Consulting
Engineers and
Scientists

Hydrogeological Investigation

Proposed Residential Development

159 Huronia Road
Barrie, Ontario

Submitted to:
N.J. Electric General Contracting
182 Berkshire Drive
Aurora, Ontario
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Submitted by:
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1. Introduction

GEI Consultants (GEI) was retained by N. J. Electric General Contracting (the Client) to complete a subsurface investigation and provide a hydrogeological report for the proposed residential development at 159 Huronia Road, in Barrie, Ontario. A site location plan is provided as Figure 1.

The property located at 159 Huronia Road in Barrie is rectangular in shape with a total site area of 0.14 hectares. The site is located on the northeast corner of the Huronia Road and Little Avenue intersection. The property is currently occupied by one residential dwelling with a single level and a basement, which will be demolished prior to any development. The site lies within a Lake Simcoe Regional Conservation Authority (LSRCA) regulated area, with the eastern portion of the site being identified as a “floodplain” and/or “floodplain setback”, however the proposed townhomes are planned to be developed outside of the floodplain.

The proposed development includes multiple townhomes with driveways directly connected to Huronia Road. Detailed site plans are not yet available and details pertaining to the townhome design, including the depth of any of basements, are not yet known. The property will be municipally serviced. An aerial image of the site is provided on Figure 2A, and the proposed concept plan is included as Figure 2B.

GEI was provided with the following correspondence, comments letter, and Conceptual Site Plan for review in preparation of this proposal:

- “Zoning By-Law Amendment Pre-Consultation Review Planning Comments”, File No. D28-111-2021, dated February 9, 2022, by the City of Barrie.
- “Conceptual Site Plan – 159 Huronia Road, Ontario”, File No. 21-1152, dated December 8, 2021, by Innovative Planning Solutions.
- “159 Huronia Road, Barrie – Floodplain Area and Elevation”, email dated February 16, 2022, by LSRCA.
- “159 Huronia Drive, Barrie, Ontario – Hydraulic Analysis and Floodplain Analysis” letter dated August 26, 2022, by Water’s Edge Environmental Solutions Team.
- “Conceptual Site Plan – 159 Huronia Road, Ontario”, File No. 21-1152, dated February 23, 2023, by Innovative Planning Solutions.

It is noted that the recommendations provided in this report must be considered preliminary in nature due to the current uncertainty of the design for the project. As the design progresses further hydrogeological review and input may be required which might necessitate the need for additional investigation and/or analysis.

GEI has also been retained to complete a geotechnical study for the site and the findings and recommendations are provided under separate cover.

It is noted that geoenvironmental assessment, chemical testing, etc. was not part of the current scope. GEI would be please to revise the scope to include geoenvironmental aspects, if requested.

1.1 Purpose and Scope of Work

The main objectives of the hydrogeological Investigation were to:

a) Establish the local hydrogeological settings of the site;

b) Provide an assessment of anticipated construction dewatering flow rates for a general servicing scenario;

c) Assess use of Low Impact Development (LID) measures;

d) Assess groundwater quality and compare the results to the applicable City of Barrie Storm Sewer Use By-Law Criteria, Provincial Water Quality Objective (PWQO), and O.Reg.153/04, as amended, Site Condition Standards (SCSs);

e) Qualitatively assess the potential impact from dewatering to the nearby structures, water bodies and water uses, if any, and comment on future regulatory agency involvement;

f) Complete a water balance (pre- and post-construction);

g) Complete a preliminary phosphorous budget; and,

h) Prepare a hydrogeological investigation report.

To achieve the investigation objectives, GEI proposed and initiated the following scope of work:

a) Conduct a background desktop review of pertinent geological and hydrogeological resources, Ministry of Environment, Conservation and Parks (MECP) Water Well Records, previous reports, and proposed site plan drawings.

b) Visit the site and note existing site conditions, site setting, topography, drainage, water features, and potential water wells within 500 m of the site, if any.

c) Utilization of the three (3) boreholes and three (3) monitoring wells, completed as part of the concurrent geotechnical investigation.

d) Revisit the site and measure groundwater levels, perform borehole permeability testing in all three (3) monitoring wells, and retrieve representative groundwater samples.

e) Submit one (1) representative unfiltered groundwater sample for laboratory testing to compare against the Town of Barrie Storm Sewer Use By-Law Criteria, PWQO standards for Metals and Total Suspended Solids (TSS) and, O.Reg. 153/04, as amended, for Petroleum Hydrocarbons (PHCs), and Volatile Organic Compounds (VOCs).

f) Submit one (1) representative filtered groundwater sample for laboratory testing to compare against the PWQO standards for Metals and TSS.

g) Test three (3) selected soil samples for particle size distribution (as per Ontario LS standards in reference to ASTM D6913 and D7928).

h) Evaluate the background information, field and laboratory data to assess construction dewatering and permanent dewatering requirements.

i) Complete a water balance (pre- and post-construction) for the proposed development.

j) Complete a preliminary phosphorous budget for the proposed development.

1.2 Regulatory Requirements

1.2.1 Water Taking – Temporary

The volume of water entering the excavation during construction will be based on both groundwater infiltration and precipitation events. Based on O.Reg. 63/16, the following dewatering limits and requirements are as follows:

- Construction Dewatering less than 50,000 L/day: The takings of both groundwater and stormwater does not require a hydrogeological report, does not require registration on the Environmental Activity and Sector Registry (EASR), and does not require a Permit-to-Take-Water (PTTW) from the MECP.
- Construction Dewatering greater than 50,000 L/day and less than 400,000 L/day: The taking of groundwater and/or stormwater requires a hydrogeological report and registration on the EASR but does not require a PTTW from the MECP.
- Construction Dewatering greater than 400,000 L/day: The taking of groundwater and/or stormwater requires a hydrogeological report and requires a PTTW from the MECP.

1.2.2 Source Water Protection

The site is within the jurisdiction of the LSRCA. The site is also within the Lake Simcoe and Couchiching / Black River Source Protection Area, in the South Georgian Bay Lake Simcoe Source Protection Region. The following documents should be used in determination of the regulatory requirements when it comes to maintaining hydrogeological function at this site:

> "*Approved South Georgian Bay Lake Simcoe Source Protection Plan",* dated June 16, 2021, by the South Georgian Bay Lake Simcoe source protection region.

Based on Source Water Protection online mapping, the following is noted:

- Wellhead Protection Area (WHPA): The site is located within a WHPA Q2 (WHPA-Q2) (Figure 3). The WHPA-Q2 includes the cone of influence around various Barrie water supply wells and any area where a future reduction in recharge would significantly impact that area.

- Intake Protection Zone (IPZ): The site is located within the Barrie Drinking Water System IPZ-3 (Figure 4).
- Highly Vulnerable Aquifer (HVA): The site is located within an HVA (Figure 5).
- Significant Groundwater Recharge Area (SGRA): The site is not located within an SGRA (Figure 6).
- The site is not located within the Oak Ridges Moraine.
- The site is not located within the Niagara Escarpment.

"Lake Simcoe Protection Plan Water Budget Policy for LSPP 4.8-DP and 6.40-DP," (by LSRCA, dated November 2018) Section 6.0 describes the policy hierarchy for water balance required for Lake Simcoe Watershed. The policies from most to least stringent are described below:

- Source Protection Plan Land Use Policy (SPP LUP) 12: *"Planning Approval Authorities shall only permit new major development (excluding single detached residential, barns and non-commercial structures that are accessory to an agricultural operation) in a WHPA-Q2 where the activity would be a significant drinking water threat, where it can be demonstrated through the submission of a hydrogeological study that the existing water balance can be maintained through the use of best management practices such as low impact development. Where necessary, implementation and maximization of off-site recharge enhancement within the same WHPA-Q2 to compensate for any predicted loss of recharge from the development."*
- Designated Policy (DP) 6.40: *"Outside of the Oak Ridges Moraine area, an application for major development within a significant groundwater recharge area (SGRA) shall be accompanied by an environmental impact study that demonstrates that the quality and quantity of groundwater in these areas and the function of the recharge areas will be protected, improved or restored."*
- Designated Policy (DP) 4.8d: *"An application for major development shall be accompanied by a stormwater management plan that demonstrates: through an evaluation of anticipated changes in the water balance between pre-development and post-development, how such changes shall be minimized."*

The site is a "major development," and is within a WHPA Zone Q2, is within an HVA, and is not within an SGRA, therefore only SPP LUP-12 and DP-4.8d apply to the site. A water balance and recommended mitigation measures are discussed in Section 5. Based on Table 2 in *"Lake Simcoe Protection Plan Water Budget Policy for LSPP 4.8-DP and 6.40-DP,"* infiltration-based practices may not be permitted from parking lots for the development (to be confirmed based on the land use classification). Infiltration of runoff from vegetated areas and rooftops is always permitted.

1.2.3 Phosphorous Loading

As per LSRCA's Phosphorus Offsetting Policy (LSRCA, 2021) "Zero Export Target" for post-development phosphorus loadings will be required. The Phosphorous Offsetting Policy is applicable for the following applications under the *Planning Act, Condominium Act and Conservation Authorities Act* as well as to *Environmental Compliance Approvals*:

- Plans of subdivision,
- Plans of condominium,
- Site plans involving a proposed impervious area that is greater than (>) 500m^2,
- Consent applications resulting in the creation of four or more new lots, and/or
- Applications under the *Conservation Authorities Act* where s28.0.1 applies.

Applications made under the Planning Act that facilitate permitted agricultural uses or the construction of an accessory structure or a single-family dwelling on an existing lot of record will not be subject to the Phosphorous Offsetting Policy requirements.

2. Background Review

The site is located on the northeast corner of the Huronia Road and Little Avenue intersection in Barrie, Ontario. The property is rectangular in shape with a total site area of 0.14 hectares. The property is currently occupied by one residential dwelling with a single level and a basement, which will be demolished prior to any development. The site lies within a LSRCA regulated area, with the southern portion of the site being identified as a “floodplain” and/or “floodplain setback”, however the proposed townhomes are planned to be developed outside of the floodplain. The surrounding area is predominantly residential land uses, with parkland located to the southeast, a school located to the west, commercial properties located to the north, and industrial properties located to the south.

2.1 Site Physiographic, Geologic and Hydrogeological Settings

The site is located approximately 150 m west of Whisky Creek and approximately 1 km south of Kempenfelt Bay. A tributary/drain is about 35 m south of the site on the south side of Little Avenue. The site is within the Lake Simcoe subwatershed, within the jurisdiction of the LSRCA.

The site is located within the physiographic region denoted as the Simcoe Lowlands and the local terrain is characterized by sand plains (Chapman and Putnam, 1984). The surficial geology of the site per the Ontario Geological Survey is described as stratified deposits of sand and gravel with minor silt, clay, and till.

The bedrock underlying the general area corresponds to the Verulam Formation, consisting of limestone and shale. Based on the MECP Water Well Records in the area, bedrock is anticipated at a depth of about 100 m below existing grade. Map P.980 from the Ontario Department of Mines, *“Drift Thickness Series, Barrie Area,”* (scale 1:50,000, compiled by G. L. Burwasser and M. J. Ford, 1974) indicates that bedrock could be encountered about 107 m below grade at the site.

2.2 Review of MECP Water Well Records and Existing Water Wells

MECP water well records were obtained within 500 m of the site area to assess the general nature of the groundwater resource in the near vicinity of the site, and historical/current uses of wells in the area. No well record was found on site and twenty-seven (27) well records were found surrounding the site (off-site), the approximate MECP well locations are shown on Figure 7 and a well records summary table is included in Appendix A.

The off-site well(s) was/were installed for the following uses:

- Sixteen (16) of the records indicate domestic use.
- Three (3) of the records indicate public supply and/or municipal use.
- Two (2) of the records indicate commercial use.
- One (1) of the records indicated monitoring and testing use.

- Six (6) of the records indicated “Not Used” use or did not indicate the well use and are assumed to be unknown.

The stratigraphic descriptions within the MECP monitoring well records are typically inaccurate due to the methodology in which they are determined (observations of cuttings and no consistency between descriptions of soil between different drillers). Though this is the case, an overall sense of the deep stratigraphy can be determined by looking at commonalities between most stratigraphic descriptions and where the wells were terminated in an aquifer. The well records typically indicate sand and clay layers with variable silt and gravel over limestone.

The noted domestic water supply wells were typically installed in the sand overburden. It is noted that fresh water was encountered at depths of 3 to 84 m in the domestic water supply wells. As the surrounding area is municipally serviced, it is expected that the domestic wells are no longer in use.

Barrie Municipal Supply Wells 3A, 4, 5, 7, 11, 12, 14, 15, and 17 to 19 are located about 2.0 km northwest of the site. The site is within a WHPA-Q2 related to these wells. The MECP records indicated that wells are installed within the overburden to a depth of 12.5 to 89.3 m below the surface.

2.3 Site Condition Standards

The MECP has developed a set of Soil, Ground water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act (April 15, 2011) and O. Reg. 153/04, as amended. The standards consist of nine tables (Table 1 through Table 9) that provide criteria for maximum concentrations of various contaminants. In general, the applicable O. Reg. 153/04, as amended, SCSs depends on the site location, land use, soil texture, bedrock depth and the applicable potable or non-potable ground water condition at the investigation site.

In order to determine the Site Sensitivity, Sections 41 and 43.1 of O. Reg. 153/04, as amended, were evaluated by GEI as shown in the following table:

CRITERIA	**RESULT**
Current Property Use	Residential
Potable vs. Non-Potable Ground Water	Potable
Proximity of Areas of Natural Significance	> 30 m
Proximity to a Water Body	> 30 m
Shallow Soil Condition	No
Land Use	Residential/Parkland/Institutional (RPI)
Applicable Site Condition Standard	Table 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition (Table 2 RPI)

2.4 Visual Inspection of the Site

A visual site inspection was carried out on December 15, 2022, by GEI staff to assess site drainage, topography and presence of surface water features.

The site is located to the northeast corner of the Huronia Road and Little Avenue intersection in Barrie, Ontario. The property is rectangular in shape with a total site area of 0.14 hectares. The surrounding area is predominantly residential land uses, with parkland located to the southeast, a school located to the west, commercial properties located to the north, and industrial properties located to the south.

The topography of the site is relatively flat with a gentle slope down towards the east / southeast such that there is an overall change in elevation of approximately 1 to 2 m from the west site limit to the east site limit and less than 1 m from the north site limit to the south site limit.

No water bodies were identified at the site.

3. Procedures and Methodology

It is noted that all elevations in this report are metric/geodetic and expressed in metres (m). All measurements are also in metric and expressed in millimetres (mm), metres (m) or kilometres (km).

Prior to the commencement of drilling activities, the borehole locations were staked in the field by GEI. Borehole ground surface elevations and coordinates (referencing NAD 83 geodetic datum) were surveyed by GEI with a Topcon HiPer SR GPS Survey unit.

Underground utilities including natural gas, electrical, telephone, water, etc. were marked out by public utility locating companies and a private locator prior to drilling.

The fieldwork for the drilling program was carried out on November 22, 2022. Boreholes 1 to 3 were advanced to 6.6 m below existing grade (Elev. 234.2 to 235.4). Borehole logs are provided in Appendix B and the borehole locations are shown on Figure 2A (aerial image) and Figure 2B (proposed plan).

The boreholes were advanced by a drilling subcontractor retained and supervised by GEI using a track-mounted drill rig, solid stem augers, and standard soil sampling equipment. Sampling was conducted using a 51 mm O.D. Split Spoon (SS) sampler. Standard Penetration Test (SPT) “N” Values (N values) were recorded for the sampled intervals as the number of blows required to drive an SS sampler 305 mm into the soil using a 63.5 kg drop hammer falling 750 mm, in accordance with ASTM D1586. In each borehole soil sampling was conducted at 0.75 m intervals for the upper 3.0 m and at 1.5 m intervals thereafter.

Monitoring wells were installed in all the boreholes by GEI to facilitate long-term groundwater monitoring, each consisting of 50 mm diameter PVC pipe with a 1.5 m long screen and protective casing. Monitoring well construction is shown on the borehole logs in Appendix B.

The GEI field staff examined, and classified characteristics of the soils encountered in the boreholes, including the presence of fill materials (if any), groundwater observations during and upon completion of the drilling, recorded observations of borehole construction, and processed the recovered samples. All recovered soil samples were logged in the field, carefully packaged, and transported to GEI’s laboratory for more detailed examination and classification.

In GEI’s laboratory, the samples were classified as to their visual and textural characteristics. Four (4) representative samples of the major soil units were selected and submitted to our laboratory for grain size analysis. Grain size results are provided in Appendix C.

3.1 Borehole Permeability

Rising head tests were completed in the three (3) monitoring wells on site on December 15, 2022. Water was manually purged from monitoring wells using LDPE piping and a foot valve. The static water level was measured prior to the start of testing, and the change in water level was monitored using an electronic level logger. The level loggers were left in the monitoring wells to allow for adequate recovery of the groundwater. The tests were completed to estimate the horizontal hydraulic conductivity (K) of the soils at the well screen depths.

The semi-log plots for drawdown versus time for the tests are provided in Appendix D.

3.2 Groundwater Sampling

To establish baseline conditions and assess the suitability for discharge of pumped groundwater to surface during potential dewatering activities, the following groundwater samples were collected from BH/MW 1 on December 13th, 2022:

- One (1) unfiltered groundwater sample was collected from BH/MW 1 and analyzed against the City of Barrie Storm Sewer Use By-Law Criteria, and PWQO Metals and TSS
- One (1) filtered groundwater sample was collected from BH/MW 1 analyzed against PWQO Metals and TSS only.

Prior to collection of the samples, approximately three (3) standing well volumes of groundwater were purged from the well. The samples were collected and placed into pre-cleaned laboratory-supplied vials and/or bottles provided with analytical test group specific preservatives, as required. Dedicated nitrile gloves were used during sample handling. The field filtered samples were processed through a 45 µm filter prior to collection in the required vials/bottles. The samples were submitted to CALA- accredited Caduceon Environmental Laboratories for analysis. The results of the groundwater chemistry are presented in the laboratory Certificates of Analysis provided in Appendix E.

4. Subsurface Conditions

4.1 Stratigraphy

The detailed soil profiles encountered in the boreholes are indicated on the attached borehole logs in Appendix B, and the geotechnical laboratory results are included in Appendix C. The borehole locations are shown in Figures 2A and 2B.

It should be noted that the conditions indicated on the borehole logs are for specific locations only and can vary between and beyond the locations. It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones and should not be interpreted as exact planes of geological change. Cross-sections are provided in Figure 8.

In addition, the descriptions provided in the borehole logs are inferred from a variety of factors, including visual observations of the soil samples retrieved, laboratory testing, measurements prior to and after drilling, and the drilling process itself (speed of drilling, shaking/grinding of the augers, etc.). The passage of time also may result in changes in conditions interpreted to exist at locations where sampling was conducted.

4.1.1 Topsoil

A surficial topsoil layer was at the ground surface in Boreholes 1, 2 and 3 ranging in thickness from 75 to 150 mm.

4.1.2 Fill

A fill layer was encountered in all boreholes. The fill layer consisted of sand/silty sand in the upper portion and gravelly sand in the bottom portion. The fill was penetrated at 2.3 to 3.0 m depth (Elev. 238.4 to 239.4). The fill had trace to some organics in all boreholes and concrete pieces were observed in Borehole 2. The fill was moist to wet with moisture contents ranging from 8 to 14%. The fill had N values ranging from 8 to 22 (loose to compact).

4.1.3 Silty Sand / Sand / Sandy Silt to Silty Sand /Sand and Gravel

Cohesionless deposits were encountered beneath the fill, locally the clayey silt in Borehole 1. These deposits consisted of silty sand to sand in Borehole 1 from 3.0 to 6.6 m depth (Elev. 238.9 to 235.4), sandy silt to silty sand in Borehole 2 from 3.0 to 6.1 m depth (Elev. 238.7 to 235.6) and sand and gravel in Borehole 3 from 2.3 to 3.0 m depth (Elev. 238.4 to 237.7). The deposits had a till like appearance in Borehole 1 and 2. Three samples of the various units were submitted to our laboratory for grainsize analysis and the results are provided in Figure C1 in Appendix C. N values ranged from 4 to 35 being loose to dense, typically compact. The soil was typically wet with moisture contents ranging from 8 to 20%.

4.1.4 Clayey Silt / Clayey Silt to Silty Clay

A 400 mm thick clayey silt layer from 2.6 to 3.0 m depth (Elev. 238.9 to 239.4) was observed below the fill and above the cohesionless soil in Borehole 1. In Boreholes 2 and 3, clayey silt and clayey silt to silty clay units were present at depths varying from 3.0 to 6.1 (Elev. 235.6 to 237.7) and extended to the 6.6 m depth of exploration (Elev. 234.2 to 235.2). A sample of the clayey silt to silty clay soil was submitted to our laboratory and the results are provided in Figure C2 in Appendix C. The soil was grey and moist to very moist with moisture contents ranging from 12 to 28%. N values in the material ranged from 16 to 32 blows indicating a very stiff to hard consistency.

