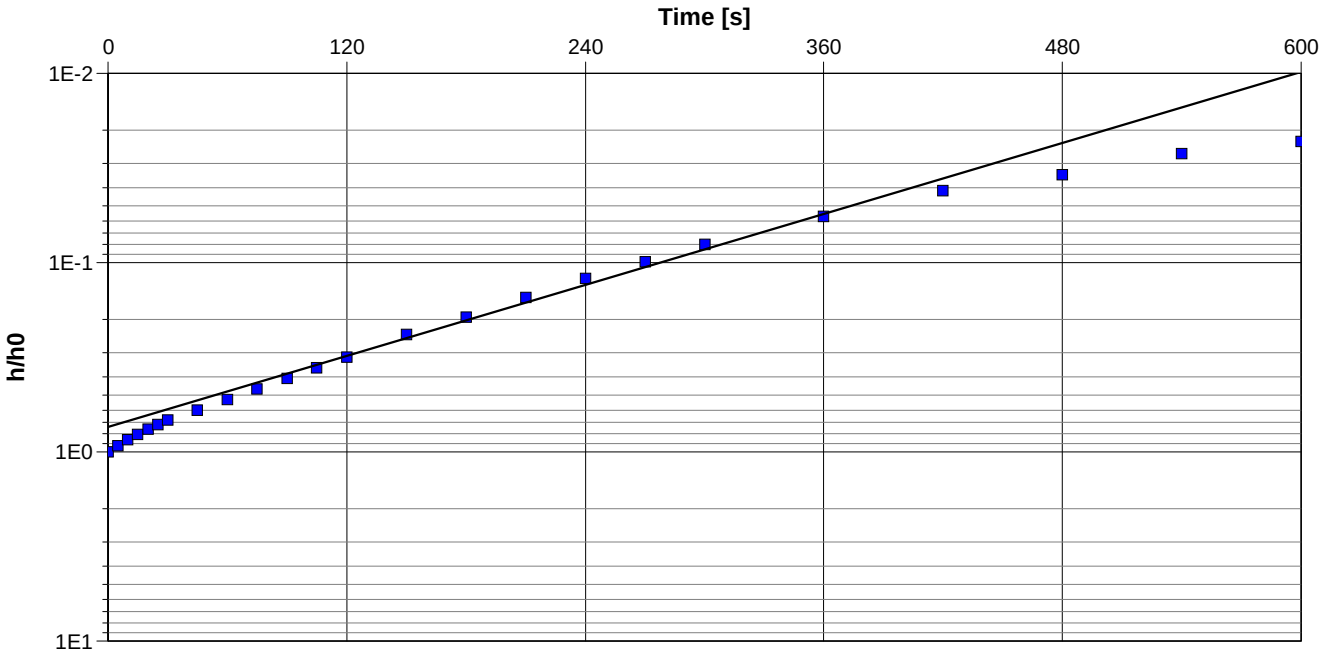
Slug Test Analysis Report

Project: 521 Huronia Road

Number: 3-19-0101

Client: Huronia Barrie Land Inc.

Location: Barrie, ON	Slug Test: Rising Head Test - BH1	Test Well: BH1
Test Conducted by: MC		Test Date: 12/5/2019
Analysis Performed by: MA	Rising Head Test - BH1	Analysis Date: 12/17/2019
Aquifer Thickness: 5.00 m		



Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH1	2.76×10^{-6}	

Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Engineering, Inspection & Testing

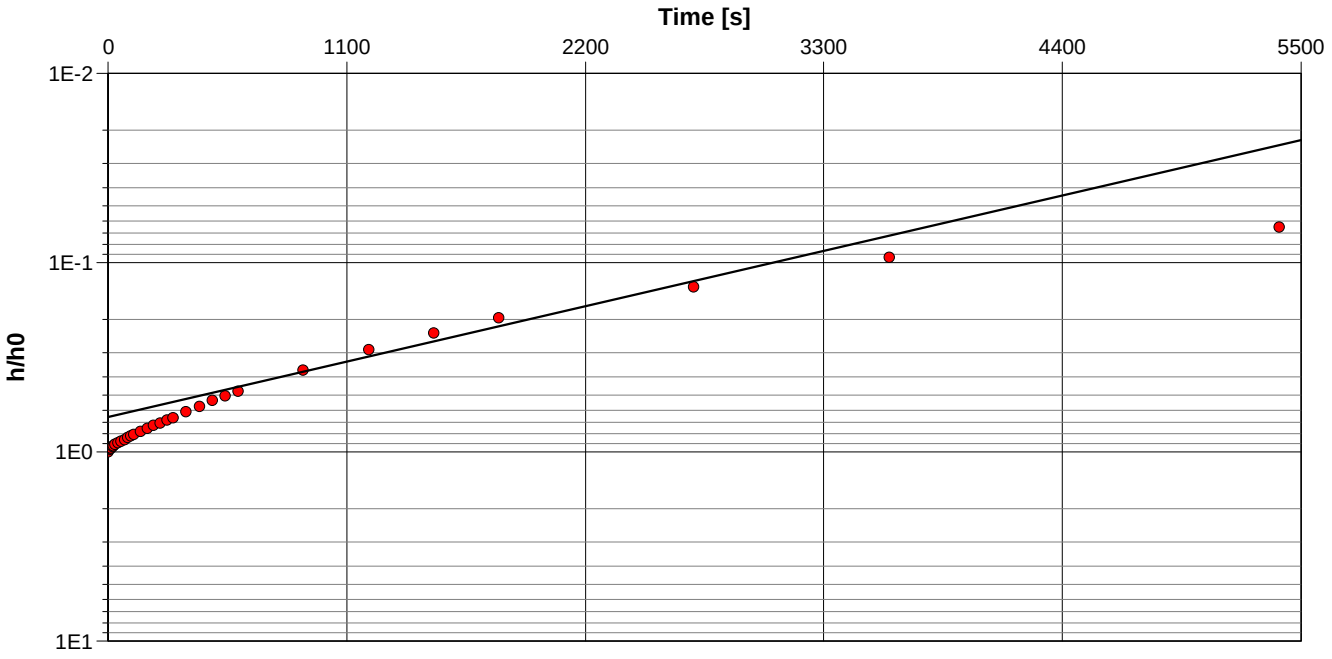
Slug Test Analysis Report

Project: 521 Huronia Road

Number: 3-19-0101

Client: Huronia Barrie Land Inc.

Location: Barrie, ON	Slug Test: Rising Head Test - BH2	Test Well: BH2
Test Conducted by: MC		Test Date: 12/5/2019
Analysis Performed by: MA	Rising Head Test - BH2	Analysis Date: 12/17/2019
Aquifer Thickness: 5.00 m		