4.2 Groundwater Level Monitoring

Unstabilized groundwater level measurements and cave measurements were taken upon the completion of drilling of each borehole as shown on the borehole logs in Appendix B. These measurements were taken to provide a rough estimate of the possible excavation and temporary groundwater control constructability considerations that may arise. All three (3) boreholes were outfitted with a monitoring well with 50 mm diameter PVC standpipe and 1.5 m long screen. Monitoring well configuration and groundwater observations are noted on the borehole logs in Appendix B, and a summary is below.

Borehole / Monitoring Well	Well Screen Location Depth (m) / Elev. (m)	Unit Screened	Depth of Cave Depth (m) / Elev. (m)	First Water Strike (m) / Elev. (m)	Unstabilized Groundwater Level Depth (m) / Elev. (m)	Stabilized Groundwater Level (Dec 6, 2022) Depth (m) / Elev. (m)
1	4.0 to 5.5 / 238.0 to 236.5	Silty Sand / Sand	5.4 / 236.5	2.3 / 239.6	2.3 / 239.6	2.6 / 239.3
2	4.6 to 6.1 / 237.2 to 235.7	Sandy Silt to Silty Sand / Clayey Silt	Open (6.6 / 235.2)	2.3 / 239.4	2.1 / 239.6	2.3 / 239.4
3	4.6 to 6.1 / 236.1 to 234.6	Clayey Silt to Silty Clay	Open (6.6 / 234.2)	1.5 / 239.2	2.1 / 238.6	2.4 / 238.3

The stabilized groundwater level measurements were observed at 2.3 to 2.6 m depth, corresponding to Elev. 238.3 to 239.4 m.

The existing fill, sand, silty sand and sand and gravel are permeable and allow for the free flow of ground water when wet. The sandy silt to silty sand is semi-permeable and is expected to generally allow for the free flow of water when wet. The clayey silt and clayey silt to silty clay are generally not permeable.

Groundwater levels are expected to show seasonal fluctuations and vary in response to prevailing climate conditions.

It is anticipated that the local water flow will be east towards Whisky Creek and regional water flow will be north towards Kempenfelt Bay. A groundwater contour map is provided in Figure 9. GEI is measuring groundwater levels in each of the three (3) monitoring wells, monthly for four (4) months at the site to determine the seasonal high levels. The results will be summarized in a future report.

It is noted that typically 12-months is recommended in accordance with the LSRCA requirements; however, at a minimum, groundwater level monitoring between March and June (4 months) is recommended.

4.3 Hydraulic Conductivity

Hydraulic conductivity tests were conducted in all three (3) of the monitoring wells. Values were calculated using AQTESOLV Pro V4.50.002 for Windows as developed by HydroSOLVE, Inc. from the rising head test data using Hvorslev's solution (1951) where the well screen was fully saturated. The semi-log plots for the results are provided in Appendix D and are summarized in the table below.

Borehole / Monitoring Well	Well Screen Location Depth (m) / Elev. (m)	Unit Screened	In-Situ Hydraulic Conductivity (K) (m/s)
1	4.0 to 5.5 / 238.0 to 236.5	Silty Sand / Sand	3.6×10^{-5}
2	4.6 to 6.1 / 237.2 to 235.7	Sandy Silt to Silty Sand / Clayey Silt	8.9×10^{-8}
3	4.6 to 6.1 / 236.1 to 234.6	Clayey Silt to Silty Clay	1.1×10^{-8}

According to Freeze and Cherry (1979), the typical range in hydraulic conductivity is as follows:

Sand:	10^{-2} m/s to 10^{-6} m/s
Silty Sand:	10^{-3} m/s to 10^{-7} m/s
Silt:	10^{-5} m/s to 10^{-9} m/s
Clay:	10^{-9} m/s to 10^{-12} m/s

The variation in measured and inferred hydraulic conductivities from the typical range in hydraulic conductivity is attributed to the effects of the wells being screened across two distinct units (BH/MW 2).

When considering the values of the measured in-situ hydraulic conductivity for the well screened only in the silty sand / sand soils (BH/MW 1), the results indicate that 4.0×10^{-5} m/s is an appropriate hydraulic conductivity for water taking calculations at this site within the silty sand / sand soils.

When considering the values of measured in-situ hydraulic conductivities for the well screened only in the clayey silt and clayey silt to silty clay soils (BH/MW 3) the results indicate that 1.5×10^{-8} m/s is an appropriate hydraulic conductivity water taking calculations at this site within the clayey silt and clayey silt to silty clay soils.

4.4 Groundwater Quality

To assess the suitability for discharge of pumped groundwater to the land surface during dewatering activities, two (2) groundwater samples, one (1) unfiltered and one (1) filtered, were collected from Borehole / Monitoring Well 1 on December 13, 2022.

For the assessment purposes, the analytical results were compared to the Town of Barrie Storm Sewer Use By-Law Criteria and the PWQO. The results of the groundwater chemistry are presented in the laboratory Certificates of Analysis provided in Appendix E. A summary of the results is presented in the table below for samples relative to the City of Barrie Storm Sewer Use By-Law Criteria and the PWQO.

Monitoring Well Sample Location	Parameters Tested	Exceedances of City of Barrie Storm Sewer Use By-Law Criteria	Exceedances of PWQO
BH/MW 1 (Unfiltered)	City of Barrie Storm Sewer Use By-Law PWQO: Metals, TSS	Storm: Copper, TSS	PWQO: Zinc, Iron Interim PWQO: Zirconium, Zinc, Vanadium, Lead, Copper, Cobalt, Aluminum
BH/MW 1 F (Filtered)	PWQO: Metals, TSS	No Exceedances	No Exceedances

The unfiltered groundwater sample collected from BH/MW 1 met the parameters tested for the City of Barrie Storm Sewer Use By-Law except copper and TSS and met the PWQO except for zinc and iron. It is also noted that the sample exceeded the interim PWQO for zirconium, zinc, vanadium, lead, copper, cobalt, and aluminum.

The filtered groundwater sample met PWQO for Metals and TSS. These chemical results suggest treatment of the dewatering discharge water by filtration may aid in reducing the concentration of metals, however, additional treatment may be required to meet both the PWQO and interim PWQO for dissolved parameters. It is noted that field filtering reduced the TSS concentration from 495 mg/L to less than 3 mg/L which would meet the requirements for Town of Barrie Storm Sewer Use By-Law Criteria of 9.5 mg/L.

If pumped groundwater will be discharged to the City of Barrie Storm Sewer, it must be suitably treated to remove the parameter exceedances prior to discharge (treatment methods to be determined by the dewatering contractor or civil engineer).

Treatment of the dewatering discharge water by filtration or sedimentation to reduce the concentration of suspended solids, and thus reduce the concentrations of non-dissolved metals, is necessary and may be effective in achieving compliance with the PWQO. However, other treatment methods may be necessary to reduce the concentration of dissolved analytes.

It is expected that during construction dewatering, the pumped water is to be first discharged to a sedimentation tank and then a silt/sediment bag, at a minimum, before being discharged to surface.

5. Discussion and Analysis

5.1 Construction Dewatering

5.1.1 Excavations and Temporary Groundwater Control

The site is located on the northeast corner of the Huronia Road and Little Avenue, in Barrie, Ontario. The site is about 52.4 m (north to south) by 28.7 m (east to west), as shown on Figure 2B.

The stabilized groundwater level measurements were observed at 2.3 to 2.6 m depth, corresponding to Elev. 238.3 to 239.4.

It is GEI's understanding that details pertaining to the townhome design, including the presence of basements (basements are assumed for purposes of this report), are not yet known. As the property will be municipally serviced, it is expected that the proposed townhomes will be serviced with municipal water and sanitary sewers and that only service laterals will be required from Huronia Road. Inverts are assumed to extend as deep as 3 m below the existing grade for the purposes of this report.

At this time, excavations for the project site are anticipated to extend 2.5 to 3.5 m below existing grade to account for engineered fill placement, service connections, and possibly basements. Below the surficial topsoil, excavations are anticipated to encounter earth fill, over the cohesionless soil units and locally the clayey silt/ silty clay to clayey silt unit. Harder digging can be expected locally in the dense cohesionless deposits. Cobbles and boulders should be expected in the sand and gravel deposit.

Based on this, excavations at the site are expected to extend approximately 1.0 m below the prevailing groundwater table.

For conservative purposes, the construction dewatering calculation is based on an open cut excavation at the present time. To excavate under dry conditions, the water level is anticipated to be lowered at least to a minimum of approximately 0.5 m below the proposed excavation depth. Based on the subsurface conditions encountered during the field investigation, a hydraulic conductivity of 4.0 x 10^{-5} m/s has conservatively been applied to the entire site.

Additional dewatering capacity may be required to maintain dry conditions within the excavation during and following significant precipitation events. It should be noted that the dewatering estimates provided in this report are based on the assumed site servicing depths. GEI must be provided with final site servicing and grading plans to verify the design assumptions or update the water taking estimates as needed.

The exact scenario where these groundwater control techniques will work are estimates only and are directly correlated to how coarse/fine the native soils are in an excavation, and both the lateral and vertical extent of the cohesionless deposits encountered. If the groundwater table is not controlled during construction, the base of the excavations will probably be unstable, leading to difficulties in excavating and placement of pipes or footings. A dewatering contractor must review and assess the subsurface conditions to verify which dewatering techniques will work for the site and proposed utility installations, based on their experience and interpretation of the data. A test dig could be carried out to assist prospective contractors determine the most appropriate dewatering methods based on their own means and methods.

Grading plans were not available for review at the time of this report, however it is speculated that some grade raise is required to keep basements above the ground water level.

5.1.2 Construction Dewatering Assumptions

The assumptions used for the calculation of the dewatering rates for the proposed development are presented below:

- Based on the results of the field investigation, a hydraulic conductivity of 4.0 x 10^{-5} m/s has been applied to the entire site.
- Based on the borehole elevation survey on site the lowest ground elevation in the vicinity of the site is approximately Elev. 240.5.
- The general site servicing scenario assumes the site servicing will include service laterals extending 20 m east from Huronia Road to each proposed townhome and will be excavated 4 m wide and 3.5 m deep (Elev. 237.0).
- The general basement scenario assumes that any basements constructed are required to be 1.0 m above the water table and, since it is understood that this approach will be followed no dewatering is anticipated for basement construction/excavation.
- In general, groundwater levels should be lowered a minimum of 0.5 m below the excavation base for servicing.
- The local high groundwater level measurement was observed at 2.3 m depth (Elev. 238.2).

5.1.3 Radius of Influence

The Radius of Influence (ROI) for the construction dewatering is based on the empirical Sichardt Equation. This equation is used to predict the distance at which the drawdown resulting from pumping is negligible. This equation is empirical and was developed to provide representative flow rates using the steady state flow dewatering equations, as discussed below.

It is noted that in steady state conditions, the radius of influence of pumping will extend until boundary flow conditions are reached and provide sufficient water inputs to the aquifer, such as recharge and surface water bodies. As a result, the distance of influence calculated using the Sichardt equation is used to provide a representative flow rate calculation, but it is not precise in determining the actual radius influenced by pumping.

The ROI of pumping (dewatering) for radial flow was calculated based on the Sichardt equation, which is described as follows:

$$R_0 = 3000\ (\mathrm{H} - \mathrm{h})\sqrt{\mathrm{K}}$$

Where:

K = Hydraulic conductivity (m/s)
H = Static Saturated Head (m)
h = Dynamic Saturated Head (m)
R_0 = Radius of influence (m)

Based on the Sichardt equation, the hydraulic conductivity of 4.0 x 10^{-5} m/s and the total groundwater drawdown required at this site, the ROI is expected to be as much as 32 m from the centre of the excavations for radial flow. Calculation details are provided in Appendix F, and zone-specific ROIs are summarized below:

Dewatering Zone	Description	ROI (m)
1	General Site Servicing Scenario Per Lateral	32

The ROI calculation is a conservative methodology and is calculated based on the assumption of active pumping during the construction dewatering. It should be noted that most of the water will be pumped during the first stage of the construction period or when a rain event occurs.

5.1.4 Temporary Dewatering Flow Rate Calculations

The Dupuit equation for linear flow from an unconfined aquifer for a fully penetrating excavation was used to obtain a flow rate estimate for the proposed linear infrastructure (servicing laterals), and is expressed as follows:

$$Q_w = Kx\frac{H^2 - h^2}{L_0}$$

Where:

Q_w = Rate of pumping (m³/s)
X = Length of excavation (m)
L_0 = Length of influence (m) ($L_0 = \frac{R_0}{2}$)
K = Hydraulic conductivity (m/s)
H = Head beyond the influence of pumping (static groundwater elevation) (m)
h = Head above base of aquifer at the excavation (m)

The dewatering rates are expected to decrease once the target water levels are achieved in the excavation footprints as groundwater will have been removed locally from storage resulting in lower seepage rates into the excavations.

Based on the assumptions provided in this report, the results of the dewatering rate estimates are summarized below, and calculation details are provided in Appendix F:

Location and Scenario	**Construction Dewatering Flow Rate Without Safety Factor**	**Construction Dewatering Flow Rate Including Safety Factor of 2**	**Construction Dewatering Flow Rate Including Safety Factor of 2 with a 10 mm Rainfall Event**
	L/day		
1 - General Site Servicing Scenario Per Lateral	14,200	28,400	29,000

As the calculated construction dewatering flow rate for one service lateral is less than 50,000 L/day, a posting on the EASR is not anticipated for the site. However, should more than one servicing lateral are excavated, dewatering rates more than 50,000 L/day are anticipated, such that a posting on the EASR will be required.

The total construction dewatering flow rate includes a factor of safety of 2.0 to account for seasonal fluctuations in the groundwater table and variation in hydrogeological properties beyond those encountered during the course of this study. This total dewatering flow rate also provides additional capacity for the dewatering contractors. A 10 mm rain event was also included in the water taking calculation.

Please note that it is the responsibility of the contractor to ensure dry conditions are maintained within the excavations at all times. Based on the calculated water taking rate, it is expected that conventional sump pump systems and/or keg wells will be adequate to control seepage at this site. Additional pumping capacity may be required to maintain dry conditions within the excavation during and following significant precipitation events. The contractor must ensure that water taking rates remain below 400,000 L/day. If the rates exceed 400,000 L/day, a PTTW from the MECP will be required for the site.

The maximum flow calculation is intended to provide a conservative estimate to account for unforeseeable conditions that may arise during construction. It should be noted that the dewatering estimates provided in this report are based on assumptions and details available at the time of this report. If changes to the design are implemented (e.g., increase to planned excavation depths, widening of excavations, etc.), the dewatering estimates must be revised to include and reflect future changes.

5.1.5 Remedial Dewatering Activities

The dewatering contractor is responsible for finalizing and implementing the discharge plan, including information such as the exact discharge location, erosion control methods, method of conveyance, treatment systems, temperature of the discharged groundwater, etc. It is the contractor’s responsibility to implement a treatment system to ensure that discharged groundwater meets the PWQO for the necessary parameters. This may be done by examining the hydrogeologic conditions in a test pit (and/or a full-range pumping test by the dewatering subcontractor).

The dewatering discharges should follow the best management practices, including sediment and erosion control measures, removal of suspended solids by a decanting tank, as well as a water quality and quantity control monitoring programs, as mentioned earlier. The contractor should be aware that the purpose of the dewatering system is to maintain stable excavation slopes and dry working conditions during excavation.

The extent and details of the dewatering scheme (trench or well dimensions, spacing, pump levels, screen size and wick gradation) are left solely to the contractor's discretion to achieve the performance objectives for maintaining stable slopes and dry working conditions and will be based on their own interpretation and analysis of site conditions, equipment, experience, and plant efficiency. The contractor should also appreciate that additional dewatering means and modifications may be required as variations in site conditions are encountered. The recommended groundwater taking and discharge plans are provided in Appendices G and H, respectively.

5.1.6 Impact Assessment for Groundwater Dewatering

For the assumed maximum groundwater drawdown of 1.7 m for construction dewatering, settlement of the soil within the zone of influence must be calculated based on the increase in effective stress (10 kPa per metre of drawdown) from reducing the pore water pressures. The maximum settlement will occur adjacent to the dewatering system where the maximum drawdown occurs. Settlement has the potential to damage buried utilities, building foundations, or cause subsidence in adjacent lands. The amount of settlement will decrease exponentially to zero towards the radius of influence limit.

Negligible settlement will occur due to the minimal drawdown within the soil overburden. The radius of influence around the servicing lateral(s) is expected to be 32 m with a portion of the excavation extending from the site to the centre of Huronia Road. The nearby residential houses across the street from the site are approximately 20 m from the assumed dewatering locations (including the centre of Huronia Road). No impacts are expected to nearby structures or land.

Another cause of significant dewatering related settlement is due to pumping of fines through the system. It is imperative that any dewatering systems (e.g., sump pumps) shall be installed adequately to ensure no soil is conveyed through the system. Sufficient filtering techniques are incorporated at the entry point to avoid migration fines in the pumping/dewatering system. The turbidity of pumped water should be monitored daily to ensure that only minimal fines are being conveyed through the system.

There are no surface water features or domestic wells in the radius of influence, so no impacts are expected. Furthermore, the construction dewatering is limited to the near surface only.

5.2 Preliminary Water Balance

5.2.1 Water Balance Components

A water balance is an accounting of the water resources within a given area. The water balance equates the precipitation (P) over a given area to the summation of the change in groundwater storage (S), evapotranspiration/evaporation (ET), surface water runoff (R) and infiltration (I) using the following equation:

$$\mathrm{P} = S + I + ET + R$$

The components of the water balance vary in space and time and depend on climatic conditions as well as the soil and land cover conditions (i.e., rainfall intensity, land slope, soil hydraulic conductivity and vegetation). For example, runoff occurs at a higher percentage during periods of snowmelt when the ground is frozen or during intense rainfall events.

Precise measurement of the water balance components is difficult, and as such, approximations and simplifications are made to characterize the water balance of a property. Field observations of the drainage conditions, land cover and soil types, groundwater levels and local climatic records are important inputs to the water balance calculations.

- <u>Precipitation (P):</u> For the purposes of approximating the annual precipitation at this site, the monthly rainfall between 1981 and 2010 was used based on Environment Canada historical weather data for the Barrie WPCC weather station (Climate ID 6117684, Latitude 44.37 N, Longitude 79.68 W, Elevation 221 m), which is located about 2.3 km northwest of the site.
- <u>Storage (S):</u> Although there are groundwater storage gains and losses on a short-term basis, the net change in groundwater storage on a long-term basis is assumed to be zero.
- <u>Evapotranspiration/Evaporation (PET):</u> The evapotranspiration and evaporation components vary based on the characteristics of the land surface cover (i.e., type of vegetation, soil moisture conditions, perviousness of surfaces, etc.). Potential evapotranspiration refers to the water loss from a vegetated surface to the atmosphere under conditions of an unlimited water supply. Evaporation occurs from a hard surface (such as flat rooftops, asphalt, gravel parking areas, etc.).
- <u>Water Surplus (R + I):</u> The difference between the mean precipitation and evapotranspiration is referred to as the water surplus. The water surplus is divided into two parts: as surface or overland runoff (R) and the infiltration into the surficial soil (I). The infiltration is comprised of two end member components: one component that moves vertically downward to underlying aquifers (referred to as percolation, deep infiltration or net recharge) and a second component that moves laterally through the near surface soil profile or shallow soils as interflow that re-emerges locally to surface (i.e., as runoff) at some short distance and time following precipitation.

5.2.2 Water Balance Approach and Methodology

The analytical approach to calculate the water balance involves monthly soil-moisture balance calculations to determine the pre-development infiltration volumes. The detailed water balance calculation is provided in Appendix I, which is summarized in this and subsequent sections of the report. The following assumptions were used as part of the soil-moisture balance calculations:

- A soil moisture balance approach assumes that soils do not release water as potential recharge while a soil moisture deficit exists.
- During wetter periods, any excess of precipitation over evapotranspiration first goes to restore soil moisture. Considering the nature of the near surface soils (silty sand / sand / sandy silt to silty sand) and vegetation cover, a soil moisture storage capacity of 75 mm was assumed.
- Once the soil moisture deficit is overcome, any further excess water can then pass through the soil as infiltration and either become interflow (indirect runoff) or recharge (deep infiltration).

Monthly potential evapotranspiration calculations accounting for latitude, climate and the actual evapotranspiration and water surplus components of the water balance based on the monthly precipitation and soil moisture conditions were calculated. The *MECP SWM Planning and Design Manual* (2003) methodology for calculating total infiltration based on topography, soil type and land cover was used, and a corresponding infiltration factor was calculated for pre- and post-development conditions. The water surplus was multiplied by the infiltration factor to determine both the pre-existing and post-condition annual volumes for run-off and infiltration for the property.

The pre-development scenario was estimated from the site inspection and aerial images, with 85% being permeable and 15% being impermeable. The post-development water balance scenario was estimated based on *“*Conceptual Site Plan – 159 Huronia Road, Ontario*”,* dated December 2021, by Innovative Planning Solutions. As detailed site plans are not yet available and details pertaining to the townhome design are not yet know, the post-construction scenario was assumed to maintain 35% of the site as permeable land to satisfy the Residential Multiple Dwelling Secondary Density (RM2) Zoning requirement for a minimum of 35% landscaped open space. The remaining 65% of the land is assumed to be impermeable and consists of townhomes and driveways. The water balance must be updated following final site configuration to reflect the final site plans.

It is noted that the infiltration and runoff values presented in Appendix I are estimates only. Single values are used for the water balance calculations, but it is important to understand that infiltration rates are dependent upon the hydraulic conductivity of the surficial soils which may vary over several orders of magnitude. As such, the margins of error for the calculated infiltration and runoff component values are potentially quite large. These margins of error are recognized, but for the purposes of this assessment, the numbers used in the water balance calculations are considered reasonable estimates based on the site-specific conditions and useful for comparison of pre- to post-development conditions.

5.2.3 Pre and Post Development Water Balance

Detailed water balance calculations are included in Appendix I. The pre and post development calculations summarized in this section are preliminary only and must be updated once site plans are finalized.

The table below summarizes the pre and post construction water balance as per the proposed site development plans.

Condition	Permeable Areas	Impermeable Areas	Average Annual Runoff Volume (m^3/year)	Average Annual Infiltration Volume (m^3/year)
Pre-Development Land Use	85%	15%	346	270
Post-Development Land Use	35%	65% (residential building and driveways)	796	111

These calculations suggest that, without mitigation such as LID measures, the proposed development will decrease average infiltration by about 159 m^3/year (59% decrease). The proposed development will increase runoff by about 450 m^3/year (130% increase). This means about 159 m^3/year of infiltration is required to maintain the water balance. The potential impacts of these changes and recommended mitigation measures are discussed below.

5.2.4 Recommended Mitigation Measures

The three broad categories which typically need to be mitigated and accounted for are:

- Reducing the volume and speed in which additional surface water runoff occurs;
- Increasing the amount of infiltration to match pre-development conditions; and
- Ensuring that the quality of existing surface water features and groundwater will not be adversely impacted.

5.2.5 Runoff Quantity

Urban development of an area affects the natural water balance. The most significant difference is the addition of impervious surfaces as a type of surface cover (e.g., roads, parking lots, driveways, rooftops). Impervious surfaces prevent infiltration of water into the underlying soils and the removal of the vegetation reduces the evapotranspiration component of the natural water balance. The evaporation component from impervious surfaces is relatively minor (estimated to be 15% of precipitation) compared to the evapotranspiration component that occurs with vegetation in this area (up to two thirds of precipitation). So, the net effect of the urbanization of the site is that most of the precipitation that falls onto impervious surfaces increases the surplus water resulting in more direct runoff from developed areas and reduced natural infiltration.

In conjunction with increased runoff, there is a reduction in infiltration to the shallow groundwater system. A reduction in infiltration can potentially lead to a lowering of the local water table and reduce the potential for this seasonal water table intersection and discharge.

Methods which do not necessarily increase infiltration rate, but decrease the volume and concentration of surface water runoff can be considered at this site include (but are not limited to):

- Increasing the topsoil thickness by about two times the normal thickness (up to 30 cm) to retain more water in storage; and
- Implementation of rainwater harvesting which intercepts, diverts and stores roof runoff (i.e., cisterns) for future use.

5.2.6 Mitigation Measures for Maintaining Infiltration

The increases in surface water runoff that will occur with urban development and mitigation of the potential impacts to the local water table due to reduction of infiltration may be minimized by using appropriate stormwater management and using LID measures to promote infiltration. These measures can be implemented on-site.

The basic premise for LID is to try to minimize changes to runoff and infiltration. As outlined in the *MECP SWMP Design Manual* (2003) and *Low Impact Development Stormwater Management Planning and Design Guide* published by the CVC and TRCA (2010), there are a suite of techniques that may be considered to promote infiltration and reduce runoff.

In order to maintain ground water function at the site the following typical LID measures can be considered as part of typical site developments (can depend on land use):

- Collection of runoff from the building rooftops and redirection to grass areas and overland flow. If feasible, it is recommended that there be a minimum 5 m flow path over pervious areas to allow this mitigation method to be fully effective;
- Provision of gentle slopes in open areas or along grass swales in order to allow time for water infiltration;
- Construction of engineered infiltration measures such as soakaway pits, infiltration galleries or bioswales. Subsurface infiltration methods can only be considered in areas where there is sufficient soil permeability and depth to water table to accommodate the systems within the unsaturated zone (typically the infiltration elevation must be kept 1 m or more above the seasonal high groundwater level).
- Construction of grass channels or filter strips which allow infiltration, discharge at a lower rate and direct roof runoff to overland flow.

Implementation of LID measures will not only allow for infiltration of the surface water into the near-surface groundwater regime but will also allow for increase in natural filtration of surficial runoff, prevent sedimentation transport and potential erosion, and help reduce flooding by increasing the transit time for water on the site. These types of LID techniques promote natural infiltration by providing additional water volumes in the pervious areas. This is particularly effective in the summer months when natural infiltration would not generally occur because the additional water overcomes the natural soil moisture deficit.

At this time no details or designs for LID measures have been provided. Should LID measures be implement for the site, the details and designs should demonstrate through plans and sections (including all dimensions, materials used and including the seasonal high groundwater level) how this infiltration deficit will be mitigated.

As it is typically a requirement of maintaining the same levels of infiltration post construction, no appreciable change in the groundwater table elevation should occur over the long-term condition.

It is noted that the infiltration rates calculated by the use of grain size analysis results are estimates only as they do not reflect the compaction, saturation, and/or layering of the soil on site, which affect the infiltration of water on site. Vertical hydraulic conductivity can be measured in-situ with a Guelph Permeameter apparatus to provide more accurate infiltration rates at specific locations and depths to inform LID designs should it be required.

5.2.7 Groundwater Quality

Depending on land use, runoff from urban developments may contain a variety of dilute contaminants such as suspended solids, chloride from road salt, oil and grease, metals, pesticide residues, phosphorous, bacteria and viruses. For groundwater, generally except for the dissolved constituents such as nitrogen and salt, most contaminants are attenuated by filtration during groundwater flow through the soils.

LID measures or end treatments such as oil/grit separators or wet ponds also help to remove suspended solids and other contaminants in runoff prior to infiltration or conveying the flows off the site, especially when a treatment train approach is taken for stormwater management. Any stormwater management facilities must be designed such that the water quality is maintained or improved prior to discharging water from the site or infiltrating water into the ground.

Runoff from residential developments (e.g., rooftops, landscaped areas) are typically considered “clean” and can be collected and infiltrated where possible. Further, infiltration-based practices may be permitted for impervious areas such as roads and driveways for lower density residential development.

Since only clean or pre-treated runoff will be infiltrated, the groundwater quality will not be degraded and will not impact nearby domestic wells, the watercourse or other nearby environmental features.

5.3 Low Impact Development

5.3.1 Preliminary Infiltration Assessment

Determination of percolation rates are based on the "*Ministry of Municipal Affairs and Housing (MMAH) Supplementary Guidelines SB-6, Percolation Time and Soil Descriptions, 2012*". The boreholes indicate fill was encountered at surface overlying cohesionless deposits of mainly silty sand / sand / sandy silt to silty sand over cohesive deposits of clayey silt / clayey silt to silty clay. The Unified Soil Classification System classifications for the predominant soils encountered on-site are summarized below with the interpreted unfactored percolation rates (T-Time) and unfactored infiltration rates:

Unified Soil Classification System Classification	Unfactored Percolation Rate (T-Time) (mins/cm)	Unfactored Infiltration Rate (mm/hr)
S.M. Silty sands, sand-silt mixtures	8 to 20	30 to 75
C.L. Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	over 50	less than 12

These infiltration rates are not applicable below the groundwater table. Appendix C of "Low Impact Development Stormwater Management and Planning Design Guide" (Version 1.0, 2010, by CVC and TRCA) suggests safety factors to be applied to infiltration rates. The safety factor applicable to the site is expected to be 2.5 but this must be confirmed once the final location and elevation of LID measures are known. If LID infiltration measures will be designed and constructed on site, it is recommended to measure the in-situ infiltration rates by excavating test pits and conducting Guelph Permeameter tests in the exact footprints and elevations of the LID measures.

It is not recommended to design LID or septic measures to infiltrate into the surficial topsoil nor fill layers due to variable soil consistency and the possibility for lower-permeability of the topsoil and/or fill. Infiltration cannot occur below the groundwater table. It is typical for the base of infiltration features to be kept at least 1 m above the seasonally high groundwater level.

5.4 Preliminary Phosphorous Budget

As per LSRCA's Phosphorus Offsetting Policy (LSRCA, 2021) "Zero Export Target" for post-development phosphorus loadings will be required. However, restricted by the premature site Storm Water Management (SWM) servicing scheme, a preliminary assessment has been completed in a way that NO on-site phosphorus mitigation measures have been provided. As the site SWM control strategy is available, the post-development Phosphorus loading calculations with Best Management Practices (BMPs) will be updated accordingly. Please note that in situations where the phosphorus load cannot achieve the "Zero Export Target", the developer or proponent will be required to provide phosphorus offsetting compensation fee to the LSRCA.

As per the MECP Lake Simcoe Phosphorus Budget Tool, March 2012, the post-development phosphorus loading is assumed to be 1.32 kg/year/ha for the site without BMPs, for a total of 0.18 kg/year for the 0.14 ha site, with an off-setting compensation fee of $19,005.00, including the 15% administration fee. The actual cash-in-lieu will be further refined based on the LSRCA's Phosphorus Offsetting Policy (LSRCA, 2021) to include proposed BMPs as per the SWM servicing strategy updates.

The preliminary Phosphorous loading calculation details are provided in Appendix J for review.

6. Limitations

The recommendations and comments provided are necessarily on-going as new information of underground conditions becomes available. More specific information with respect to the conditions between samples, or the lateral and vertical extent of materials may become apparent during excavation operations. The interpretation of the borehole information must, therefore, be validated during excavation operations. Consequently, conditions not observed during this investigation may become apparent. Should this occur, GEI should be contacted to assess the situation and additional testing and reporting may be required.

GEI should be retained for a general review of the final design drawings and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, GEI will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of the design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. could be greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

This report was authorized by, and prepared by GEI for, the account of N.J. Electric General Contracting (as provided the signed Standard Professional Services Agreement). Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. GEI accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this project.

7. Closure

We trust that this information is satisfactory for your purposes. Should you have any questions or comments, please do not hesitate to contact our office.

Yours truly,

GEI Consultants

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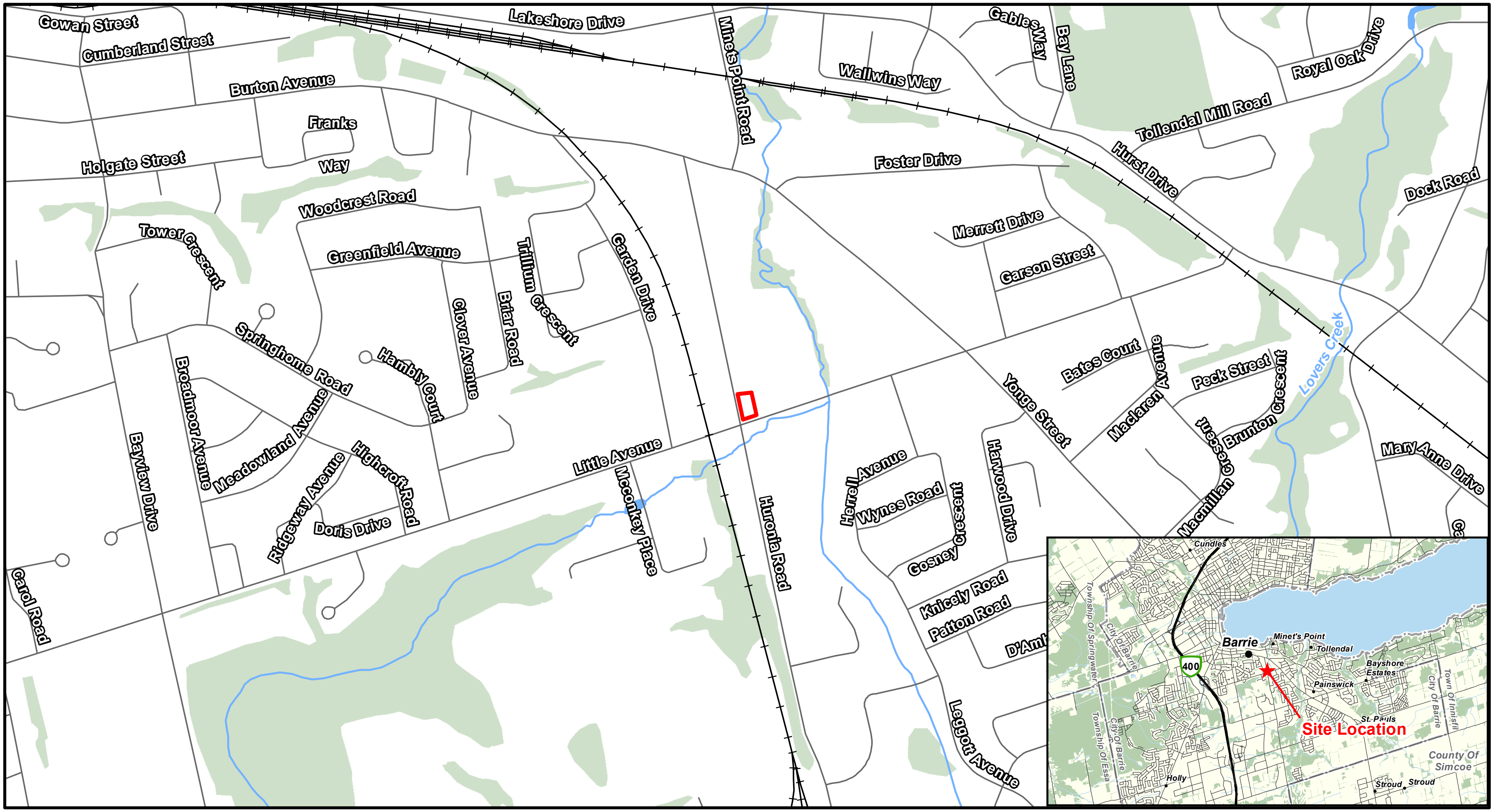
Figures



Legend

▭	Site Location	―	Watercourse
┼	Railway	🟦	Waterbody
―	Road	🟩	Wooded Area

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario 2023.

0 150 300 m

1:12,000

N

Hydrogeological Investigation
Proposed Residential Development
59 Huronia Road, Barrie, ON

Innovative Planning Solutions

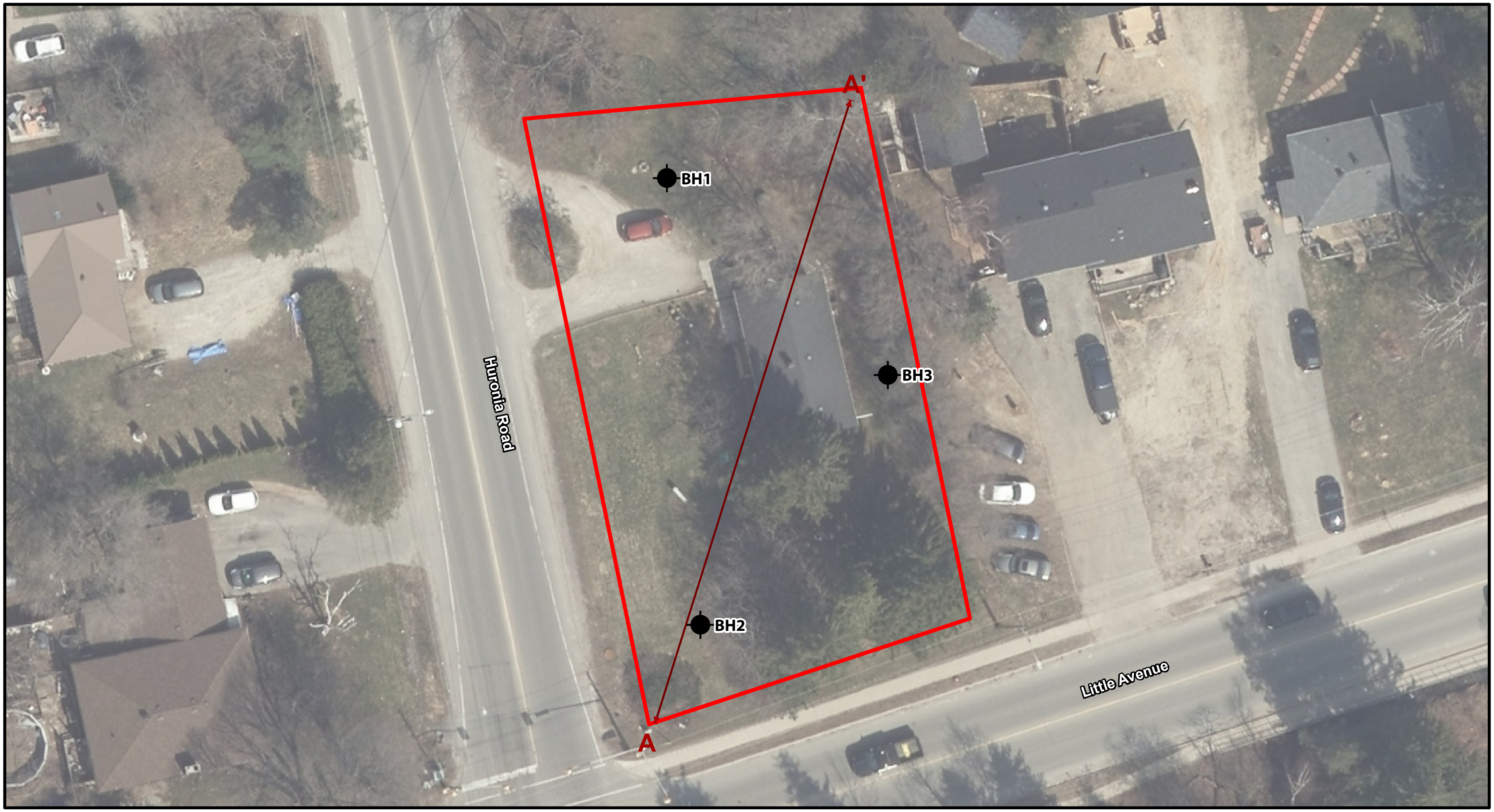
GEI Consultants

Project 2204000

SITE LOCATION PLAN

March 2023

Fig. 1



Legend

🟥 Site Location

● Approximate Borehole/Monitoring Well Location

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
3. Orthoimagery © First Base Solutions, 2023.
Imagery taken in 2021.