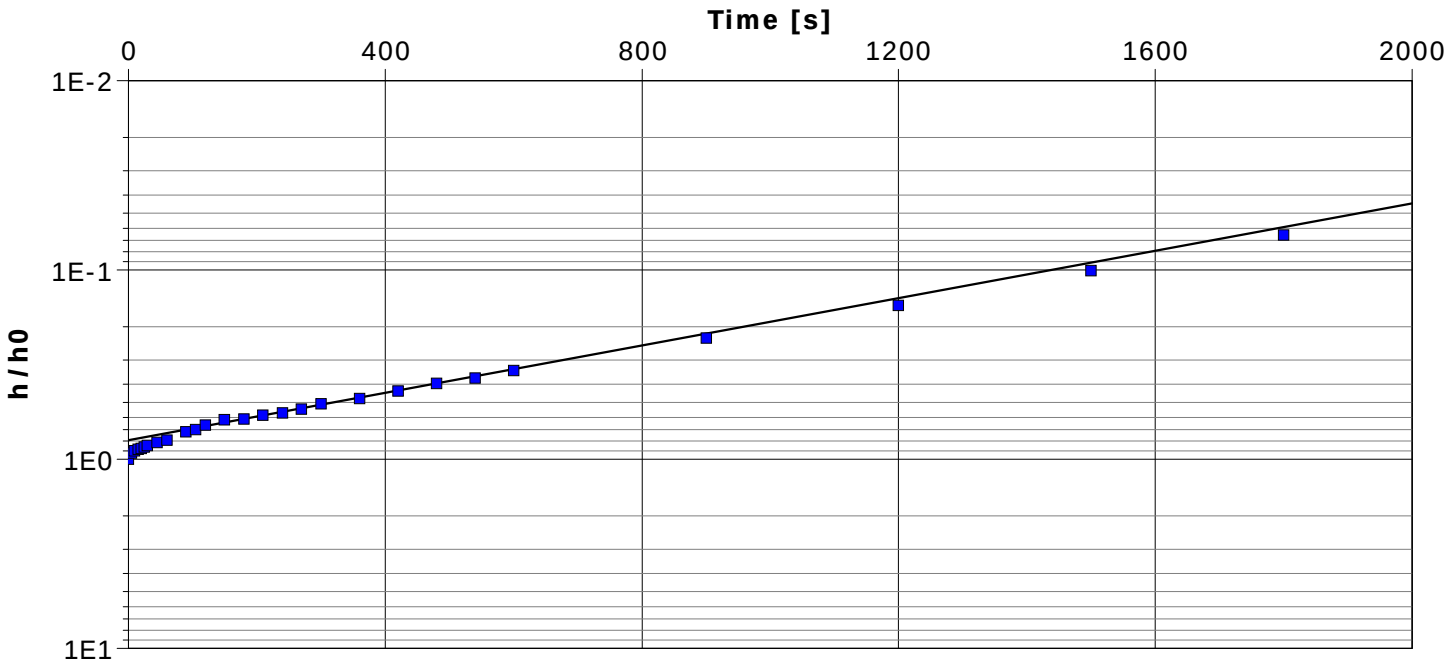


Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH2	2.14×10^{-7}	

Terraprobe Inc. 220 Bayview Dr, unit 25 Barrie, Ontario	**Slug Test Analysis Report**
	Project: 512 Huronia Road
	Number: 3-19-0101-46
	Client: Huronia Barrie Land Inc.

Location: Barrie, Ontario	Slug Test: Rising Head Test - BH 3	Test Well: BH3
Test Conducted by: MC		Test Date: 06/01/2020
Analysis Performed by: Bo	Bouver & Rice	Analysis Date: 06/01/2020
Aquifer Thickness: 5.00 m		

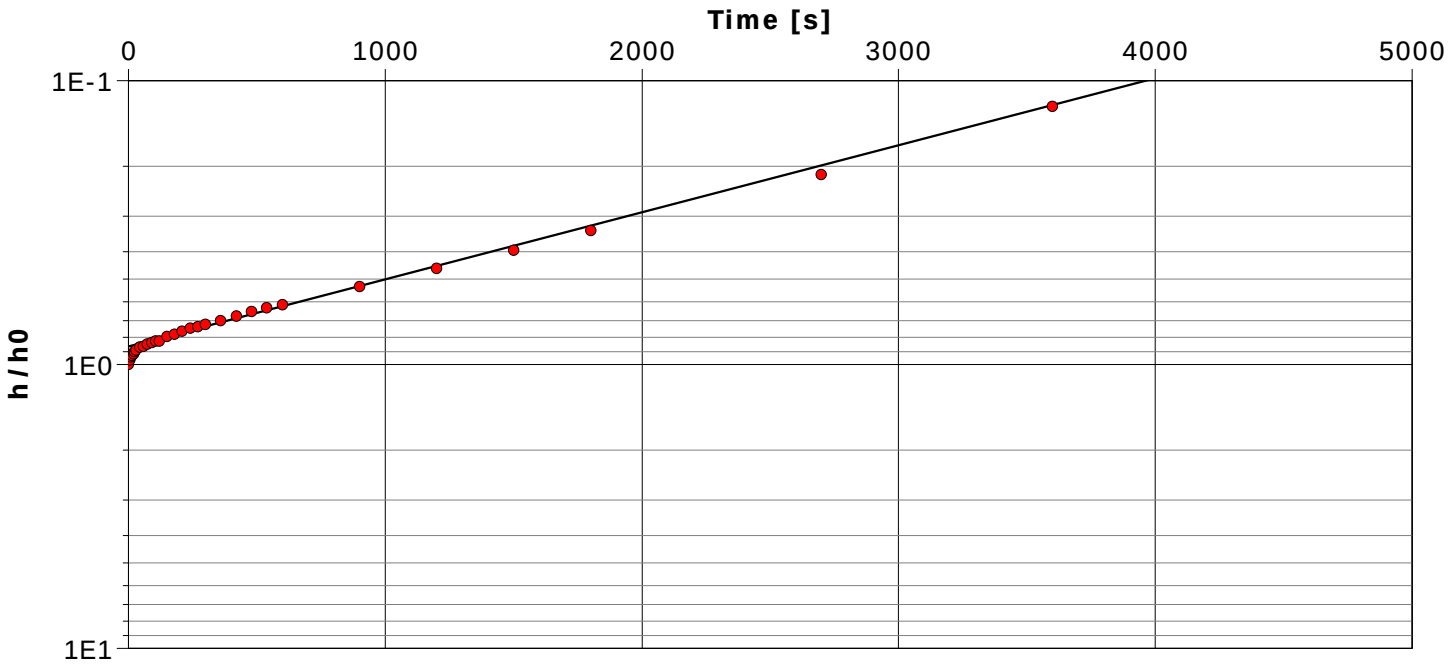


Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH3	5.59×10^{-7}	

Terraprobe Inc. 220 Bayview Dr, unit 25 Barrie, Ontario	**Slug Test Analysis Report**
	Project: 512 Huronia Road
	Number: 3-19-0101-46
	Client: Huronia Barrie Land Inc.