0 6 12 m
1:500

N

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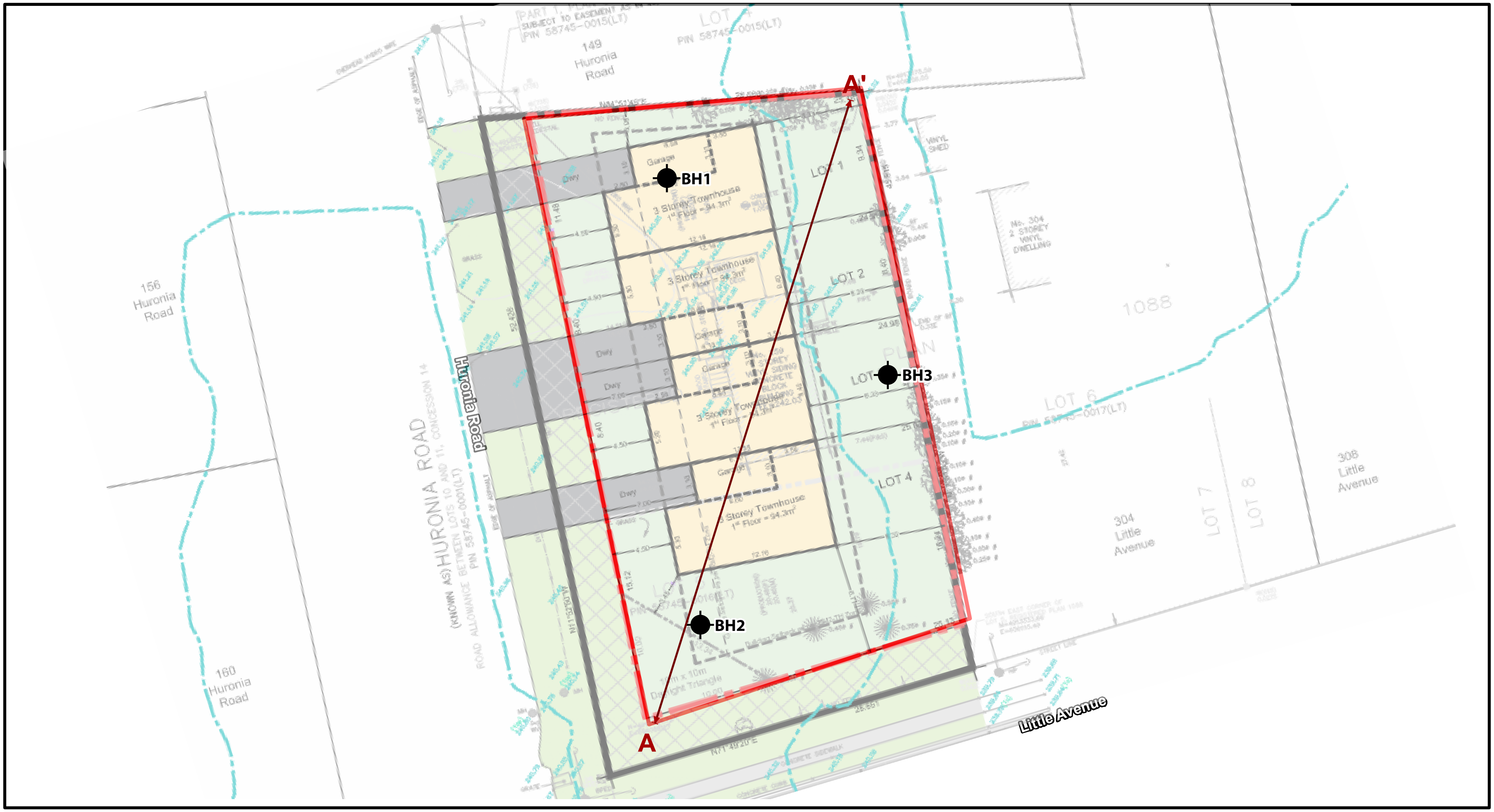
BOREHOLE LOCATION PLAN (AERIAL)

March 2023

Fig. 2A



Legend

🟥 Site Location

● Approximate Borehole/Monitoring Well Location

↔ Cross Section Location

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
3.'Conceptual Site Plan', Innovative Planning Solutions,(Feb., 23, 2023).

0 6 12
m
1:500

N

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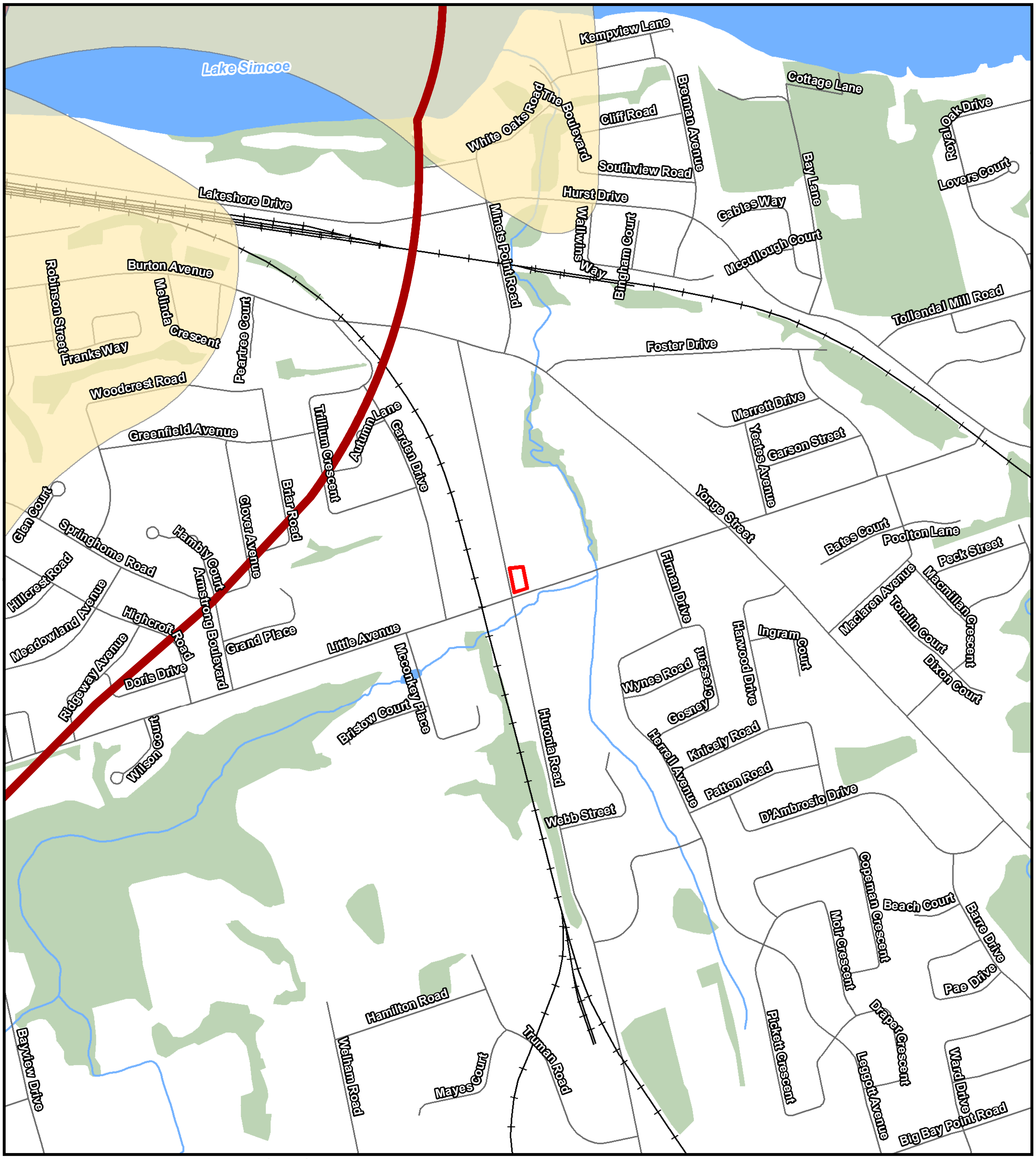
BOREHOLE LOCATION PLAN (CONCEPT PLAN)

March 2023

Fig. 2B



NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
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3. Contains information made available under the Lake Simcoe Region Conservation Authority Open Data Licence v1.0. Q1Q2 features digitized (approximate) from LIO Source Water Protection online map image.

Legend

- ▭ Subject Lands
- ┼ Railway
- — Road
- — Watercourse
- 🟦 Waterbody
- 🟩 Wooded Area

Wellhead Protection Area (LSRCA 2023)

Zone

- 🟫 A
- 🟫 B
- 🟥 C
- 🟨 C1
- 🟨 D
- ▭ Q1
- ▭ Q2

N

0 150 300 m

1:12,000

Hydrogeological Investigation
Proposed Residential Development
59 Huronia Road, Barrie, ON

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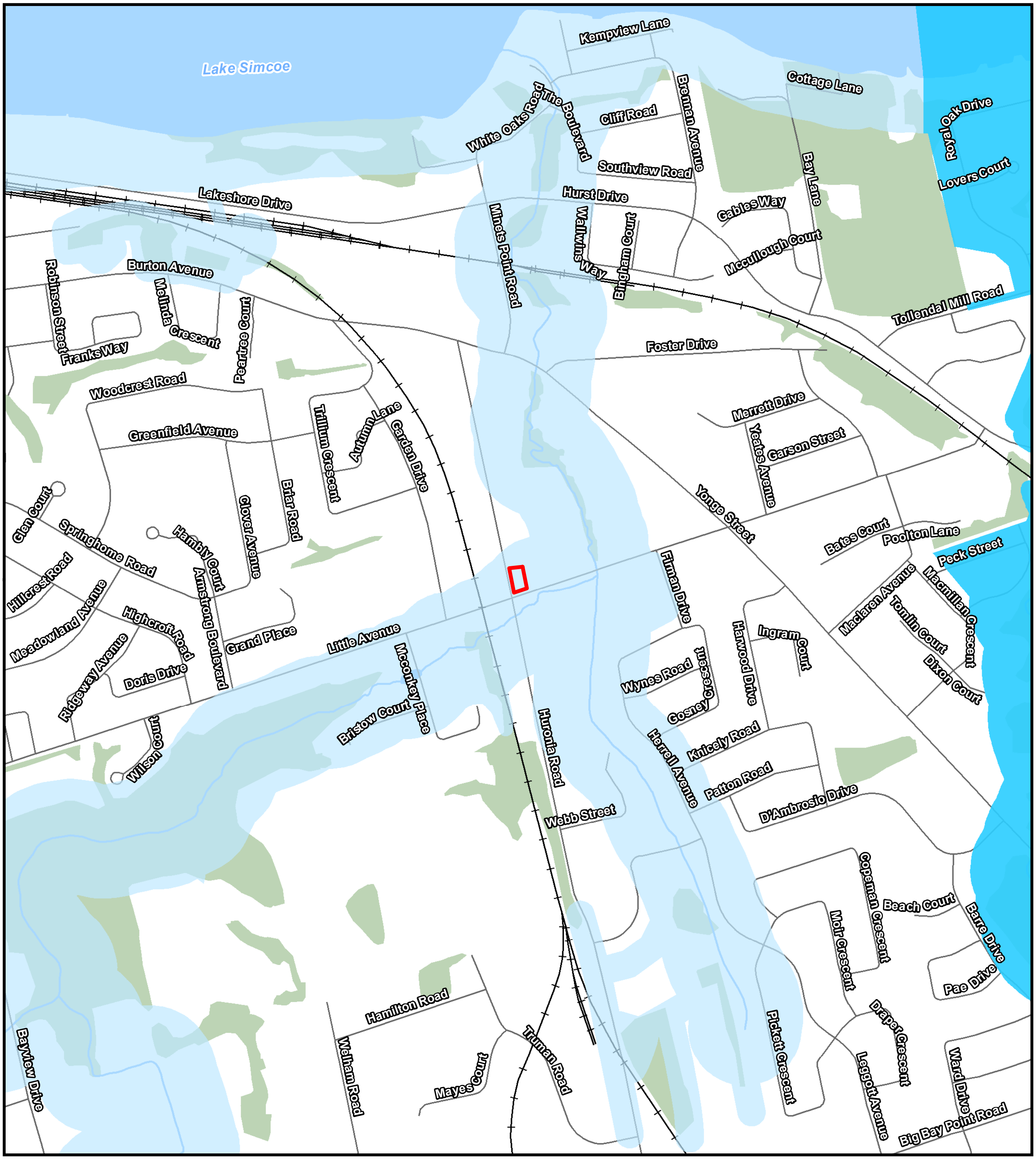
Project 2204000

WELLHEAD PROTECTION AREAS

March 2023

Fig. 3



NOTES:
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Legend

▭ Subject Lands
┼ Railway
— Road
— Watercourse
🟦 Waterbody
🟩 Wooded Area

Intake Protection Zone (LSRCA 2023)

Zone

🟦 1
🟦 2
🟦 3

N

0 150 300 m
1:12,000

Hydrogeological Investigation
Proposed Residential Development
59 Huronia Road, Barrie, ON

Innovative Planning Solutions

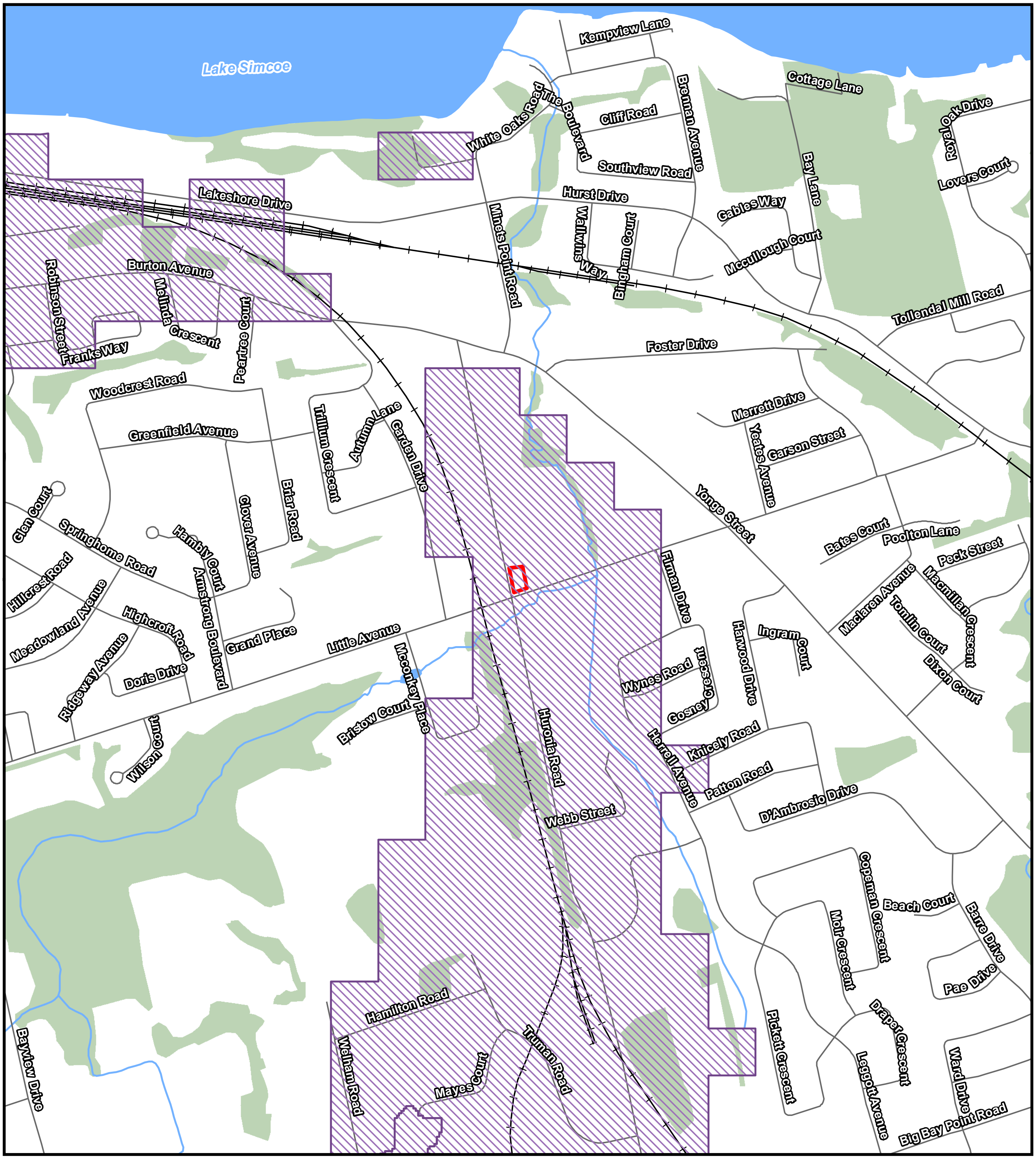
GEI Consultants

Project 2204000

INTAKE PROTECTION ZONES

March 2023

Fig. 4



NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2023.
3. Contains information made available under the Lake Simcoe Region Conservation Authority Open Data Licence v1.0.

Legend
- ▭ Subject Lands
- ┼ Railway
- ─ Road
- ─ Watercourse
- 🟦 Waterbody
- 🟩 Wooded Area
- ▨ Highly Vulnerable Aquifer (LSRCA 2023)

N

0 150 300 m
1:12,000

Hydrogeological Investigation
Proposed Residential Development
59 Huronia Road, Barrie, ON

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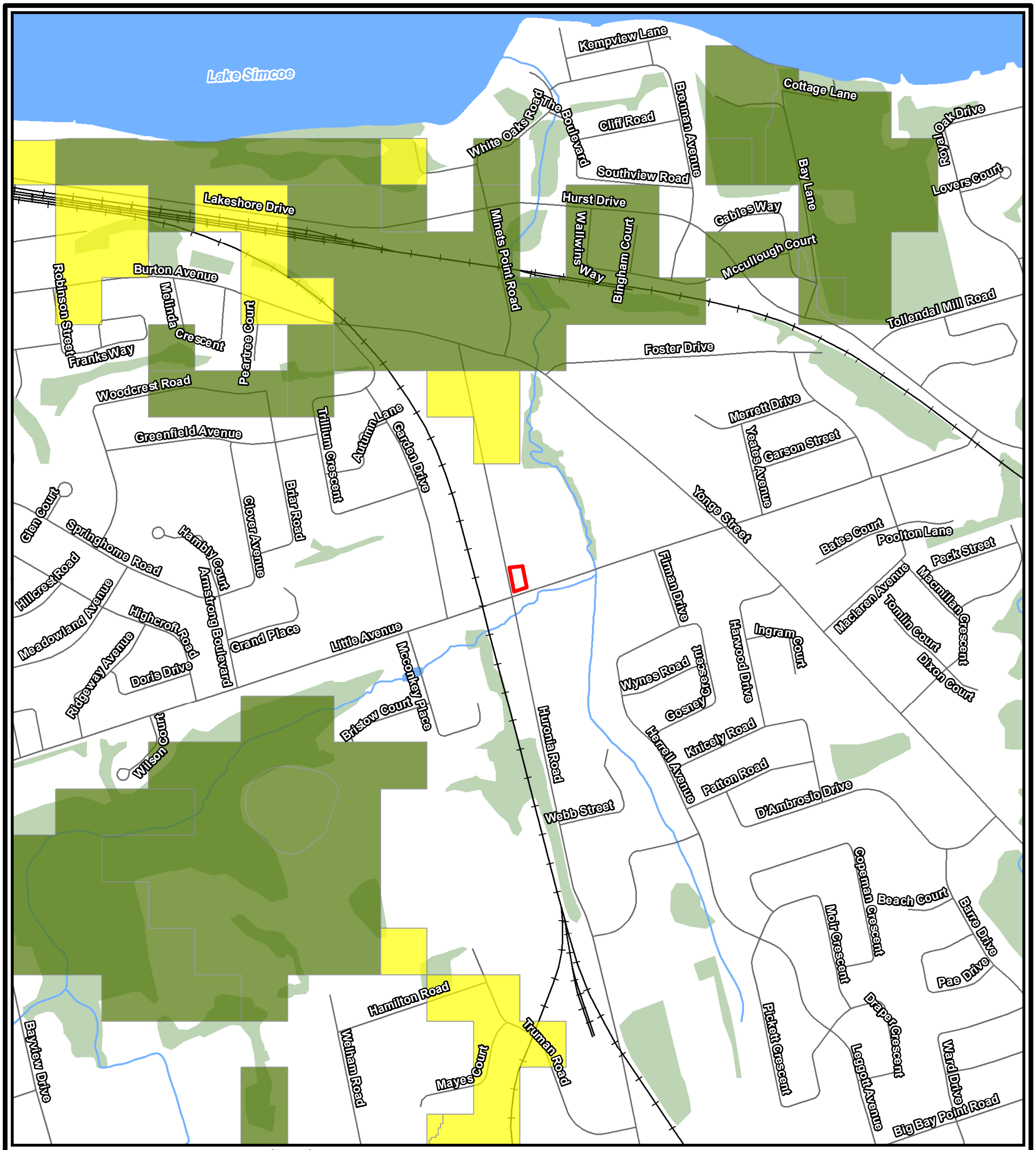
Project 2204000

HIGHLY VULNERABLE AQUIFER

March 2023

Fig. 5



NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
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Legend

- ▭ Subject Lands
- —+— Railway
- — Road
- — Watercourse
- 🟦 Waterbody
- 🟩 Wooded Area

Significant Groundwater Recharge Area (LSRCA 2023)

- 🟩 2-4
- 🟨 6

N

0 150 300 m

1:12,000

Hydrogeological Investigation
Proposed Residential Development
59 Huronia Road, Barrie, ON

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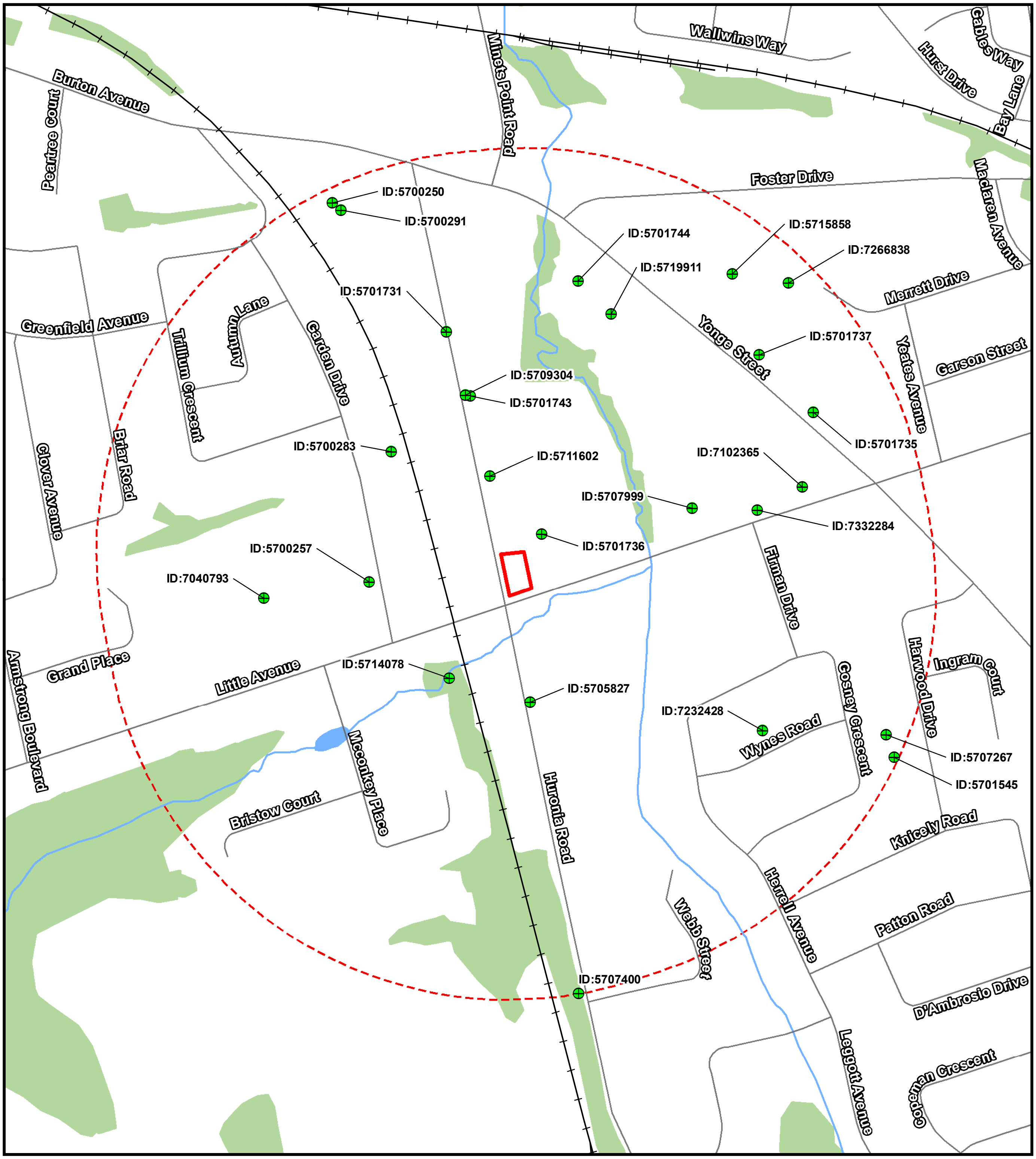
SIGNIFICANT GROUNDWATER RECHARGE AREA

March 2023

Fig. 6



NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2023.

Legend

□ Site Location
⬚ Site Location +500m
⊕ MECP Well Records Within 500m of Site Location
— Road
┼ Railway
— Watercourse
🟦 Waterbody
🟩 Wooded Area

N

0 50 100
m
1:7,000

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Proposed Residential Development
59 Huronia Road, Barrie, ON

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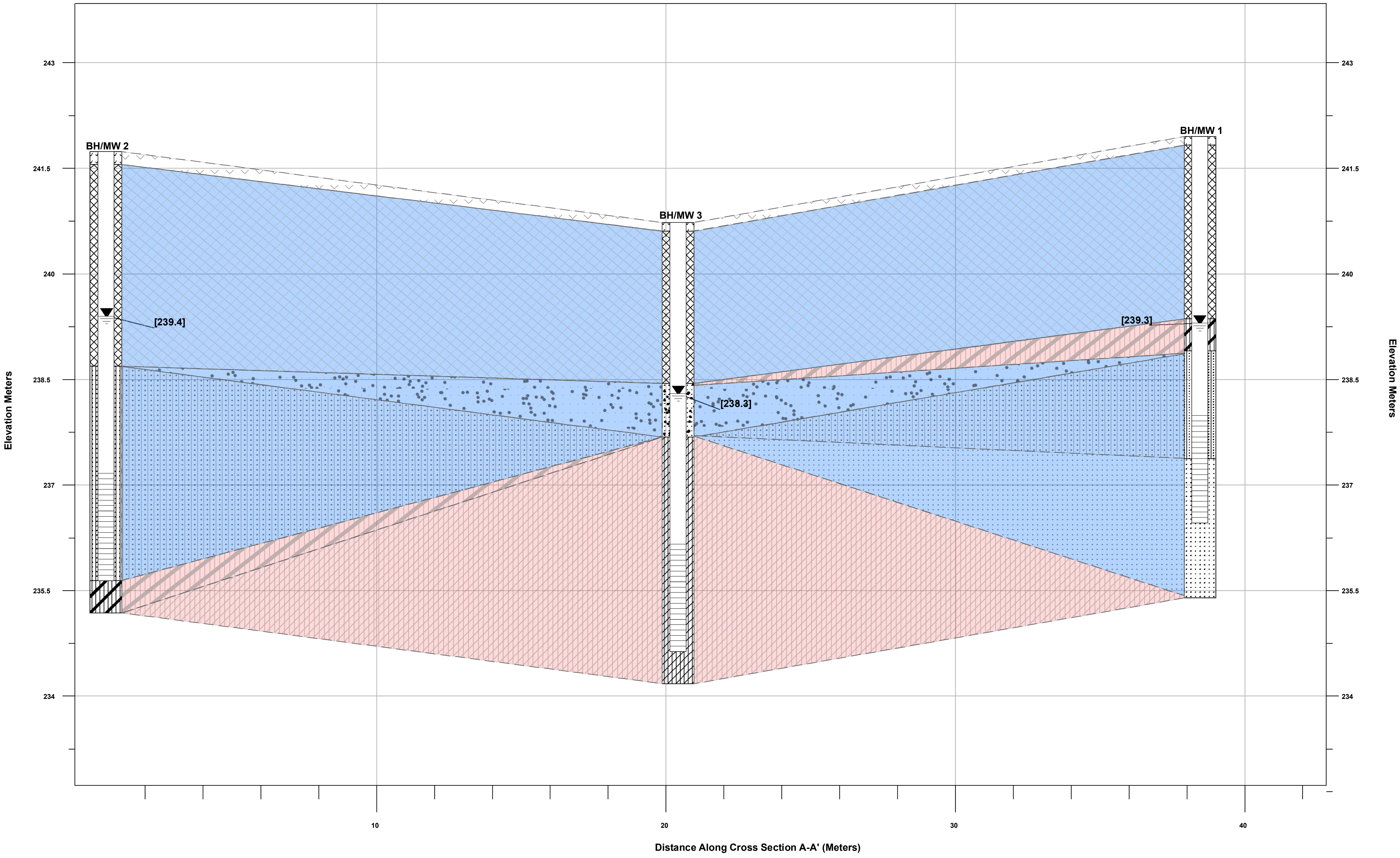
MECP WELL RECORD LOCATIONS

March 2023

Fig. 7



NOTES:
1. Subsurface conditions known only at borehole locations.
2. Horizontal distances are approximate.

Legend

▼ Water Level in Monitoring Well
[xx.xx] Water Levels (masl) Measured December 6, 2022

Strata

⌄ Topsoil
▨ Fill
▨ Gravel and Sand
▨ Clayey Silt
▨ Clayey Silt to Silty Clay
▨ Silty Sand
▨ Sand
🟥 Aquitard
🟦 Aquifer

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Proposed Residential Development
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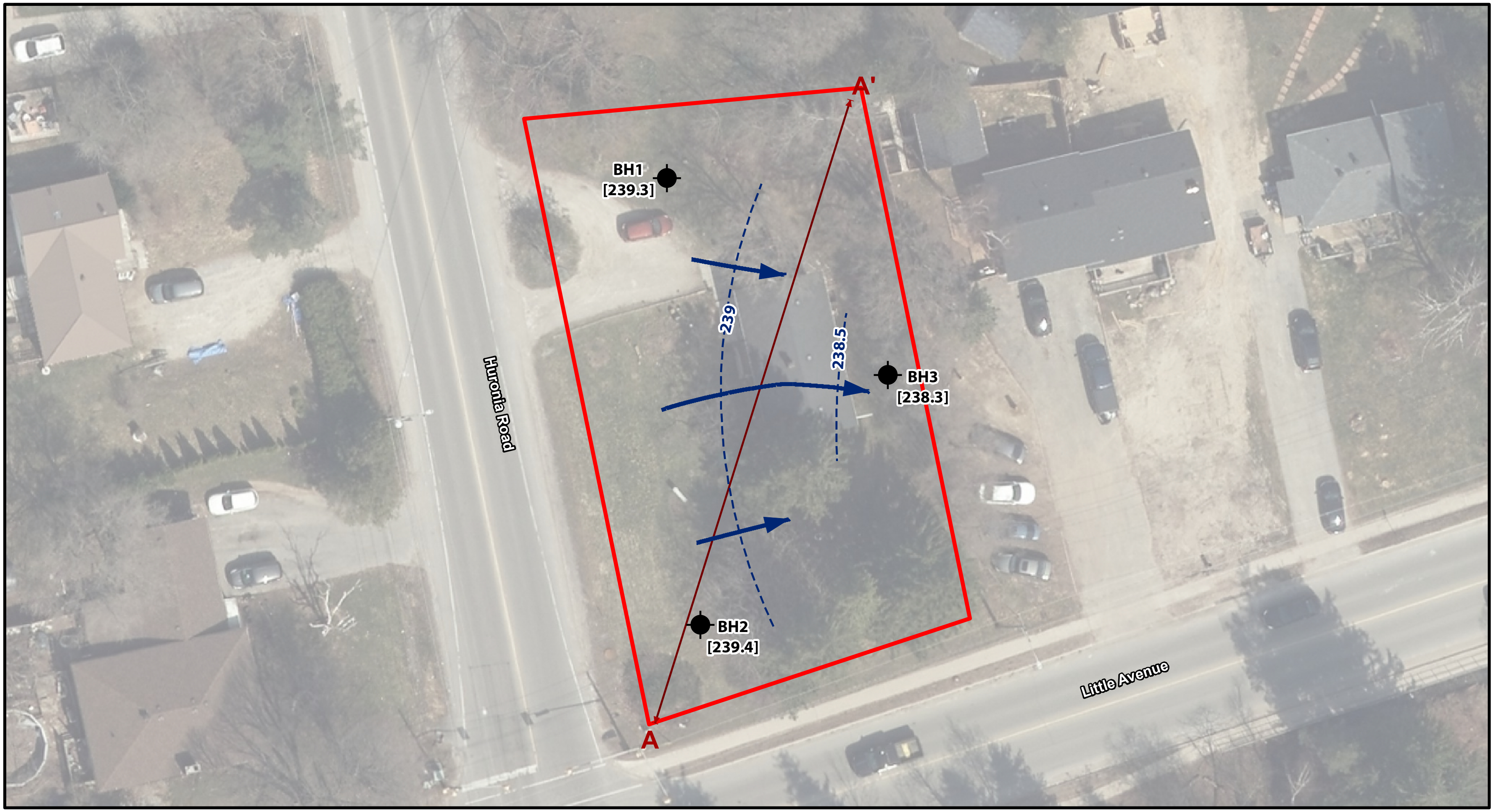
GEOLOGICAL CROSS SECTION A-A'

Project 2204000

January 2023

Fig. 8



Legend

🟥 Site Location

● Approximate Borehole/Monitoring Well Location

– – – Groundwater Contour

➜ Interpreted Direction of Groundwater Flow

[xx.xx] Water Level (masl), Measured Dec 6, 2022

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
3. Orthoimagery © First Base Solutions, 2023.
Imagery taken in 2021.

0 6 12 m
1:500

N

Hydrogeological Investigation
Proposed Residential Development
59 Huronia Road, Barrie, ON

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GROUNDWATER CONTOUR MAP

March 2023

Fig. 9

Appendix A

MECP Water Well Records

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	Well ID Only	WELL	FORMATION
BARRIE CITY	17 605785 4913322 W	2007/01 7215	2				0010 10	7040793	7040793 (Z64523) A049070	
BARRIE CITY	17 606451 4913460 W	2008/02 7314	1.97	FR 0006		NU	0005 10	7102365	7102365 (Z59752) A066226	GREY FILL LOOS 0005 BRWN FILL SNDY 0015 SILT
BARRIE CITY	17 606014 4913223 W	1977/02 2801	36 20 12		85/148/7 50/49:0	MN CO	0281 25	5714078	5714078 ()	BRWN LOAM 0001 GREY CLAY GRVL PCKD 0020 GREY SAND GRVL LOOS 0048 BRWN CLAY GRVL HARD 0142 GREY SAND CLAY LOOS 0164 GREY CLAY GRVL HARD 0226 GREY SAND CLAY LOOS 0271 GREY CLAY SLTY HARD 0276 GREY SAND GRVL LOOS 0307 GREY CLAY HARD 0308
BARRIE CITY	17 605880 4913802 W	1967/08 1510	4	FR 0085	25/35/10/ 2:0	CO	0105 8	5700291	5700291 ()	PRDG 0006 CLAY GRVL 0035 HPAN 0085 MSND 0115
BARRIE CITY	17 605942 4913503 W	1966/09 4607	30	FR 0010	10//2/:	DO		5700283	5700283 ()	BRWN CLAY 0005 MSND 0018
BARRIE CITY	17 605869 4913811 W	1960/07 1637	4	FR 0105	28/58/4/3 :0	DO	0100 5	5700250	5700250 ()	GRVL FILL 0007 MSND GRVL STNS 0015 GRVL STNS 0042 CLAY 0090 FSND 0100 MSND 0105
BARRIE CITY	17 605915 4913342 W	1960/12 2514	6	FR 0056	33/56/2/6 :0	DO	0056 4	5700257	5700257 ()	LOAM 0002 MSND 0006 BRWN CLAY 0023 CSND 0028 YLLW FSND 0060
BARRIE CITY (INNISFI	17 606395 4913431 W	6946						7332284	7332284 (C44700) A262885 P	
BARRIE CITY (INNISFI	17 606031 4912827 W	2015/12 7241	2			MT	0020 10	7260410	7260410 (Z225045) A183426	BRWN FSND 0020 BRWN FSND WBRG 0030
INNISFIL TOWNSHIP	17 606402 4913158 W	2014/08 7360						7232428	7232428 (C25999) A167912 P	
INNISFIL TOWNSHIP CON 13 011	17 606554 4913153 W	1970/03 2514	6	FR 0275	73/207/9/ 1:30	DO	0275 3	5707267	5707267 ()	LOAM 0001 BRWN MSND CLAY BLDR 0115 BLUE CLAY 0133 GREY CLAY FSND 0177 GREY CLAY 0230 GREY SILT 0264 GREY CLAY 0275 MSND 0278
INNISFIL TOWNSHIP CON 13 011	17 606174 4912833 W	1970/07 4608	30	FR 0024	14/22/5/1 :0	DO		5707400	5707400 ()	BRWN CLAY STNS 0017 GREY CLAY 0022 GREY MSND 0024

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	Well ID Only	WELL	FORMATION
INNISFIL TOWNSHIP CON 13 011	17 606214 4912823 W	1978/10 4608	30	FR 0012	12///:	DO		5715833	5715833 ()	BRWN CLAY STNY 0012 GRVL 0013 GREY CLAY STNY 0024
INNISFIL TOWNSHIP CON 13 011	17 606564 4913125 W	1963/05 2514	6	FR 0026	24/37/2/2 :30	DO	0026 3	5701545	5701545 ()	BRWN CLAY 0019 BRWN CLAY STNS 0024 CSND 0028 BRWN CLAY MSND GRVL 0036 BLUE CLAY 0040
INNISFIL TOWNSHIP CON 13 011	17 606114 4913193 W	1968/10 4608	30	FR 0012	8///:	DO		5705827	5705827 ()	BRWN CLAY STNS 0005 GREY CLAY STNS 0012 GRVL 0020
INNISFIL TOWNSHIP CON 14 011	17 606434 4913712 W	2016/02 7215	2				0006 10	7266838	7266838 (Z229920) A202941	BRWN SILT 0016
INNISFIL TOWNSHIP CON 14 011	17 606064 4913473 W	1974/09 3203	5	FR 0115	38/58/8/1 :0	DO	0119 3	5711602	5711602 ()	PRDG 0009 BRWN SAND 0012 BRWN SAND CLAY 0021 GREY SAND CLAY 0025 GREY CLAY 0115 GREY FSND 0122
INNISFIL TOWNSHIP CON 14 011	17 606034 4913573 W	1972/04 4816	6	FR 0221 FR 0245	32/77/35/ 2:0	PS	0236 4	5709304	5709304 ()	SAND GRVL 0023 GREY CLAY 0110 SAND 0135 GREY CLAY 0190 CLAY SAND 0221 MSND 0245
INNISFIL TOWNSHIP CON 14 011	17 606314 4913433 W	1971/04 3203	5	FR 0089	25/70/6/1 :30	DO	0108 3	5707999	5707999 ()	BRWN LOAM 0001 BRWN MSND 0012 GREY CLAY MSND 0046 GREY CLAY 0089 GREY FSND 0111
INNISFIL TOWNSHIP CON 14 011	17 606364 4913723 W	1978/10 1204	5	FR 0102	30/60/8/1 :0	DO	0105 3	5715858	5715858 ()	PRDG 0024 BRWN SAND GRVL 0040 GREY CLAY 0102 BRWN SAND 0108
INNISFIL TOWNSHIP CON 14 011	17 606214 4913673 W	1984/12 4816	6	FR 0113	40/80/9/2 :0	DO	0106 3	5719911	5719911 ()	SAND GRVL STNS 0035 BRWN FSND 0047 GREY FSND 0075 CLAY 0100 GREY FSND 0113
INNISFIL TOWNSHIP CON 14 011	17 606010 4913651 W	1966/12 4608	30	FR 0014	14//2/:	DO		5701731	5701731 ()	MSND 0027
INNISFIL TOWNSHIP CON 14 011	17 606464 4913552 W	1959/03 1637	4	FR 0215	47/125/1/ :	DO		5701735	5701735 ()	BRWN CLAY 0018 BLDR CLAY 0028 GRVL CLAY 0074 CLAY 0090 QSND CLAY 0213 MSND GRVL 0215
INNISFIL TOWNSHIP CON 14 011	17 606128 4913401 W	1959/05 2801	5					5701736	5701736 ()	LOAM 0001 MSND SILT GRVL 0013 BLUE CLAY 0115 CLAY MSND 0172 CLAY MSND GRVL 0267 BLUE CLAY GRVL BLDR 0331 LMSN 0332
INNISFIL TOWNSHIP CON 14 011	17 606397 4913623 W	1962/06 4102	30	FR 0012	12//2/:	DO		5701737	5701737 ()	MSND 0020