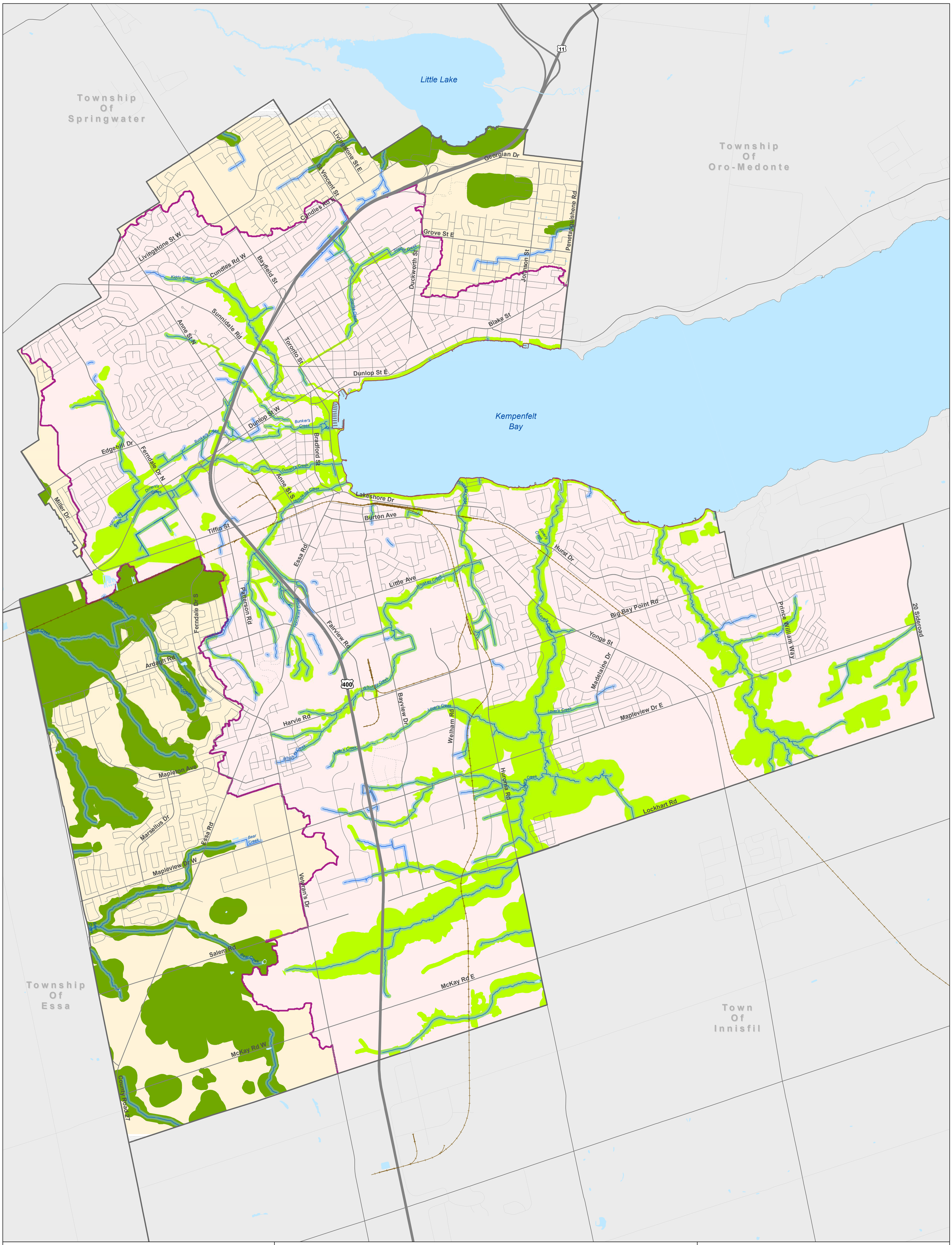
Location: Barrie, Ontario	Slug Test: Rising Head Test - BH 4	Test Well: BH4
Test Conducted by: MC		Test Date: 06/01/2020
Analysis Performed by: Bo	Bouwer & Rice	Analysis Date: 06/01/2020
Aquifer Thickness: 5.00 m		



Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [m/s]	
BH4	2.11×10^{-7}	

APPENDIX J



OFFICIAL PLAN
Schedule F
Conservation Authority Regulation Limits
Office Consolidation
January 2018

- Watercourse
- 30 Metre Watercourse Setback
- Waterbody
- Lake Simcoe Region Conservation Authority Regulation Limits
- Nottawasaga Valley Conservation Authority Regulation Limits
- Lake Simcoe Regional Conservation Authority
- Nottawasaga Valley Conservation Authority

Barrie

1:20,000

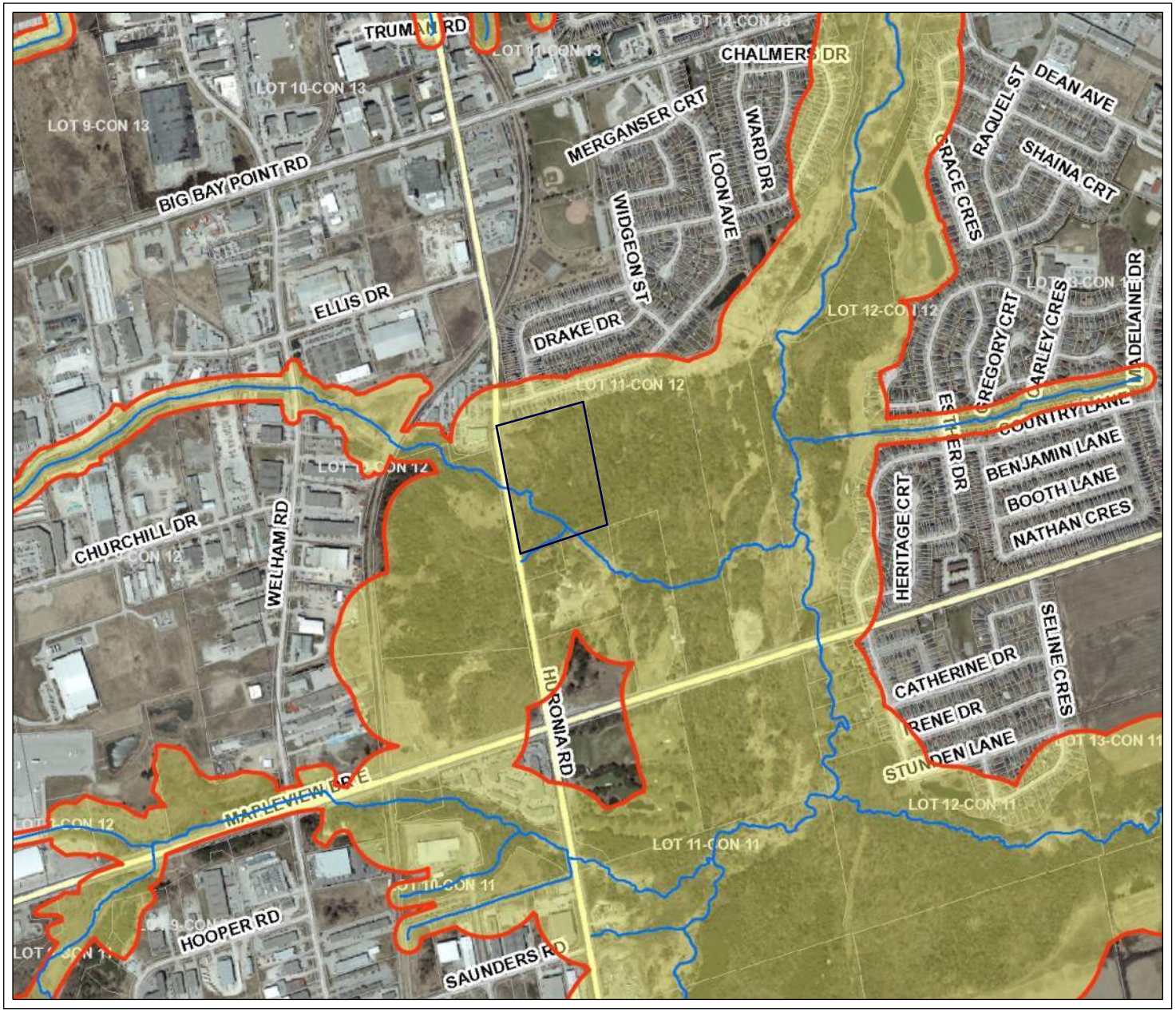
0 0.5 1 2 km

N

GIS Branch 4/26/2018

Lake Simcoe Region conservation authority

521 Huronia Rd - LSRCA Regulated Area



Features

- LSRCA Watershed Boundary
- Lake Simcoe
- Watercourse
- Regulated Area Boundary
- Regulated Area
- Road Labels
- Assessment Parcel
- Lot and Concession
- Roads
  - Hwy 400 Series
  - Highway, Arterials
  - Local Road
- Railway

Printed On:
10/19/2020

WGS_1984_Web_Mercator_Auxiliary_Sphere

Mapped By:

Scale 1: 14,154

719 0 360 719 Meters

Ontario

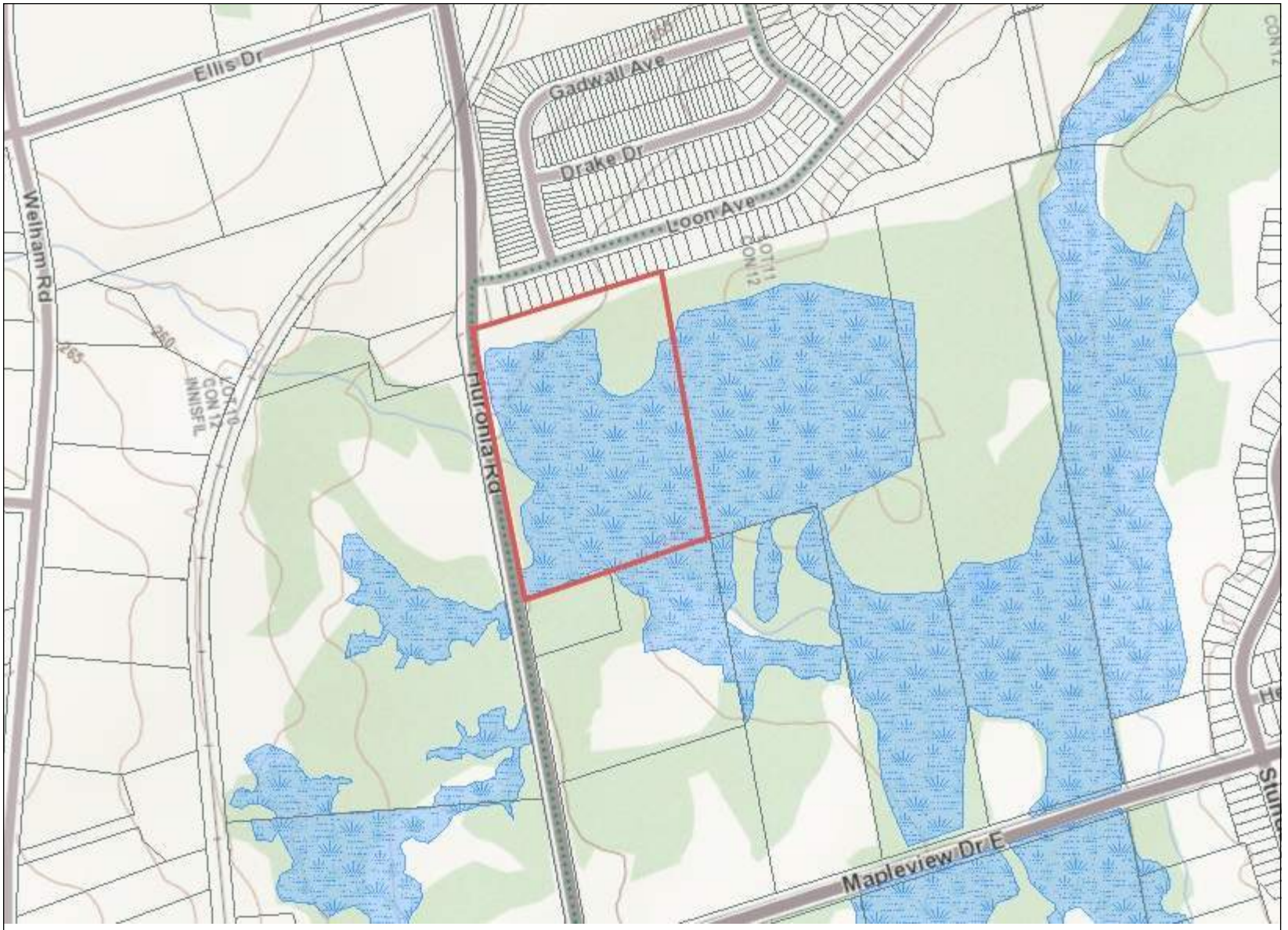
Ministry of Natural Resources and Forestry

Make-a-Map: Natural Heritage Areas

521 Huronia Rd - MNF Map

Map created: 10/19/2020

Notes: Enter map notes



Legend

- Assessment Parcel
- Woodland
- Conservation Reserve
- Provincial Park
- Natural Heritage System
- Ecoregion

Wetland

- Provincially Significant Wetland Evaluated
- Non - Provincially Significant Wetland Evaluated
- Unevaluated Wetland

Area of Natural Heritage & Scientific Interest (ANSI)

- Provincially Significant Life Science ANSI
- Provincially Significant Earth Science ANSI

Greenbelt Plan

- Boundary
- Greenbelt External Connections

Land Use Designations

- Protected Countryside
- Greenbelt Towns and Villages
- Greenbelt Hamlets
- Urban River Valley
- Greenbelt: Specialty Crop Area

Niagara Escarpment Plan (NEP)

- Boundary
- Parks and Open Space System

Land Use Designations

- Escarpment Natural Area
- Escarpment Protection Area
- Escarpment Rural Area
- Mineral Resource Extraction Area
- Escarpment Recreation Area
- Urban Area
- Minor Urban Centre

Oak Ridges Moraine Conservation Plan (ORM)

- Boundary

Land Use Designations

- Natural Core Area
- Natural Linkage Area
- Countryside Area
- Rural Settlement
- Palgrave Estates Residential Community
- Settlement Area

0.3 0 0.16 0.3

Kilometers

This map may not display all features listed in the legend because the feature layer was not turned on at the time the map was made; the features do not exist in the geographic range; or features have not been mapped. Absence of a feature in the map does not mean they do not exist in this area.

Ontario

Ministry of Natural Resources and Forestry

Make-a-Map: Natural Heritage Areas

521 Huronia Rd - MNF Map 2

Map created: 10/19/2020

Notes: Enter map notes

Legend

- Assessment Parcel
- Woodland
- Conservation Reserve
- Provincial Park
- Natural Heritage System
- Ecoregion

Wetland

- Provincially Significant Wetland Evaluated
- Non - Provincially Significant Wetland Evaluated
- Unevaluated Wetland

Area of Natural Heritage & Scientific Interest (ANSI)

- Provincially Significant Life Science ANSI
- Provincially Significant Earth Science ANSI

Greenbelt Plan

- Boundary
- Greenbelt External Connections

Land Use Designations

- Protected Countryside
- Greenbelt Towns and Villages
- Greenbelt Hamlets
- Urban River Valley
- Greenbelt: Specialty Crop Area

Niagara Escarpment Plan (NEP)

- Boundary
- Parks and Open Space System

Land Use Designations

- Escarpment Natural Area
- Escarpment Protection Area
- Escarpment Rural Area
- Mineral Resource Extraction Area
- Escarpment Recreation Area
- Urban Area
- Minor Urban Centre

Oak Ridges Moraine Conservation Plan (ORM)