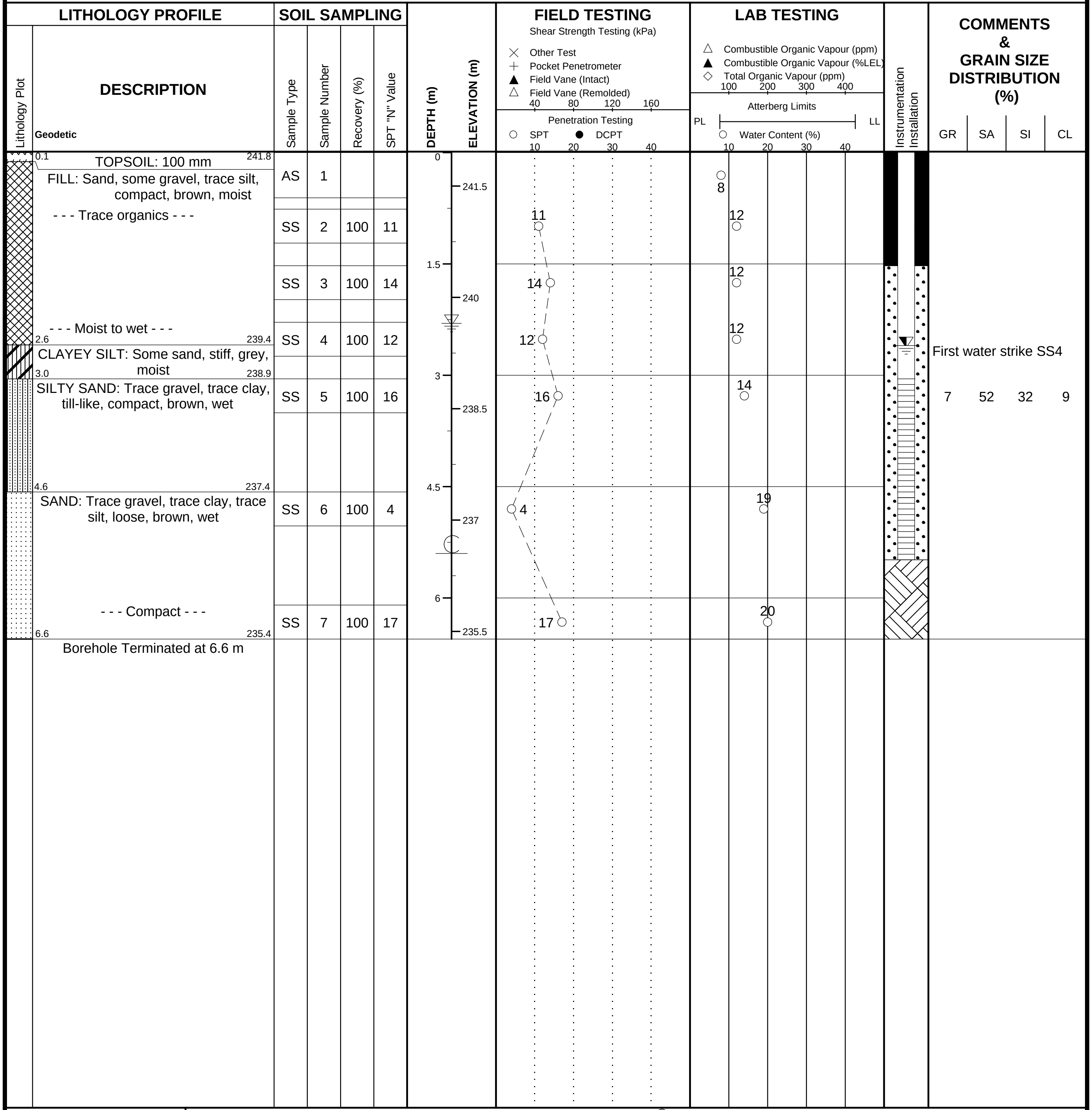
Appendix B

Borehole Logs

RECORD OF BOREHOLE No. 1

Project Number: **2204000**
Project Client: **Innovative Planning Solutions**
Project Name: **Proposed Residential Development**
Project Location: **Barrie, ON**
Drilling Location: **See Borehole Location Plan**
Local Benchmark:

Drilling Method: **Solid Stem Augers**
Drilling Machine: **Track Mount**
Logged By: **BH**
Reviewed By: **GW**
Northing: **4913371.3**
Easting: **606089.7**
Date Started: **Nov 22/22**
Date Completed: **Nov 22/22**



Depth (m)	Elevation (m)	DESCRIPTION
0.1	241.8	TOPSOIL: 100 mm
2.6	239.4	FILL: Sand, some gravel, trace silt, compact, brown, moist - - - Trace organics - - - - - - Moist to wet - - -
3.0	238.9	CLAYEY SILT: Some sand, stiff, grey, moist
4.6	237.4	SILTY SAND: Trace gravel, trace clay, till-like, compact, brown, wet
6.6	235.4	SAND: Trace gravel, trace clay, trace silt, loose, brown, wet - - - Compact - - -

Borehole Terminated at 6.6 m

Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)	GR	SA	SI	CL	COMMENTS
AS	1			8					
SS	2	100	11	12					
SS	3	100	14	12					
SS	4	100	12	12					First water strike SS4
SS	5	100	16	14	7	52	32	9	
SS	6	100	4	19					
SS	7	100	17	20					

COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GEI CONSULTANTS
647 Welham Road, Unit 14
Barrie, Ontario L4N 0B7
T : (705) 719-7994
www.geiconsultants.com

Groundwater depth encountered on completion of drilling: 2.3 m.
Cave depth after auger removal: 5.4 m.
Groundwater depth observed on: Dec 6/22 at depth of: 2.6 m.
Groundwater Elevation: 239.3 m

Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.

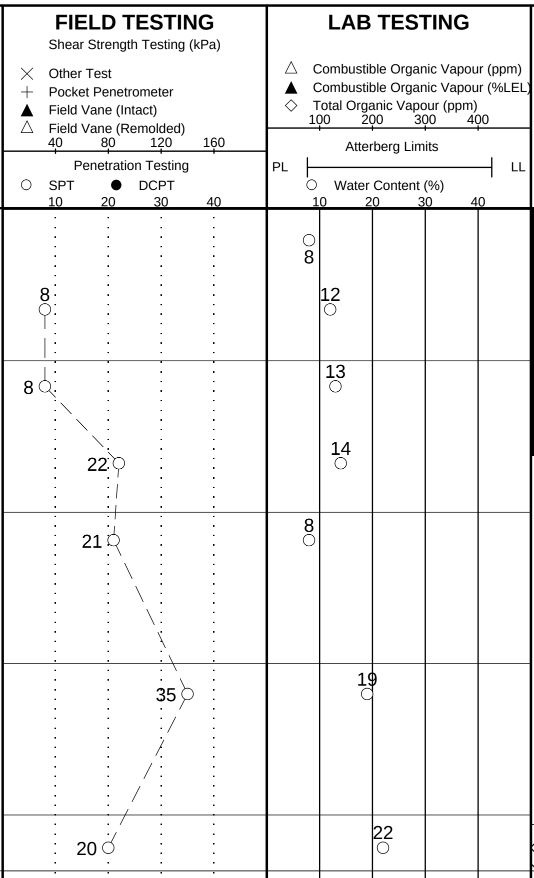
Scale: **1 :75**
Page: **1 of 1**

RECORD OF BOREHOLE No. 2

GEI Consultants

Project Number: **2204000**
Project Client: **Innovative Planning Solutions**
Project Name: **Proposed Residential Development**
Project Location: **Barrie, ON**
Drilling Location: **See Borehole Location Plan**
Local Benchmark:

Drilling Method: **Solid Stem Augers**
Drilling Machine: **Track Mount**
Logged By: **BH**
Reviewed By: **GW**
Northing: **4913333.4**
Easting: **606092.5**
Date Started: **Nov 22/22**
Date Completed: **Nov 22/22**



Depth (m)	Elevation (m)	Description	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)	Comments	GR	SA	SI	CL
0.0	241.7	Geodetic										
0.2	241.6	TOPSOIL: 150 mm										
		FILL: Silty sand, some gravel, trace organics/topsoil, loose, brown, moist	AS	1			8					
		- - - Sand, some concrete pieces and organics, trace silt - - -	SS	2	100	8	12					
		- - - Trace rootlets - - -	SS	3	100	8	13					
		- - - Gravelly sand, trace silt, compact, wet - - -	SS	4	35	22	14	First water strike SS4				
3.0	238.7	SANDY SILT TO SILTY SAND: Some clay, trace gravel, till-like, compact, brown, moist	SS	5	100	21	8		4	36	42	18
		- - - Trace clay, dense - - -	SS	6	100	35	19					
6.1	235.6	CLAYEY SILT: Some sand, very stiff, grey, very moist	SS	7	40	20	22					
6.6	235.2	Borehole Terminated at 6.6 m										

Depth scale (m): 0, 1.5, 3, 4.5, 6
Elevation scale (m): 241.5, 240, 238.5, 237, 235.5

Groundwater depth encountered on completion of drilling: 2.1 m.
Cave depth after auger removal: Open
Groundwater depth observed on: Dec 6/22 at depth of: 2.3 m.
Groundwater Elevation: 239.4 m

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647 Welham Road, Unit 14
Barrie, Ontario L4N 0B7
T : (705) 719-7994
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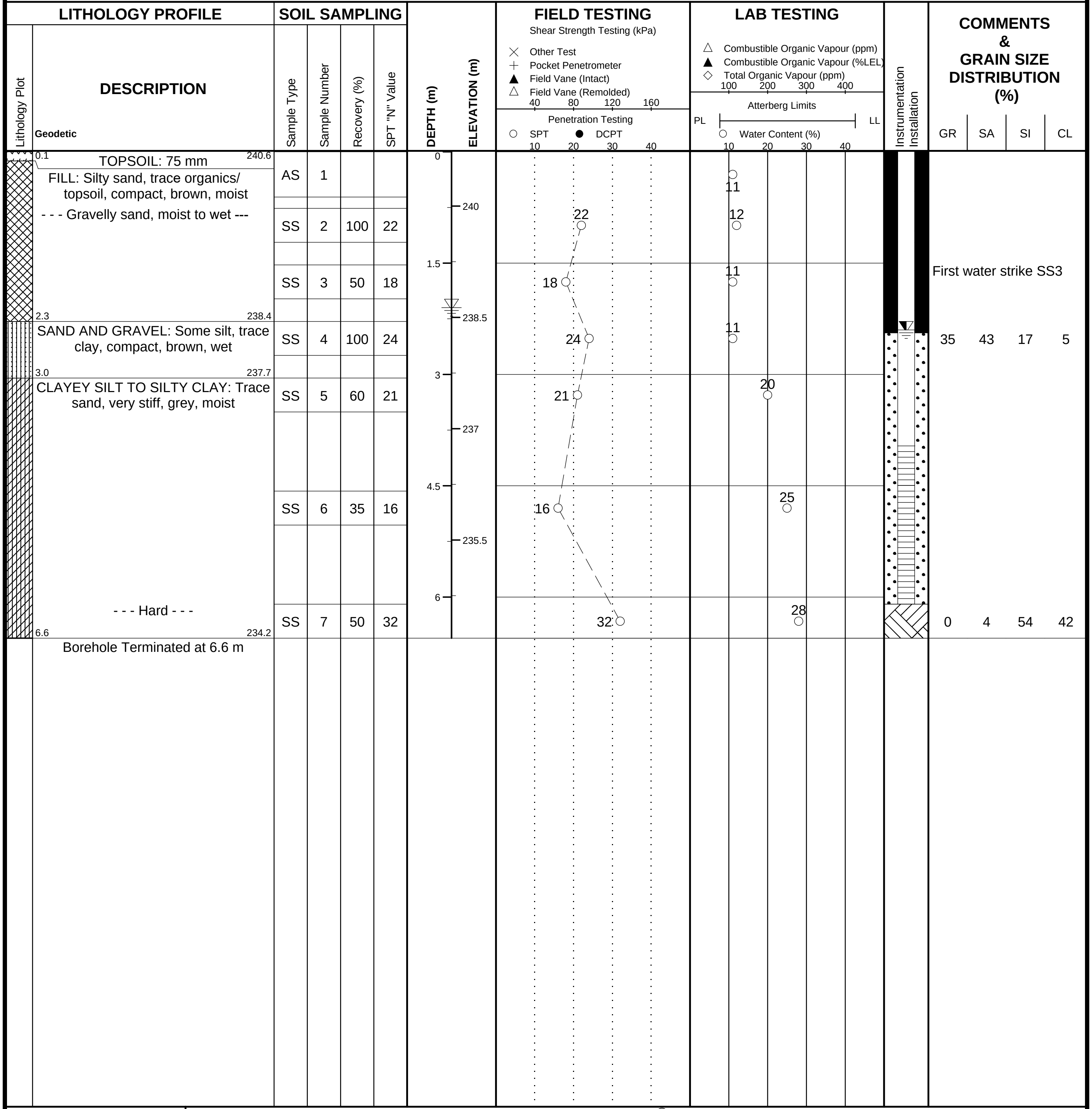
Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.

Scale: **1 :75**
Page: **1 of 1**

RECORD OF BOREHOLE No. 3

Project Number: **2204000**
Project Client: **Innovative Planning Solutions**
Project Name: **Proposed Residential Development**
Project Location: **Barrie, ON**
Drilling Location: **See Borehole Location Plan**
Local Benchmark:

Drilling Method: **Solid Stem Augers**
Drilling Machine: **Track Mount**
Logged By: **.**
Reviewed By: **GW**
Northing: **4913354.6**
Easting: **606108.4**
Date Started: **Nov 22/22**
Date Completed: **Nov 22/22**



Depth (m)	Elevation (m)	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)	COMMENTS	GR	SA	SI	CL
0.1	240.6	TOPSOIL: 75 mm										
		FILL: Silty sand, trace organics/ topsoil, compact, brown, moist	AS	1			11					
		- - - Gravelly sand, moist to wet ---	SS	2	100	22	12					
			SS	3	50	18	11	First water strike SS3				
2.3	238.4	SAND AND GRAVEL: Some silt, trace clay, compact, brown, wet	SS	4	100	24	11		35	43	17	5
3.0	237.7	CLAYEY SILT TO SILTY CLAY: Trace sand, very stiff, grey, moist	SS	5	60	21	20					
			SS	6	35	16	25					
		- - - Hard - - -	SS	7	50	32	28		0	4	54	42
6.6	234.2	Borehole Terminated at 6.6 m										

GEI CONSULTANTS
647 Welham Road, Unit 14
Barrie, Ontario L4N 0B7
T : (705) 719-7994
www.geiconsultants.com

Groundwater depth encountered on completion of drilling: 2.1 m.
Cave depth after auger removal: Open
Groundwater depth observed on: Dec 6/22 at depth of: 2.4 m.
Groundwater Elevation: 238.3 m

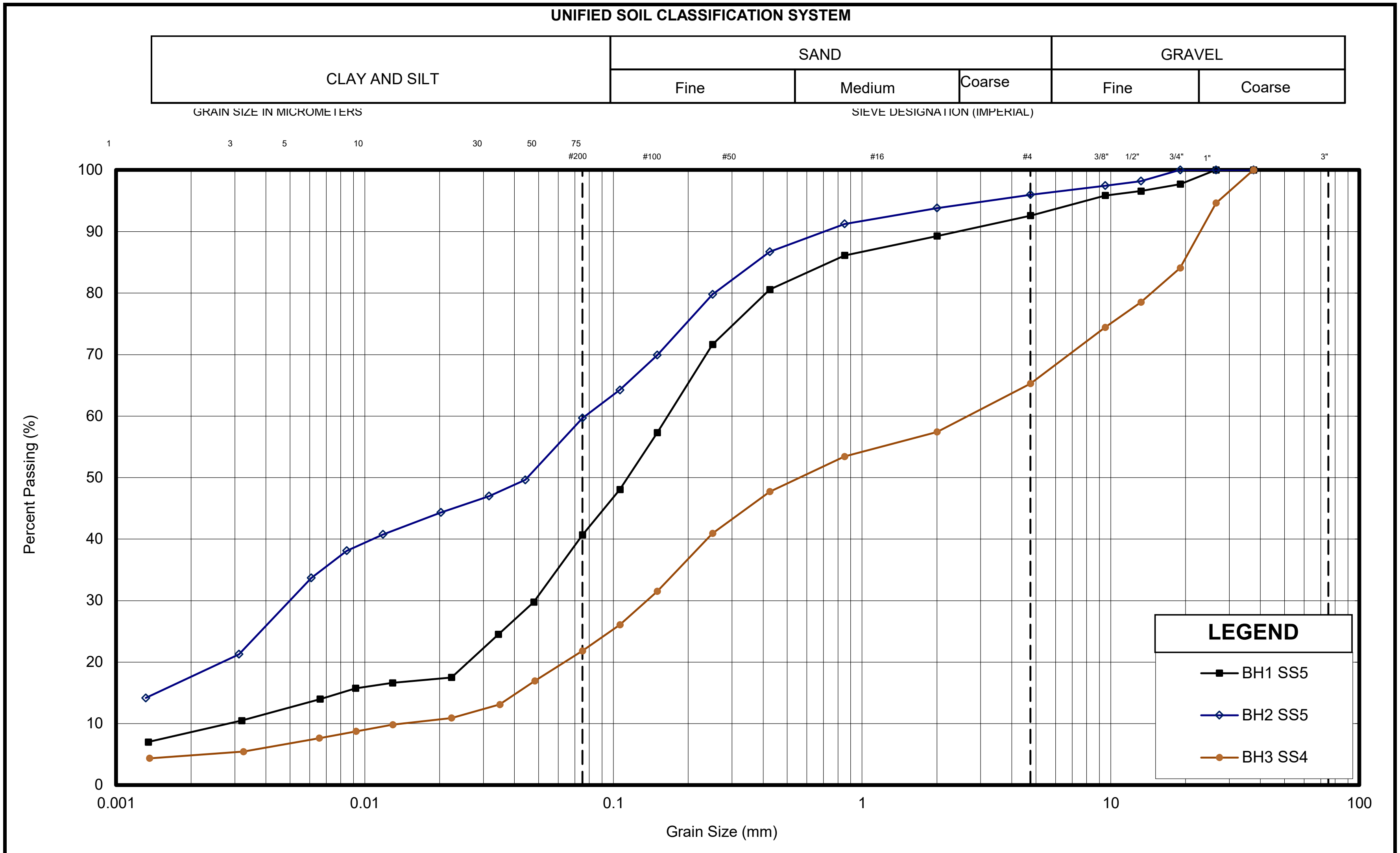
Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.

Scale: **1 :75**

Page: **1 of 1**

Appendix C

Geotechnical Laboratory Testing



Sample	Description	Gr.	Sa.	Si.	Cl.	D_{10}	D_{30}	D_{60}	C_u	C_c
BH1 SS5	SILTY SAND, Trace Clay, Trace Gravel	7	52	32	9	0.003	0.048	0.165	55.0	4.7
BH2 SS5	SAND AND SILT, Some Clay, Trace Gravel	4	36	42	18	-	0.005	0.077	-	-
BH3 SS4	GRAVEL AND SAND, Some Silt, Trace Clay	35	43	17	5	0.014	0.136	2.657	189.8	0.5

GEI Consultants

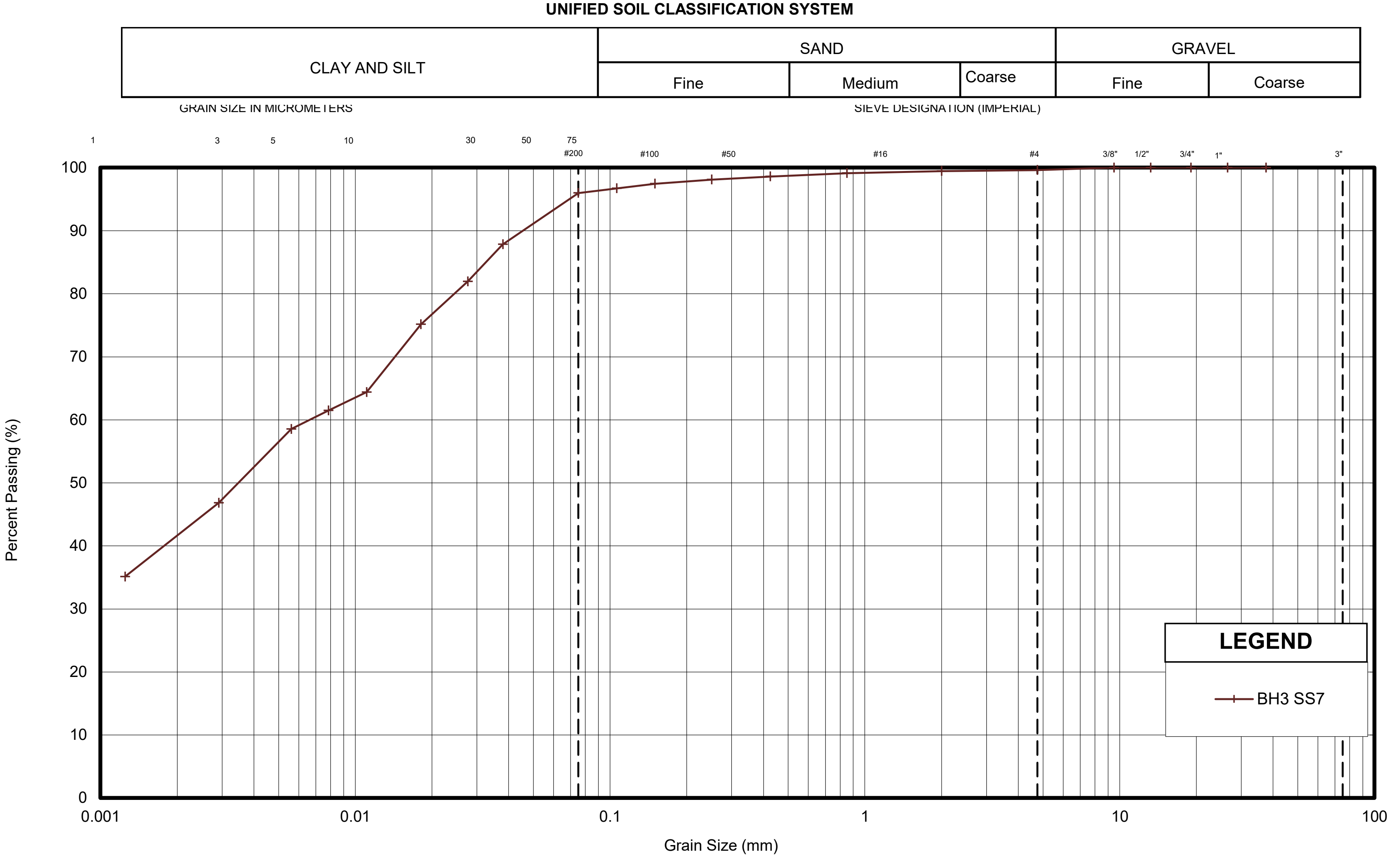
GRAIN SIZE DISTRIBUTION - 159 Huronia Road