- Boundary

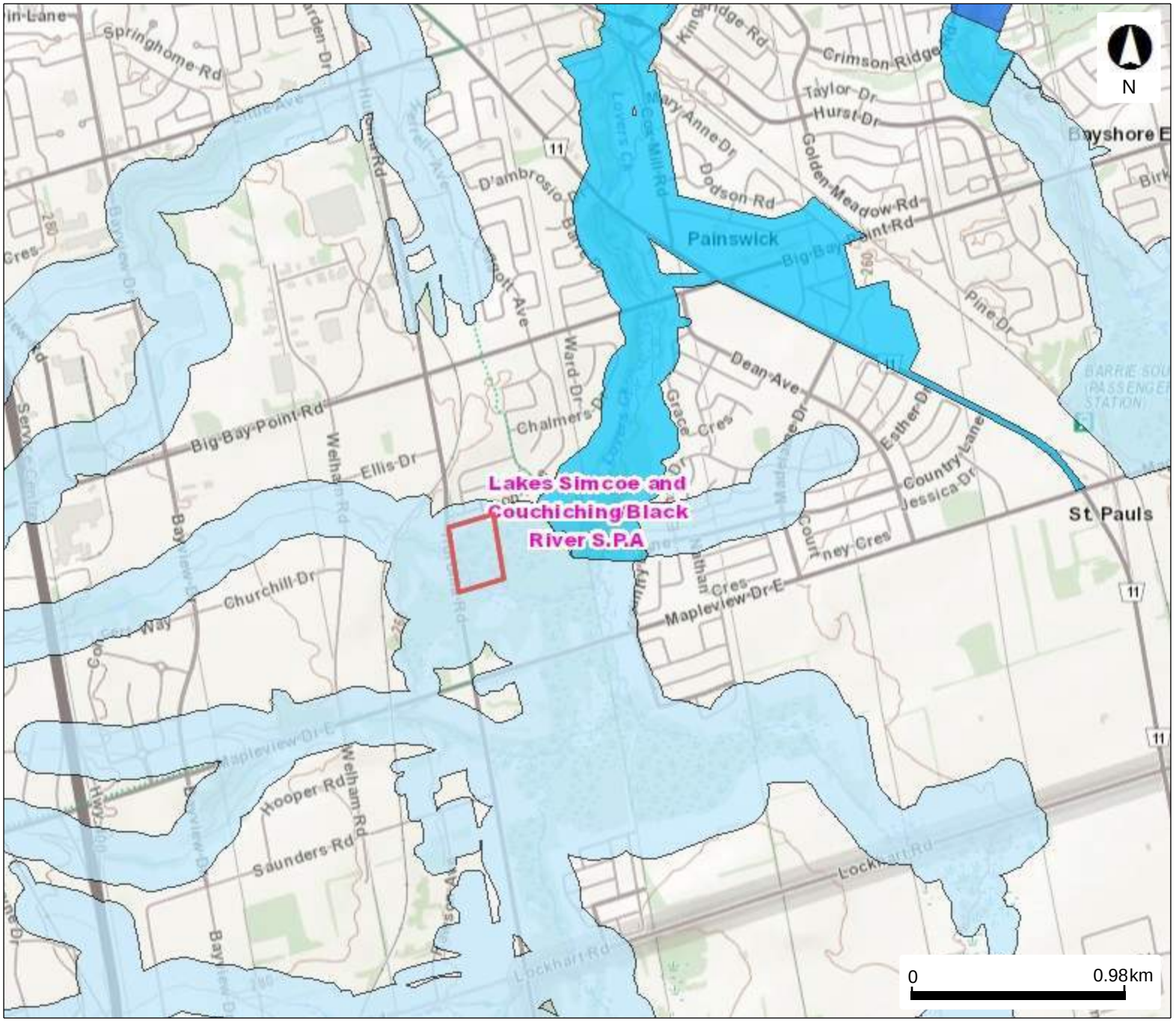
Land Use Designations

- Natural Core Area
- Natural Linkage Area
- Countryside Area
- Rural Settlement
- Palgrave Estates Residential Community
- Settlement Area

0.3 0 0.16 0.3 Kilometers

This map may not display all features listed in the legend because the feature layer was not turned on at the time the map was made; the features do not exist in the geographic range; or features have not been mapped. Absence of a feature in the map does not mean they do not exist in this area.

Intake Protection Zone



Legend

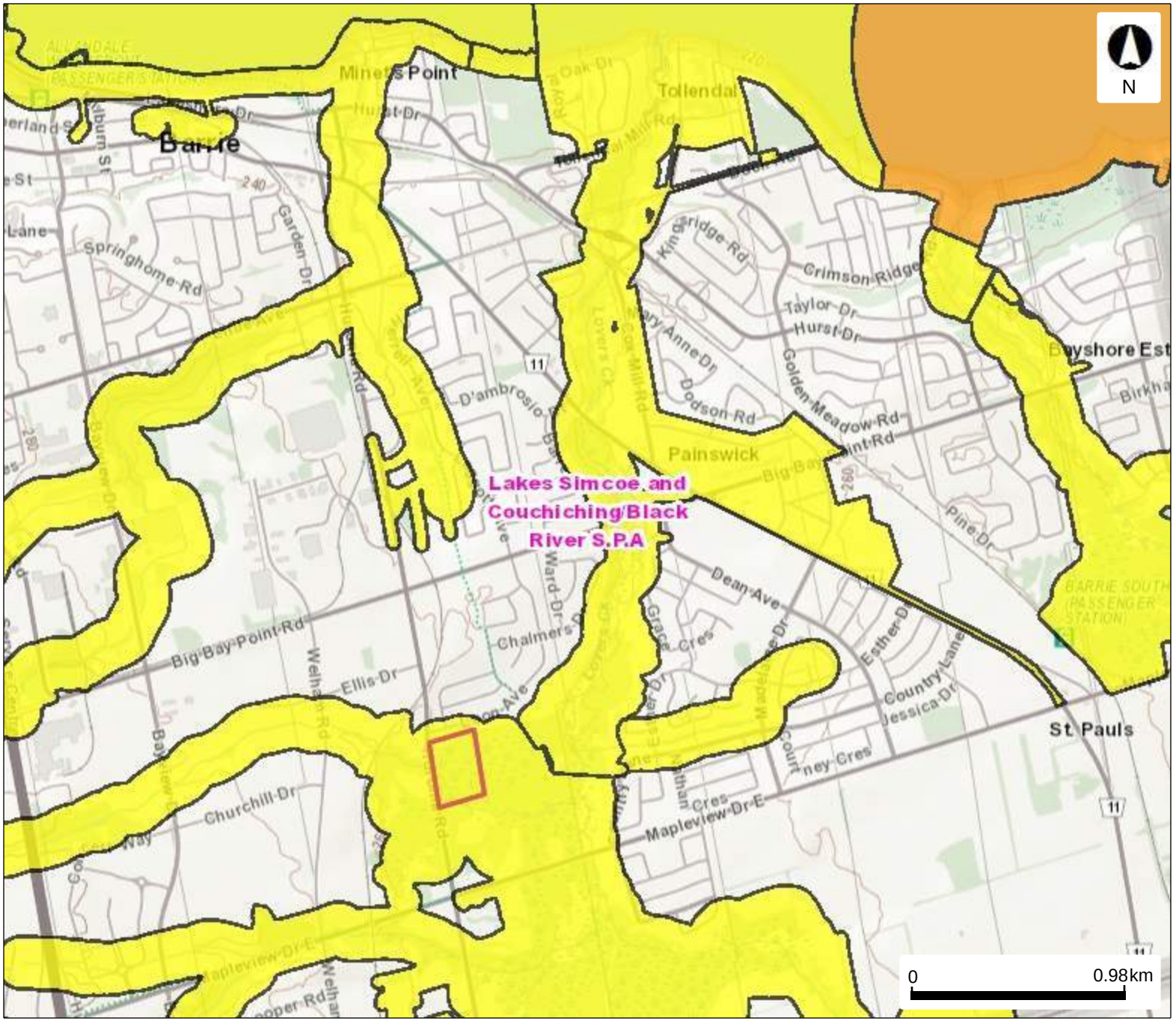
- Source Protection Areas
- WHPA Groundwater Under Direct Influence (WHPA-E)
- Intake Protection Zone 1
- Event Based Areas
- Intake Protection Zone 2
- Intake Protection Zone 3

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: 10/19/2020
Map Center: 44.34755 N, -79.65576 W

Vulnerable Scoring Area - Surface Water



Legend

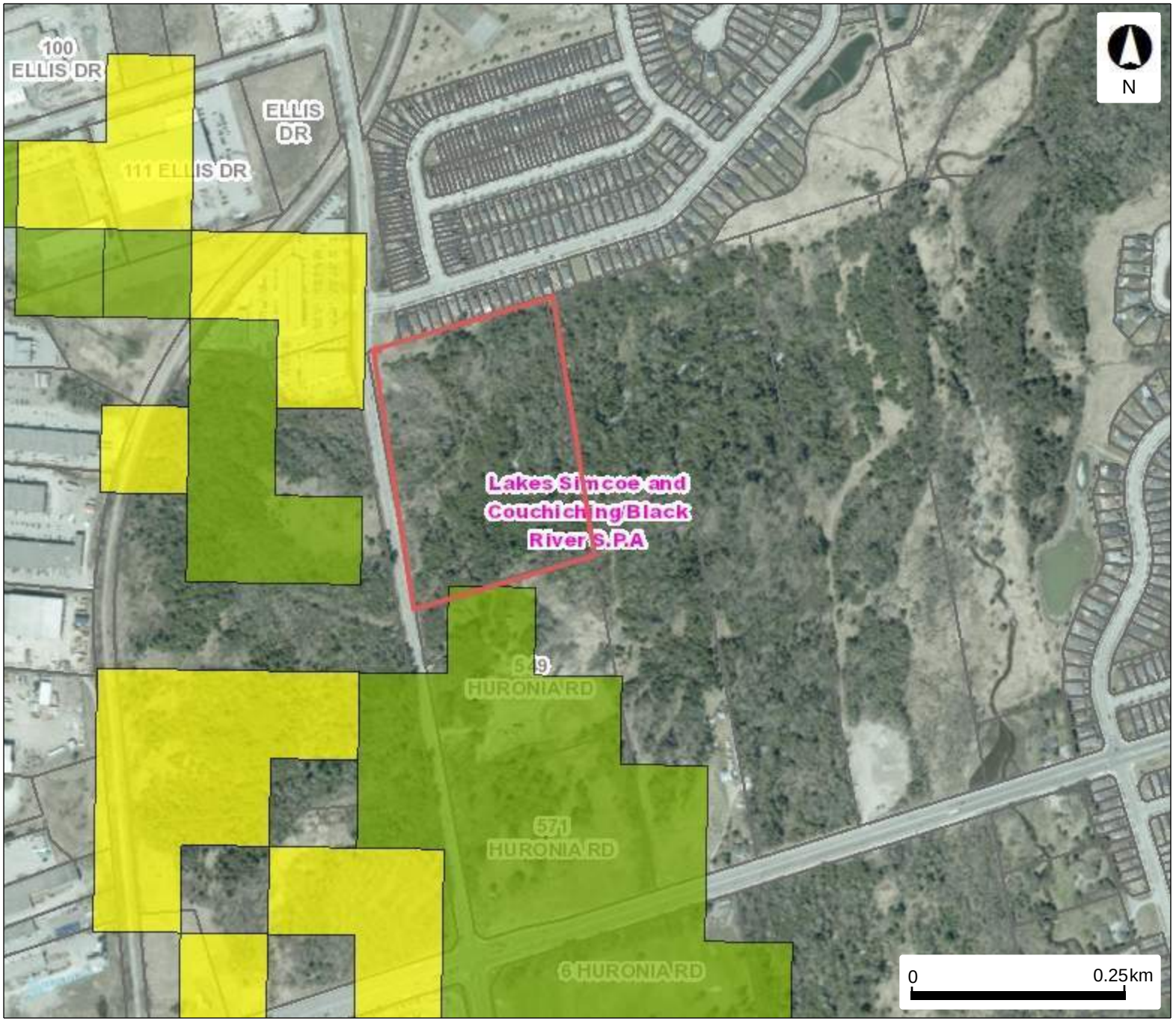
- Source Protection Areas
- Event Based Areas
- Vulnerable Scoring Area - Surface Water
  - 0 - 3.9
  - 4 - 7.9
  - 8 - 8.9
  - 9 - 10

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: 10/19/2020
Map Center: 44.35639 N, -79.65464 W

Significant Groundwater Recharge Area



Legend

- Source Protection Areas
- Significant Groundwater Recharge Area
  - 0
  - 2
  - 4
  - 6
- Event Based Areas
- Assessment Parcel

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: 10/19/2020
Map Center: 44.34522 N, -79.66065 W

Highly Vulnerable Aquifer

Legend

- Source Protection Areas
- Highly Vulnerable Aquifers
- Event Based Areas
- Assessment Parcel

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: 10/19/2020
Map Center: 44.34522 N, -79.66065 W

APPENDIX K

Guelph Permeameter

SOILMOISTURE

Input

Result

Single Head Method (1)

Reservoir Cross-sectional area in cm^2

(enter "35.22" for Combined and "2.16" for Inner reservoir): 35.22

Enter water Head Height ("H" in cm): 5

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 2

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

Steady State Rate of Water Level Change ("R" in cm/min): 12.0000

Res Type	35.22
H	5
a	3
H/a	1.667
a*	0.04
C0.01	0.809
C0.04	0.842
C0.12	0.803
C0.36	0.803
C	0.842
R	#####
Q	7.044
pi	3.142

α^* = 0.04 cm^{-1}

C = 0.842059

Q = 7.044

K_{fs} = 6.14E-03 cm/sec
3.68E-01 cm/min
6.14E-05 m/sec
1.45E-01 inch/min
2.42E-03 inch/sec

Φ_m = 1.53E-01 cm^2/min

Single Head Method (2)

Reservoir Cross-sectional area in cm^2

(enter "35.22" for Combined and "2.16" for Inner reservoir): 35.22

Enter water Head Height ("H" in cm): 10

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 3

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

Steady State Rate of Water Level Change ("R" in cm/min): 18.0000

Res Type	35.22
H	10
a	3
H/a	3.33333
a*	0.12
C0.01	1.21841
C0.04	1.29023
C0.12	1.28754
C0.36	1.28754
C	1.28754
R	18.000
Q	10.566
pi	3.1415

α^* = 0.12 cm^{-1}

C = 1.287543

Q = 10.566

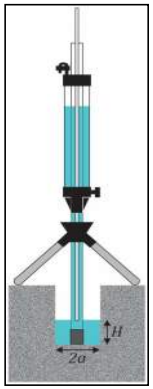
K_{fs} = 1.14E-02 cm/sec
6.87E-01 cm/min
1.14E-04 m/ses
2.70E-01 inch/min
4.51E-03 inch/sec

Φ_m = 9.54E-02 cm^2/min

Average

K_{fs} = 8.79E-03 cm/sec
5.28E-01 cm/min
8.79E-05 m/s
2.08E-01 inch/min
3.46E-03 inch/sec

Φ_m = 1.24E-01 cm^2/min



Double Head Method

Reservoir Cross-sectional area in cm^2

(enter "35.22" for Combined and "2.16" for Inner reservoir): 35.22

Enter the first water Head Height ("H1" in cm): 5

Enter the second water Head Height ("H2" in cm): 10

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 3

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

α^* = 0.12 cm^{-1}

α = 0.0547

Steady State Rate of Water Level Change ("R1" in cm/min): 12.0000

Steady State Rate of Water Level Change ("R2" in cm/min): 18.0000

Q_1 = 7.044

Q_2 = 10.566

Res Type:	35.22
H1/a:	1.666667
H2/a:	3.333333
C1-0.01:	0.809485
C2-0.01:	1.21841
C1-0.04:	0.842059
C2-0.04:	1.290234
C1-0.12:	0.803154
C2-0.12:	1.287543
C1-0.36:	0.803154
C2-0.36:	1.287543
G-Denominator:	1525.687

C_1 = 0.803154

C_2 = 1.287543

G_1 = 0.005264

G_2 = 0.00422

G_3 = 0.055692

G_4 = 0.024148

K_{fs} = 7.50E-03 cm/sec
4.50E-01 cm/min
7.50E-05 m/sec
1.77E-01 inch/min
2.95E-03 inch/sec

Φ_m = 1.37E-01 cm^2/min

θ_{fs} = 0 cm^3/cm^3

θ_i = 0 cm^3/cm^3

Sorptivity 0.0000 $(cm\ min^{-\frac{1}{2}})$

Calculation formulas related to shape factor (C). Where H_1 is the first water head height (cm), H_2 is the second water head height (cm), a is borehole radius (cm) and α^* is microscopic capillary length factor which is decided according to the soil texture-structure category. For one-head method, only C_1 needs to be calculated while for two-head method, C_1 and C_2 are calculated (Zang et al., 1998).