SILTY SAND / SANDY SILT / GRAVEL AND SAND

FIGURE No. C1

REF. No. 2204000

DATE March 2023



Sample	**Description**	**Gr.**	**Sa.**	**Si.**	**Cl.**	**D_{10}**	**D_{30}**	**D_{60}**	**C_u**	**C_c**
BH3 SS7	CLAY AND SILT, Trace Sand	-	4	54	42	-	-	0.007	-	-

GEI Consultants

GRAIN SIZE DISTRIBUTION - 159 Huronia Road

CLAYEY SILT TO SILTY CLAY

FIGURE No. C2
REF. No. 2204000
DATE March 2023

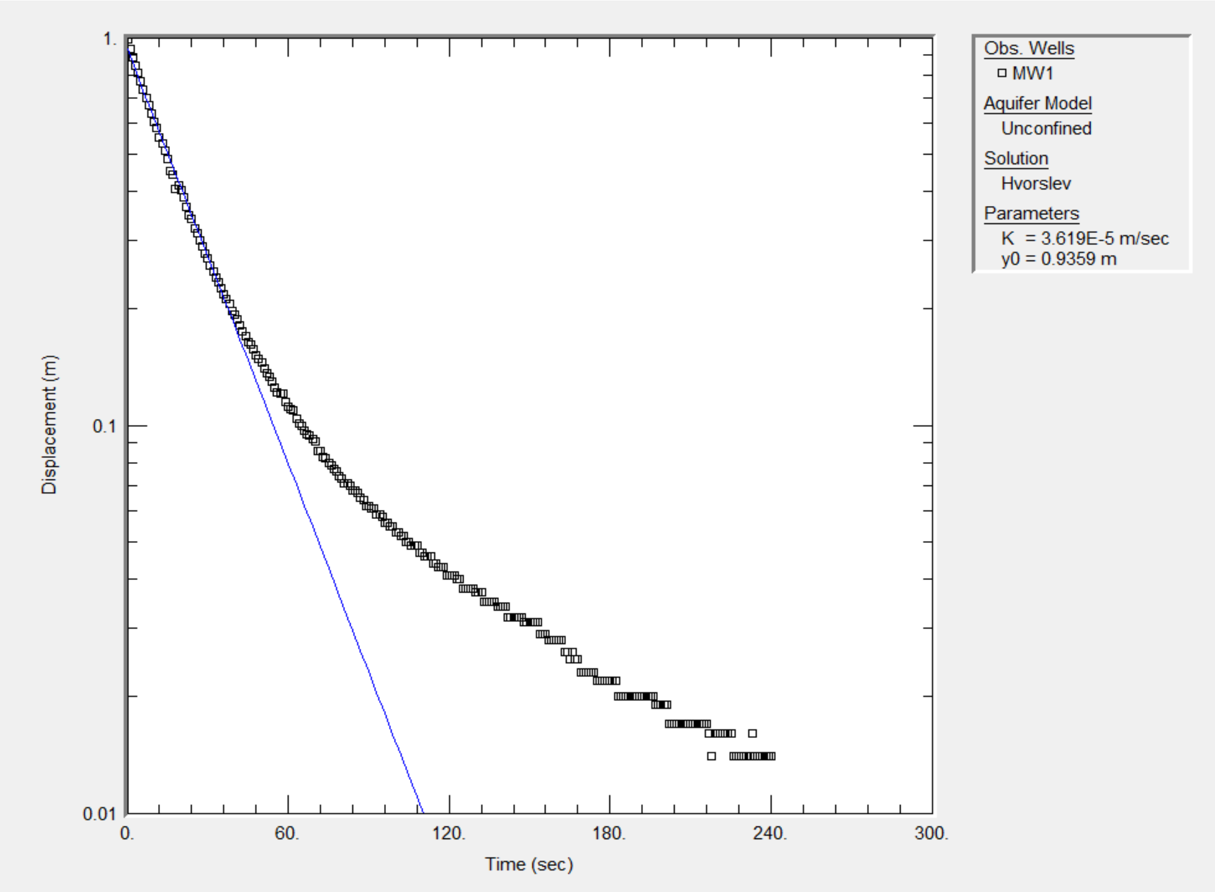
Appendix D

Borehole Permeability Plots

Estimation of K by Slug Test, based on Hvorslev's equation

Date:	December 15, 2022
Conducted by:	S. Patrick

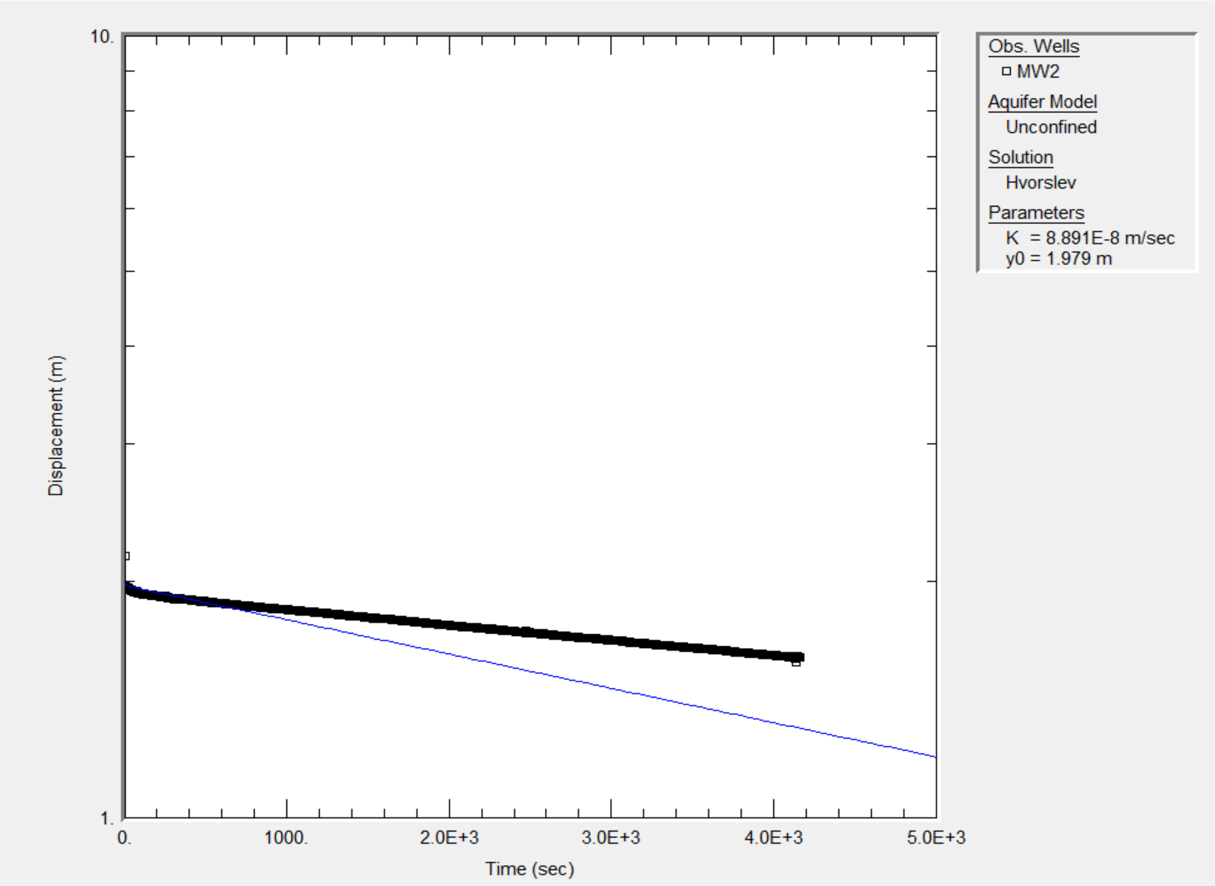
Well Number:	GEI-MW1	
Well Screen Bottom:	5.49	mbgs
Top of Pipe:	0.75	mags
Well Casing Diameter:	5.08	cm
Local Well Elevation:	242.00	masl
Static Water Level:	2.56	mbgs
$K = r^2\ln(L/R)/(2LTo) =$	**$3.6x10^{-5}$**	m/s



Estimation of K by Slug Test, based on Hvorslev's equation

Date:	December 15, 2022
Conducted by:	S. Patrick

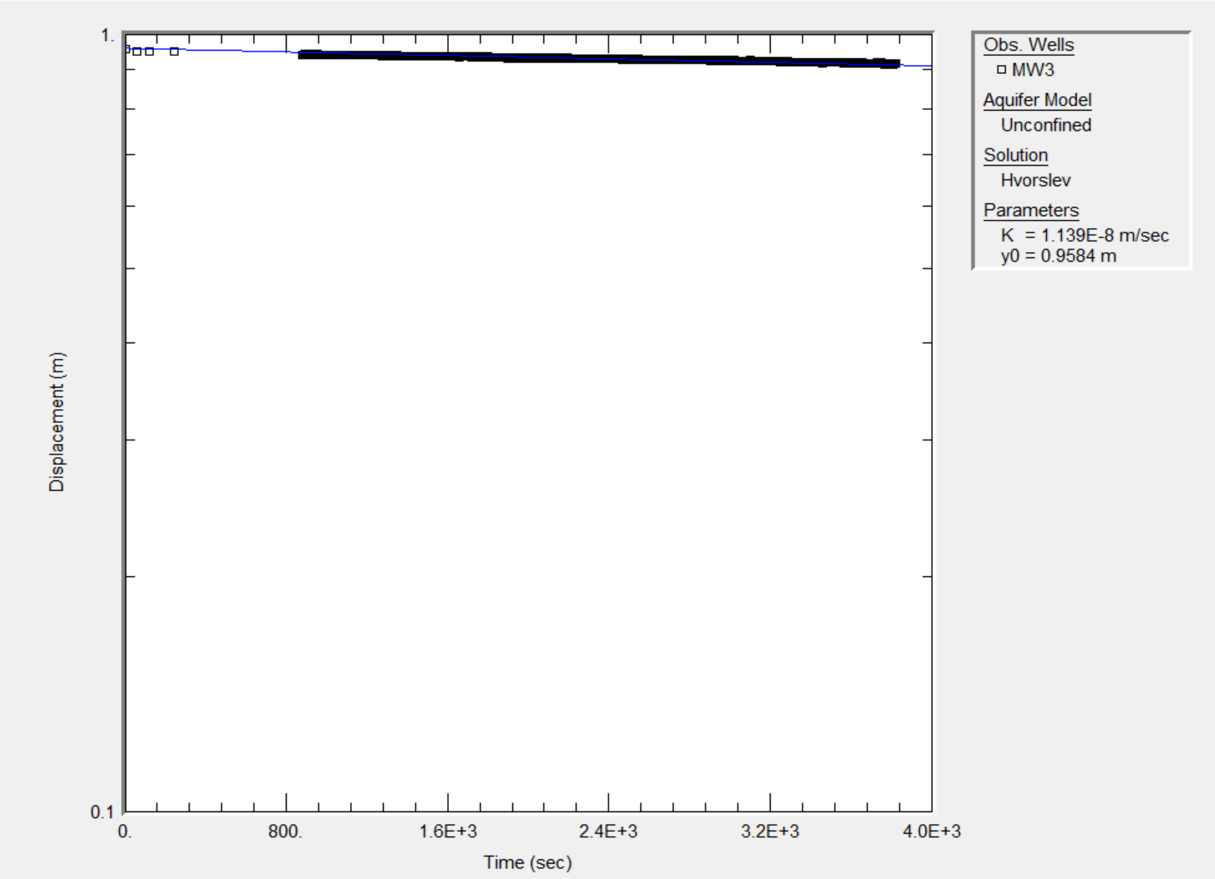
Well Number:	GEI-MW2	
Well Screen Bottom:	6.10	mbgs
Top of Pipe:	0.74	mags
Well Casing Diameter:	5.08	cm
Local Well Elevation:	241.70	masl
Static Water Level:	2.29	mbgs
$K = r^2\ln(L/R)/(2LTo) =$	**$8.9\text{x}10^{-8}$**	m/s



Estimation of K by Slug Test, based on Hvorslev's equation

Date:	December 15, 2022
Conducted by:	S. Patrick

Well Number:	GEI-MW3	
Well Screen Bottom:	6.10	mbgs
Top of Pipe:	0.73	mags
Well Casing Diameter:	5.08	cm
Local Well Elevation:	240.70	masl
Static Water Level:	2.13	mbgs
$K = r^2\ln(L/R)/(2LTo) =$	**1.1x10^{-8}**	m/s



Appendix E

Water Quality Laboratory Certificate Of Analysis And Chain Of Custody

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B22-36077

Report To:

GEI Consultants
647 Welham Rd, Unit 14,
Barrie ON L4N 0B7 Canada
Attention: Geoff White

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 14-Dec-22

DATE REPORTED: 30-Dec-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:

P.O. NUMBER: 2204000

WATERWORKS NO.

Parameter	**Qty**	**Site Analyzed**	**Analyst Initials**	**Date Analyzed**	**Lab Method**	**Reference Method**
Anions	1	Holly Lane	VK	20-Dec-22	A-IC-01 (o)	SM4110C
pH	1	Holly Lane	SYL	15-Dec-22	A-PH-01 (o)	SM 4500H
Total Suspended Solids	2	Kingston	ama	15-Dec-22	A-TSS-001 (k)	SM2540D
BOD	1	Kingston	JWF	15-Dec-22	C-BOD-001 (k)	SM 5210B
Chromium (VI)	2	Holly Lane	LMG	20-Dec-22	D-CRVI-01 (o)	MOE E3056
Mercury	2	Holly Lane	PBK	16-Dec-22	D-HG-02 (o)	SM 3112 B
Metals - ICP-OES	2	Holly Lane	NHG	19-Dec-22	D-ICP-01 (o)	SM 3120
Metals - ICP-MS	2	Holly Lane	ST	20-Dec-22	D-ICPMS-01 (o)	EPA 200.8

Barrie Sanitary - Barrie Sanitary & Combined and Storm
Barrie-Sanitary/Combined - Sanitary/Combined Sewer Guidelines
Barrie-Storm Sewer - Storm Sewer Guidelines

CBurke

Christine Burke
Lab Manager

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B22-36077

Report To:

GEI Consultants
647 Welham Rd, Unit 14,
Barrie ON L4N 0B7 Canada
Attention: Geoff White

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 14-Dec-22

DATE REPORTED: 30-Dec-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:

P.O. NUMBER: 2204000

WATERWORKS NO.

	Client I.D.		MW1	MW1F			**Barrie Sanitary**	
	Sample I.D.		B22-36077-1	B22-36077-2			**Barrie-Sanitary/Combined**	**Barrie-Storm Sewer**
	Date Collected		13-Dec-22	13-Dec-22				
Parameter	**Units**	**R.L.**						
pH @25°C	pH Units		7.66				9.5	9.5
Total Suspended Solids	mg/L	3	**495**	< 3			350	15
BOD(5 day)	mg/L	3	< 3				300	15
Chloride	mg/L	0.5	792				1500	
Aluminum	mg/L	0.01	7.20	0.05			50	
Antimony	mg/L	0.0001	0.0002	0.0002			5.0	
Arsenic	mg/L	0.0001	0.0012	< 0.0001			1.0	
Beryllium	mg/L	0.002	< 0.002	< 0.002				
Boron	mg/L	0.005	0.029	0.017				
Cadmium	mg/L	).000015	0.000086	< 0.000015			0.7	0.001
Chromium	mg/L	0.001	0.009	< 0.001			2.0	0.08
Chromium (VI)	mg/L	0.001	< 0.001	< 0.001 [1]				
Cobalt	mg/L	0.0001	0.0055	0.0002			5.0	
Copper	mg/L	0.0001	**0.0128**	0.0010			2.0	0.01
Iron	mg/L	0.005	12.7	< 0.005			50	
Lead	mg/L	0.00002	0.00457	< 0.00002			0.7	0.05
Mercury	mg/L	0.00002	< 0.00002	< 0.00002			0.01	
Molybdenum	mg/L	0.01	< 0.01	< 0.01			5.0	
Nickel	mg/L	0.0002	0.0107	0.0022			2.0	0.05
Selenium	mg/L	0.001	< 0.001	< 0.001			1.0	
Silver	mg/L	0.0001	< 0.0001	< 0.0001			0.4	
Thallium	mg/L	0.00005	0.00011	< 0.00005				
Tungsten	mg/L	0.01	< 0.01	< 0.01				
Uranium	mg/L	0.00005	0.00375	0.00385				

Barrie Sanitary - Barrie Sanitary & Combined and Storm
Barrie-Sanitary/Combined - Sanitary/Combined Sewer Guidelines
Barrie-Storm Sewer - Storm Sewer Guidelines

CBurke

Christine Burke
Lab Manager

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Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 14-Dec-22
DATE REPORTED: 30-Dec-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2204000
WATERWORKS NO.

	Client I.D.		MW1	MW1F			**Barrie Sanitary**	
	Sample I.D.		B22-36077-1	B22-36077-2			**Barrie-Sanitary/Combined**	**Barrie-Storm Sewer**
	Date Collected		13-Dec-22	13-Dec-22				
Parameter	**Units**	**R.L.**						
Vanadium	mg/L	0.005	0.021	< 0.005			5.0	
Zinc	mg/L	0.005	0.032	< 0.005			2.0	0.04
Zirconium	mg/L	0.003	0.005	< 0.003				

1 . Chromium (VI) result is based on total chromium

Barrie Sanitary - Barrie Sanitary & Combined and Storm
Barrie-Sanitary/Combined - Sanitary/Combined Sewer Guidelines
Barrie-Storm Sewer - Storm Sewer Guidelines

CBurke

Christine Burke
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DATE RECEIVED: 14-Dec-22
DATE REPORTED: 30-Dec-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2204000
WATERWORKS NO.

Summary of Exceedances

Sanitary/Combined Sewer Guidelines

MW1	Found Value	Limit
Total Suspended Solids (mg/L)	495	350

Storm Sewer Guidelines

MW1	Found Value	Limit
Total Suspended Solids (mg/L)	495	15
Copper (mg/L)	0.0128	0.01

Barrie Sanitary - Barrie Sanitary & Combined and Storm
Barrie-Sanitary/Combined - Sanitary/Combined Sewer Guidelines
Barrie-Storm Sewer - Storm Sewer Guidelines

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

CBurke

Christine Burke
Lab Manager

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Final Report

C.O.C.: ---

REPORT No. B22-36077 (i)

Rev. 1

Report To:

GEI Consultants
647 Welham Rd, Unit 14,
Barrie ON L4N 0B7 Canada
Attention: Geoff White

Caduceon Environmental Laboratories
112 Commerce Park Drive
Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 14-Dec-22

DATE REPORTED: 30-Dec-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:

P.O. NUMBER: 2204000

WATERWORKS NO.

Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
Chromium (VI)	2	Holly Lane	LMG	20-Dec-22	D-CRVI-01 (o)	MOE E3056
Mercury	2	Holly Lane	PBK	16-Dec-22	D-HG-02 (o)	SM 3112 B
Metals - ICP-OES	2	Holly Lane	NHG	19-Dec-22	D-ICP-01 (o)	SM 3120
Metals - ICP-MS	2	Holly Lane	ST	20-Dec-22	D-ICPMS-01 (o)	EPA 200.8

PWQO - Provincial Water Quality Objectives
Interim PWQO - Interim PWQO
PWQO - Provincial Water Quality Objectives

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 14-Dec-22
DATE REPORTED: 30-Dec-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2204000
WATERWORKS NO.