Soil Texture-Structure Category	$\alpha^*(cm^{-1})$	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left(\frac{H_1/a}{2.081 + 0.121\left(H_2/a\right)}\right)^{0.672}$
Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.	0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.091\left(H_1/a\right)}\right)^{0.683}$ $C_2 = \left(\frac{H_2/a}{1.992 + 0.091\left(H_2/a\right)}\right)^{0.683}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093\left(H_1/a\right)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093\left(H_2/a\right)}\right)^{0.754}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093\left(H_1/a\right)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093\left(H_2/a\right)}\right)^{0.754}$

Calculation formulas related to one-head and two-head methods. Where R is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm^2/s), α^* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm) , H_2 is the second head of water established in borehole (cm) and C is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)}$ $\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1}$
One Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_2 = \frac{H_1 C_2}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $K_{fs} = G_2Q_2 - G_1Q_1$ $G_3 = \frac{(2H_2^2 + a^2C_2)C_1}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	$G_4 = \frac{(2H_1^2 + a^2C_1)C_2}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $\Phi_m = G_3Q_1 - G_4Q_2$

Guelph Permeameter

SOILMOISTURE

Input

Result

Single Head Method (1)

Reservoir Cross-sectional area in cm^2

(enter "35.22" for Combined and "2.16" for Inner reservoir): 35.22

Enter water Head Height ("H" in cm): 5

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 2

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

Steady State Rate of Water Level Change ("R" in cm/min): 0.5000

Res Type	35.22
H	5
a	3
H/a	1.667
a*	0.04
C0.01	0.809
C0.04	0.842
C0.12	0.803
C0.36	0.803
C	0.842
R	0.500
Q	0.294
pi	3.142

α^*= 0.04 cm^{-1}

C = 0.842059

Q = 0.2935

K_{fs} = 2.56E-04 cm/sec
1.53E-02 cm/min
2.56E-06 m/sec
6.04E-03 inch/min
1.01E-04 inch/sec

Φ_m = 6.39E-03 cm^2/min

Single Head Method (2)

Reservoir Cross-sectional area in cm^2

(enter "35.22" for Combined and "2.16" for Inner reservoir): 35.22

Enter water Head Height ("H" in cm): 10

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 3

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

Steady State Rate of Water Level Change ("R" in cm/min): 0.5000

Res Type	35.22
H	10
a	3
H/a	3.33333
a*	0.12
C0.01	1.21841
C0.04	1.29023
C0.12	1.28754
C0.36	1.28754
C	1.28754
R	0.500
Q	0.2935
pi	3.1415

α^*= 0.12 cm^{-1}

C = 1.287543

Q = 0.2935

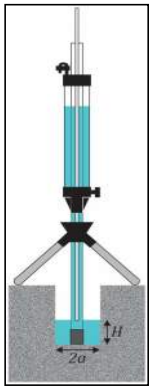
K_{fs} = 3.18E-04 cm/sec
1.91E-02 cm/min
3.18E-06 m/ses
7.51E-03 inch/min
1.25E-04 inch/sec

Φ_m = 2.65E-03 cm^2/min

Average

K_{fs} = 2.87E-04 cm/sec
1.72E-02 cm/min
2.87E-06 m/s
6.78E-03 inch/min
1.13E-04 inch/sec

Φ_m = 4.52E-03 cm^2/min



Double Head Method

Reservoir Cross-sectional area in cm^2

(enter "35.22" for Combined and "2.16" for Inner reservoir): 35.22

Enter the first water Head Height ("H1" in cm): 5

Enter the second water Head Height ("H2" in cm): 10

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 3

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

α^*= 0.12 cm^{-1}

α= -0.0331

Steady State Rate of Water Level Change ("R1" in cm/min): 0.5000

Steady State Rate of Water Level Change ("R2" in cm/min): 0.5000

Q_1 = 0.2935

Q_2 = 0.2935

Res Type:	35.22
H1/a:	1.666667
H2/a:	3.333333
C1-0.01:	0.809485
C2-0.01:	1.21841
C1-0.04:	0.842059
C2-0.04:	1.290234
C1-0.12:	0.803154
C2-0.12:	1.287543
C1-0.36:	0.803154
C2-0.36:	1.287543
G-Denominator:	1525.687

C_1 = 0.803154

C_2 = 1.287543

G_1 = 0.005264

G_2 = 0.00422

G_3 = 0.055692

G_4 = 0.024148

K_{fs} = -3.07E-04 cm/sec
-1.84E-02 cm/min
-3.07E-06 m/sec
-7.24E-03 inch/min
-1.21E-04 inch/sec

Φ_m = 9.26E-03 cm^2/min

Θ_{fs} = 0 cm^3/cm^3

Θ_i = 0 cm^3/cm^3

Sorptivity 0.0000 $(cm\ min^{-\frac{1}{2}})$

Calculation formulas related to shape factor (C). Where H_1 is the first water head height (cm), H_2 is the second water head height (cm), a is borehole radius (cm) and α^* is microscopic capillary length factor which is decided according to the soil texture-structure category. For one-head method, only C_1 needs to be calculated while for two-head method, C_1 and C_2 are calculated (Zang et al., 1998).

Soil Texture-Structure Category	$\alpha^*(cm^{-1})$	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left(\frac{H_1/a}{2.081 + 0.121\left(H_2/a\right)}\right)^{0.672}$
Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.	0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.091\left(H_1/a\right)}\right)^{0.683}$ $C_2 = \left(\frac{H_2/a}{1.992 + 0.091\left(H_2/a\right)}\right)^{0.683}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093\left(H_1/a\right)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093\left(H_2/a\right)}\right)^{0.754}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093\left(H_1/a\right)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093\left(H_2/a\right)}\right)^{0.754}$

Calculation formulas related to one-head and two-head methods. Where R is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm^2/s), α^* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm) , H_2 is the second head of water established in borehole (cm) and C is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)}$ $\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1}$
One Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_2 = \frac{H_1 C_2}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $K_{fs} = G_2Q_2 - G_3Q_1$ $G_3 = \frac{(2H_2^2 + a^2C_2)C_1}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	$G_4 = \frac{(2H_1^2 + a^2C_1)C_2}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $\Phi_m = G_3Q_1 - G_4Q_2$

APPENDIX L

Water Balance

1. Climate Information *(for LSRCA use the rate provided on their website)*

Precipitation	914	mm/a	0.91	m/a
Evapotranspiration	545	mm/a	0.55	m/a
Water Surplus	369	mm/a	0.37	m/a

2. Infiltration Rates

Table 2 Approach - Infiltration Factors

Hilly land, average slope of 28 to 47 m per km	0.1
Open Sandy Loam	0.4
Woodland	0.2
TOTAL:	0.7

Infiltration (Infil. Fac - Water Surplus)	258.3	mm/a	0.2583	m/a
Run-off (Water Surplus - B19)	111	mm/a	0.1107	m/a

Table 3 Approach - Typical Recharge Rates

silty sand to sandy silt	150 - 200	mm/a
silt	125 - 150	mm/a
clayey silt	100 - 125	mm/a

The site development area is underlain by silty sand to silty clay till.

Based on the above, the recharge rate is	125	mm/a	0.125	m/a
with runoff of	244	mm/a	0.244	m/a

Property Statistics

3. Pre- Development Site Coverage

Area Covered by Existing Building	0	m^2	0.00	ha
Area Covered by Existing Hard Surface Paving	0	m^2	0.00	ha
Area Covered by Existing Landscaped area	11,092	m^2	1.11	ha
TOTAL	11,092	m^2	1.11	ha

4. Post-Development Coverage

Area Covered by Building with Additions	2,731	m^2	0.27	ha
Area Covered by Hard Surface Paving	3,750	m^2	0.38	ha
Area Covered by Landscaped Area	4,611	m^2	0.46	ha
TOTAL:	11,092	m^2	1.11	ha

Water Balance

5. Annual Water Balance Before Building Additions

Land Use	Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Evaporation (m^3)	Infiltration (m^3)	Run-Off (m^3)
Building (entire site)	0	0	-	-	-	-
Hard Surface Paving	0	0	-	-	-	-
Landscape Area (entire site)	11,092	10,138	6,045		1,387	2,706
TOTAL	**11,092**	**10,138**	**6,045**	**0**	**1,387**	**2,706**

6. Annual Water Balance After Building Additions

Land Use	Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Evaporation (m^3)	Infiltration (m^3)	Run-Off (m^3)
Building (entire site)	2,731	2,496	-	-	-	2,496
Hard Surface Paving	3,750	3,428	-	-	-	3,428
Landscape Area (entire site)	4,611	4,214	2,513	-	576	1,125
TOTAL	**11,092**	**10,138**	**2,513**	**0**	**576**	**7,049**

7. Comparison of Pre-Development (before buidling additions) and Post-Development (after building additions)

	Precipitation (m^3)	Evapotranspiration (m^3)	Evaporation (m^3)	Infiltration (m^3)	Run-Off (m^3)
Pre-Development	10, 138	6,045	-	1,387	2,706
Post-Development	10,138	2,513	-	576	7,049
				811	

8. Requirement for Infiltration of Roof Runoff

Volume of roof (building additions) run-off captured (90%)	2,496	m^3
Volume of post-development infiltration without roof run-off	576	m^3
Volume of roof run-off required to match pre-development infiltration rates	811	m^3
Percentage of roof run-off (building additions roof) required to match pre-development infiltration	32%	

APPENDIX M

	Borehole No.	T-BH1		T-BH2		T-BH3		T-BH4	
	Ground Elev. (masl)	252.0		251.7		250.5		249.3	
	Well Screen Elev. (masl)	243.2-240.2		242.3-239.3		244.2-241.2		244.1-241.1	
	Strata Screened	Lower Sands		Lower Sands		Silty Clay Till/Lower Sands		Silty Clay Till/Lower Sands	
Terraprobe Inc. Monitoring Wells	Date	Depth (m)	Elev. (masl)	Depth (m)	Elev. (masl)	Depth (m)	Elev. (masl)	Depth (m)	Elev. (masl)
	Sept 30, 2019	2.4	249.6	2.6	249.1	3.7	246.8	4.1	245.2
	Dec 5, 2019	1.9	250.1	1.8	249.9	3.0	247.5	3.5	245.8
	Jan 3, 2020	1.7	250.3	1.8	249.9	2.8	247.7	3.2	246.1
	Aug 28, 2020	1.8	250.2	1.9	249.8	2.7	247.8	3.3	246.0
	Oct 9, 2020	1.9	250.1	2.0	249.7	2.9	247.6	3.4	245.9
	Oct 13, 2020	1.9	250.1	2.0	249.7	2.9	247.6	3.4	245.9
	Oct 23, 2020	1.8	250.2	1.9	249.8	2.8	247.7	3.3	246.0
	Oct 30, 2020	1.8	250.2	1.9	249.8	2.8	247.7	3.3	246.0
	Nov 6, 2020	1.9	250.1	1.9	249.8	2.8	247.7	3.4	245.9
	Dec 17, 2020	1.6	250.4	1.6	250.1	2.4	248.1	2.9	246.4
	Jan 25, 2021	1.9	250.1	2.0	249.7	3.0	247.5	3.4	245.9
	Feb 27, 2021	2.1	249.9	2.2	249.5	3.1	247.4	3.6	245.7
	Mar 31, 2021	1.7	250.3	1.8	249.9	2.7	247.8	3.2	246.1
	Apr 30, 2021	1.7	250.3	1.8	249.9	2.7	247.8	3.2	246.1
	May 18, 2021	1.8	250.2	1.9	249.8	2.7	247.8	3.3	245.9
	June 14, 2021	2.1	249.9	2.2	249.5	3.1	247.7	3.1	246.2
	Maximum GW Elevation (masl)	**250.4**		**250.1**		**248.1**		**246.4**	

	Borehole No.	BH101		BH102		BH103		BH104		BH105	
	Ground Elev. (masl)	246.9		246.8		246.1		246.6		245.8	
	Well Screen Elev. (masl)	245.7 - 242.6		245.6 - 242.5		245.2 - 242.1		245.4 - 242.3		244.6 - 241.5	
	Strata Screened	Silty Clay Till		Silty Clay Till		Upper Sands/ Silty Clay Till		Silty Clay Till		Upper Sands/ Silty Clay Till	
Grounded Engineering Monitoring Wells	Date	Depth (m)	Elev. (masl)	Depth (m)	Elev. (masl)	Depth (m)	Elev. (masl)	Depth (m)	Elev. (masl)	Depth (m)	Elev. (masl)
	Oct 9, 2020	0.9	246.0	0.8	246.0	0.3	245.8	0.4	246.2	0.3	245.5
	Oct 13, 2020	0.9	246.0	0.7	246.1	0.2	245.9	0.3	246.3	0.3	245.5
	Oct 23, 2020	0.8	246.1	0.7	246.1	0.1	246.0	0.2	246.4	0.2	245.6
	Oct 30, 2020	0.7	246.2	0.7	246.1	0.1	245.9	0.1	246.4	0.2	245.6
	Nov 6, 2020	0.7	246.2	0.6	246.2	0.2	245.9	0.2	246.4	0.2	245.6
	Dec 17. 2020	0.3	246.6	0.4	246.4	0.1	246.0	0.1	246.5	0.2	245.6
	Jan 25, 2021	0.7	246.2	0.6	246.2	0.2	245.9	0.3	246.3	0.2	245.6
	Feb 27, 2021	0.8	246.1	0.6	246.2	0.2	245.9	0.3	246.3	0.2	245.6
	Mar 31, 2021	0.4	246.5	0.4	246.4	0.2	245.9	0.2	246.4	0.2	245.6
	Apr 30, 2021	0.4	246.4	0.4	246.3	0.04	246.1	0.1	246.5	0.2	245.6
	May 18, 2021	0.7	246.2	0.6	246.2	0.2	245.8	0.4	246.2	0.3	245.5
	Jun 14, 2021	1.3	245.6	1.0	245.8	0.5	245.6	0.6	245.9	0.5	245.3
	Maximum GW Elevation (masl)	**246.6**		**246.4**		**246.1**		**246.5**		**245.6**	