	Client I.D.		MW1	MW1F			**PWQO**	
	Sample I.D.		B22-36077-1	B22-36077-2			**Interim PWQO**	**PWQO**
	Date Collected		13-Dec-22	13-Dec-22				
Parameter	**Units**	**R.L.**						
Aluminum	µg/L	10	**7200**	50			75	
Antimony	µg/L	0.1	0.2	0.2			20	
Arsenic	µg/L	0.1	1.2	< 0.1			5	5
Beryllium	µg/L	2	< 2	< 2				11
Boron	µg/L	5	29	17			200	
Cadmium	µg/L	0.015	0.086	< 0.015			0.1	0.2
Chromium	µg/L	1	9	< 1				
Chromium (VI)	µg/L	1	< 1	< 1 [1]				1
Cobalt	µg/L	0.1	**5.5**	0.2			0.9	
Copper	µg/L	0.1	**12.8**	1.0			5	
Iron	µg/L	5	**12700**	< 5				300
Lead	µg/L	0.02	**4.57**	< 0.02			1	5
Mercury	µg/L	0.02	< 0.02	< 0.02				0.2
Molybdenum	µg/L	10	< 10	< 10			40	
Nickel	µg/L	0.2	10.7	2.2				25
Selenium	µg/L	1	< 1	< 1				100
Silver	µg/L	0.1	< 0.1	< 0.1				0.1
Thallium	µg/L	0.05	0.11	< 0.05			0.3	0.3
Tungsten	µg/L	10	< 10	< 10			30	
Uranium	µg/L	0.05	3.75	3.85			5	
Vanadium	µg/L	5	**21**	< 5			6	
Zinc	µg/L	5	**32**	< 5			20	30
Zirconium	µg/L	3	**5**	< 3			4	

[1] Chromium (VI) result is based on total chromium

PWQO - Provincial Water Quality Objectives
Interim PWQO - Interim PWQO
PWQO - Provincial Water Quality Objectives

CBurke

Christine Burke
Lab Manager

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Rev. 1

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Barrie ON L4N 8W8
Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 14-Dec-22

DATE REPORTED: 30-Dec-22

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:

P.O. NUMBER: 2204000

WATERWORKS NO.

Summary of Exceedances

Interim PWQO

MW1	Found Value	Limit
Zirconium (µg/L)	5	4
Zinc (µg/L)	32	20
Vanadium (µg/L)	21	6
Lead (µg/L)	4.57	1
Copper (µg/L)	12.8	5
Cobalt (µg/L)	5.5	0.9
Aluminum (µg/L)	7200	75

Provincial Water Quality Objectives

MW1	Found Value	Limit
Zinc (µg/L)	32	30
Iron (µg/L)	12700	300

PWQO - Provincial Water Quality Objectives
Interim PWQO - Interim PWQO
PWQO - Provincial Water Quality Objectives

CBurke

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Christine Burke
Lab Manager

GENERAL SAMPLE SUBMISSION FORM

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SAMPLES SUBMITTED TO:
- Kingston ☐
- Ottawa ☐
- Richmond Hill ☐
- Barrie ☒
- London ☐
- Windsor ☐

TESTING REQUIREMENTS
- ☐ O'Reg 153/04
- ☐ O'Reg 406/19
- ☐ RPI
- ☐ Coarse
- ☐ MISA
- ☐ Other: Barrie Storm Sewer
- ☐ Table (1 - 9)
- ☐ Table (1 - 9.1)
- ☐ ICC
- ☐ Medium/Fine
- ☒ PWQO
- ☐ Record of Site
- ☐ SPLP Table (1 - 9.1)
- ☐ Agricultural
- ☐ O'Reg 558 TCLP
- ☐ Landfill Monitoring

REPORT NUMBER (Lab Use)
B22-36077

Are any samples to be submitted intended for Human Consumption under any Drinking Water Regulations? ☐ Yes ☒ No (If yes, submit all Drinking Water Samples on a Drinking Water Chain of Custody)

Organization: GEI Consultants
Contact: Geoffrey White
Tel: 705-350-1852
Fax:
Email: gwhite@geiconsultants.com
Additional Info (email, cell, etc):
Address: 647 Wellham Road, Barrie
Quote #:
P.O. #:
Invoicing Address (if different):
Project Name/#: 2204000
Additional Info:

ANALYSES REQUESTED: PWQO Metals; PWQO TSS; Barrie Storm Sewer; Suspected Highly Contaminated

TURNAROUND SERVICE REQUESTED (see back page)
*Must be arranged in advance

☐	Platinum*	200% Surcharge
☐	Gold*	100% Surcharge
☐	Silver	50% Surcharge
☐	Bronze	25% Surcharge
☒	Standard	5-7 days
☐	Specific Date:	

* Sample Matrix Legend: WW=Waste Water, SW=Surface Water, GW=Groundwater, LS=Liquid Sludge, SS=Solid Sludge, S=Soil, Sed=Sediment, PC=Paint Chips, F=Filter, Oil = Oil

Lab No.	Sample Source and/or Sample Identification	S.P.L.	Sample Matrix *	Date Collected (yy-mm-dd)	Time Collected	Indicate Test For Each Sample By Using A Check Mark In The Box Provided: PWQO Metals	PWQO TSS	Barrie Storm Sewer									X	Field pH	Field Temp.	# Bottles/ Sample	Field Filtered Y/N
1	MW1		GW	~~22-07-19~~ 22-12-13		X		X												6	N
2	MW1 F		GW	~~22-07-19~~ 22-12-13		X	X													4	Y

#1&2 gen chem + #2 → K

#1 gen chem → O

#1&2 metals + crvi + Hg → O

SAMPLE SUBMISSION INFORMATION

	Sampled by:	Submitted by:
Print:	S.Patrick	S.Patrick
Sign:		
Date (yy-mm-dd)/Time:	~~21-07-19~~ 22-12-13	~~21-07-19~~ 22-12-13

SHIPPING INFORMATION
- Courier (Client account) ☐
- Courier (Caduceon account) ☐
- Drop Off ☒
- Caduceon (Pick-up) ☐

Invoice
\# of Pieces

REPORTING / INVOICING
- Report by Fax ☐
- Report by Email ☒
- Invoice by Email ☒
- Invoice by Mail ☐

SAMPLE RECEIVING INFORMATION (LABORATORY USE ONLY)
Received By (print): Autumn
Signature: AH
Date Received (yy-mm-dd): 22-12-14
Time Received: 8CW
Laboratory Prepared Bottles: ☒ Yes ☐ No
Sample Temperature °C: 7.7
Labeled by: AH

Comments:

Page 1 of 1

G

CofC, May 2020 Revision No: 23

Appendix F

Construction Dewatering Calculations

Construction Dewatering Rate Estimate

159 Huronia Road, Barrie, Ontario

Temporary Construction Dewatering Rate Estimates - Zone 1: Per Service Lateral

Description	**Symbol**	**Values**	**Unit**	**Explanation**
Input Data				
Lowest Ground Elevation		240.5	m asl	
Highest Groundwater Elevation		238.2	m asl	Highest groundwater level 2.3 mbgs measured on Dec 6, 2022
Lowest Proposed Excavation		237.0	m asl	3.5 mbgs
Aquifer Bottom		236.5	m asl	Assume at target water level
Hydraulic Conductivity	K	4.00E-05	m/s	Greatest K measures on site
Length of Excavation	x	20	m	Assumed
Width of Excavation	a	3	m	Assumed
Output				
Top of Aquifer		238.2	m asl	Highest groundwater level 2.3 mbgs measured on Dec 6, 2022
Target Water Level		236.5	m asl	Assume 0.5 m below lowest proposed excavation
Water Level above aquifer bottom before dewatering	H	1.7	m	
Target Water Level above above aquifer bottom	h	0.0	m	
Radius of Influence	L (R_0)	32	m	Sichardt Equation
Precipitation		600	L/day	10 mm rain event
Construction Dewatering Flow Rate - Steady State	Q	14	m^3/day	Construction Dewatering Flow - Dupuit Equation
Maximum Construction Flow Rate (safety factor of 2)	2Q	28	m^3/day	

Construction Dewatering Flow Rate - Steady State	Q	**14,200**	L/day
Maximum Construction Flow Rate (safety factor of 2)	2Q	**28,400**	L/day
Maximum Construction Flow Rate (safety factor of 2) with 10 mm rainfall event	2Q	**29,000**	L/day

Appendix G

Groundwater Taking Plan

Construction Dewatering Discharge Rate and Zone of Influence

The Radius of Influence and temporary dewatering discharge rate were estimated in Section 5.1 and the details are summarized below.

Dewatering Zone	Description	ROI (m)
1	General Site Servicing Scenario Per Lateral	32

Potential Settlement and Monitoring

Settlement Estimate

The potential settlement was estimated by a qualified professional engineer as described below.

For the estimated 1.7 m drawdown for dewatering, settlement of the soil within the zone of influence must be calculated based on the increase in effective stress (10 kPa per metre of drawdown) from reducing the pore water pressures. The maximum settlement is estimated to be 5mm or less and will occur adjacent to the dewatering system where the maximum drawdown occurs. Settlement has the potential to damage buried utilities, building foundations, or cause subsidence in adjacent lands. The amount of settlement will decrease exponentially to zero towards the radius of influence limit. Due to the relatively negligible amount of settlement calculated, no structures, infrastructure of buried utilities within near proximity of the proposed temporary construction dewatering will be adversely affected.

Another cause of significant dewatering related settlement is due to pumping of fines through the system. It is imperative that any dewatering systems shall be designed and installed adequately to ensure no soil is conveyed through the system. Sufficient filtering techniques are incorporated at the entry point to avoid migration fines in the pumping/dewatering system. The turbidity of pumped water should be monitored daily to ensure that minimal fines are being conveyed.

Potential Impact on Other Water Users

Since the proposed residential subdivision and the surrounding areas are municipally serviced temporary dewatering activities will not impact any water well users.

Reduction of Ground Water Flow to Waterbodies

Given the short duration of the proposed construction dewatering and that the water removed will ultimately be returned back to the watershed, it is not anticipated that the proposed construction dewatering activity will negatively impact the groundwater flow to Whiskey Creek.

Water Quantity, Quality and Ground Water Level Monitoring Program

If the dewatering discharge water is treated by filtration (a decantation tank and silt bag at a minimum) to remove sediment and fines, the water quality is expected to improve to likely meet the PWQO.

Discharge Options

Based on the groundwater quality analysis to date dewatering discharge can be directed to the surface provided groundwater quality during dewatering activities comply with the applicable PWQO.

If the groundwater quality of the construction dewatering discharge does not meet the applicable standards treatment options should be evaluated and/or the system should be shut down.

Water Quality Monitoring and Potential Treatment Plan

The monitoring plan for discharge to the surface is outlined on Table G-1.

Ground Water Level Monitoring Program

The ground water level monitoring program is outlined on Table G-2.

Discharge Rate Monitoring

In accordance with O.Reg.63/16 daily ground water takings are to be measured and recorded by the dewatering contractor using a flow measuring device.

For each day of water taking a total daily water taking volume must be recorded. All water taking volumes for the duration of the EASR must be submitted annual through the MECP online reporting system.

Summary of Qualifications

Sarah Griffith, G.I.T.

Ms. Sarah Griffith, G.I.T. is a geoscientist-in-training registered with the Professional Geoscientists of Ontario with more than two years of experience of experience specializing in geoenvironmental and hydrogeological investigations.

She has been trained in to complete local scale ground water assessments, well feasibility studies, water budgets, supervising the installation, development, sampling and decommissioning of monitoring wells, in-situ borehole permeability testing, determination of ground water flow characteristics, surface water sampling, and preparation of hydrogeological reports and compliance monitoring programs in accordance with the applicable MECP requirements.

Geoffrey White, P.Eng.

Mr. Geoffrey White, P.Eng., is a senior geotechnical engineer with twenty-six years of interdisciplinary professional experience specializing in geotechnical and materials engineering, geoenvironmental and hydrogeologic investigations and project management.

His hydrogeological experience includes long-term/short-term groundwater and surface water monitoring, local scale groundwater assessments, water budgets, supervising the installation, development, sampling and decommissioning of monitoring wells, and determination of groundwater flow characteristics.

Date of Plan Preparation

This plan prepared on the date March 27, 2023.

TABLE G-1

WATER QUALITY MONITORING PLAN FOR DEWATERING DISCHARGE TO SURFACE [1]

Period	Monitoring Location	Parameters[2]	Monitoring Frequency[3]	Trigger For Mitigation	Mitigation Measures / Comments
Trial Dewatering	Dewatering discharge	○ PWQO Metals ○ City of Barrie Storm Sewer Use By-Law Criteria	Once during trial dewatering	Exceeds the PWQO and/or the City of Barrie Storm Sewer Use By-Law Criteria	Modify treatment method and/or shut down.
	Surface Water	○ Water Level ○ Turbidity		Establish background conditions	Not applicable.
During Construction	Dewatering discharge	○ PWQO Metals ○ City of Barrie Storm Sewer Use By-Law Criteria	Weekly then every four weeks after 3 consecutive weekly compliant samples[3]	Exceeds the PWQO and/or the City of Barrie Storm Sewer Use By-Law Criteria	Modify treatment method and/or shut down.
		○ Turbidity	Daily until stable (minimum 5 samples) then weekly[3]	Exceeds 15 NTU.	
	Discharge point (should dewatering discharge be discharged into the creek)	○ Impact Assessment	At each sampling event	Sedimentation, erosion	Reduce pumping and/or improve sediment/erosion control measures
	Surface Water	○ Water Level ○ Turbidity	Daily for first 5 days of dewatering and then weekly for the duration of dewatering.	Visible lowering of surface water levels, and/or turbidity increases by more than 10% when compared to the turbidity measured during the trial dewatering.	

Notes:

(1) It is recommended that discharge be treated by a sediment control items such as a decantation tank and filtration bags.

(2) Parameters may be removed from future testing after three consecutive compliant results and with agreement by QP. If dewatering moves to a different location all initial parameters must be retested.

(3) If dewatering moves to a different location or a non-compliant result is detected, the sampling will return to the initial frequency.

TABLE G-2

SUMMARIZED GROUND WATER LEVEL MONITORING PLAN

Period	Monitoring Location	Method	Monitoring Frequency	Trigger For Mitigation	Mitigation Measures / Comments
During Construction	On-site monitoring well	Water level meter	Every two weeks	Water level more than 1 m lower than proposed depth of excavation	Reduce pumping
Post-Construction	On-site monitoring well	Water level meter	Every two weeks for four weeks, then every four weeks until 90% recovery	Water level recovery less than 90% of baseline level	Continue monitoring

Appendix H

Discharge Plan

Construction Dewatering Discharge Rate and Zone of Influence

The Radius of Influence and temporary dewatering discharge rate were estimated in Section 5.1 and the details are summarized below.

Location and Scenario	Drawdown	ROI	Construction Dewatering Flow Rate Without Safety Factor	Construction Dewatering Flow Rate Including Safety Factor of 2	Construction Dewatering Flow Rate Including Safety Factor of 2 with a 10 mm Rainfall Event
	m		L/day		
1 - General Site Servicing Scenario Per Lateral	1.7	32	14,200	28,400	29,000

Proposed Discharge Method and Location

It is understood that the preferred discharge location would be to the surface. Dewatering discharge will be directed by hose or pipe from the dewatering system to any pre-treatment systems (i.e., silt bag and sediment tank), and then by hose or pipe to the preferred discharge location.

In the event of a significant rainfall event (100-year storm event), on-site excavation will cease until the dewatering system can be re-evaluated and/or storm water flow subsides.

Erosion and Sediment Control Measures

The construction dewatering setup will include sediment and erosion control measures, and sufficient filtration to ensure removal of suspended solids prior to discharge in accordance with typical Best Management Practices.

Statements

If discharge is directed to the surface with adherence to the water quantity and quality monitoring program outlined in the Water Taking Plan in Appendix G, no adverse effect on the environment is expected.

The discharge water temperature was considered in determining the method of transfer and discharge and is not expected to have an adverse impact.

Summary of Qualifications

Sarah Griffith, G.I.T.

Ms. Sarah Griffith is a geoscientist-in-training registered with the Professional Geoscientists of Ontario with more than two years of experience of experience specializing in geoenvironmental and hydrogeological investigations.

She has been trained in to complete local scale ground water assessments, well feasibility studies, water budgets, supervising the installation, development, sampling and decommissioning of monitoring wells, in-situ borehole permeability testing, determination of ground water flow characteristics, surface water sampling, and preparation of hydrogeological reports and compliance monitoring programs in accordance with the applicable MECP requirements.

Geoffrey White, P.Eng.

Mr. Geoffrey White is a senior geotechnical engineer with twenty-six years of interdisciplinary professional experience specializing in geotechnical and materials engineering, geoenvironmental and hydrogeologic investigations and project management.

His hydrogeological experience includes long-term/short-term groundwater and surface water monitoring, local scale groundwater assessments, water budgets, supervising the installation, development, sampling and decommissioning of monitoring wells, and determination of groundwater flow characteristics.

Date of Plan Preparation

This plan prepared on the date March 27, 2023.

Appendix I

Preliminary Water Balance

Water Balance

MONTHLY AND YEARLY WATER BALANCE COMPONENTS

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Potential Evapotranspiration Calculation	Average Temperature: T (°C)	-7.7	-6.6	-2.1	5.6	12.3	17.9	20.8	19.7	15.3	8.7	2.7	-3.5	6.9
	Heat Index: $i=(T/5)^{1.514}$	0.00	0.00	0.00	1.19	3.91	6.90	8.66	7.97	5.44	2.31	0.39	0.00	36.8
	Unadjusted Potential Evapotranspiration: U (mm)	0.0	0.0	0.0	25.2	59.0	88.5	104.1	98.1	74.7	40.6	11.5	0.0	501.7
	Adjusting Factor for U (Latitude 44°)	0.81	0.81	1.02	1.13	1.27	1.28	1.30	1.20	1.04	0.94	0.80	0.76	-
	Adjusted Potential Evapotranspiration - PET (mm)	0.0	0.0	0.0	28.5	74.9	113.3	135.3	117.8	77.7	38.1	9.2	0.0	594.8
Pervious Components	Precipitation: P (mm)	82.5	61.8	58.1	62.2	82.4	84.8	77.2	89.9	94	77.5	88.9	73.6	932.9
	Adjusted Potential Evapotranspiration: PET (mm)	0.0	0.0	0.0	28.5	74.9	113.3	135.3	117.8	77.7	38.1	9.2	0.0	594.8
	P - PET	82.5	61.8	58.1	33.7	7.5	-28.5	-58.1	-27.9	16.3	39.4	79.7	73.6	338.1
	Change in Soil Moisture Storage (mm)	0.0	0.0	0.0	0.0	0.0	-28.5	-58.1	-27.9	16.3	39.4	0.0	0.0	-
	Water Holding Capacity (max. 75 mm)	75.0	75.0	75.0	75.0	75.0	46.5	0.0	0.0	16.3	55.7	75.0	75.0	-
	Water Surplus Available for Infiltration or Runoff	82.5	61.8	58.1	33.7	7.5	0.0	0.0	0.0	0.0	0.0	60.4	73.6	377.6
	Potential Infiltration based on MECP Infiltration Factor (mm)	49.5	37.1	34.9	20.2	4.5	0.0	0.0	0.0	0.0	0.0	36.2	44.2	226.5
	Potential Surface Water Runoff (mm)	33.0	24.7	23.2	13.5	3.0	0.0	0.0	0.0	0.0	0.0	24.2	29.4	151.0
Impervious Components	Precipitation: P (mm)	-												932.9
	Potential Evaporation: PE (mm), Assume 15%	-												139.9
	Potential Surface Water Runoff: P - PE (mm)	-												793.0

PRE- AND POST-DEVELOPMENT WATER BALANCE (NO LOW IMPACT DEVELOPMENT MEASURES IN PLACE)

		Total Land Area (m^2)	Est. Fraction of Land	Est. Land Area (m^2)	Runoff (m^3/annum)	Infiltration (m^3/annum)	**Runoff Increase Pre to Post**
Existing Land Use (Pre-Development)	Pervious Area	1400	85%	1190	180	270	130%
	Impervious Area (existing structures)		15%	210	167	0	**Infiltration Decrease Pre to Post**
	TOTAL	-	100%	1400	346	270	-59%
Proposed Land Use (Post-Development)	Pervious Area (RM2 Zoning - minimum landscaped open space)	1400	35%	490	74	111	**Infiltration Required to Meet Pre-Development Conditions (m^3)**
	Impervious Area (residential buildings and driveways)		65%	910	722	0	
	TOTAL	-	100%	1400	796	111	159

Notes

1. Both potential infiltration and surface water runoff are independent of temperature
2. Assumption is in January maximum soil moisture storage value is present (75 mm)
3. Water Holding Capacity & Infiltration Factors taken from Table 3.1 of MOE SWMPDM, 2003
4. Average Temp. and Precip. taken from Environment Canada station "Barrie WPCC" between 1981 and 2010
5. Adjusting Factor for U based on Lorente, 1961

Infiltration Criteria	Site Description	Infiltration Factor
Topography	Hilly Land - Average Slope 28 to 47 m/km	0.1
Soils	Open Sandy Loam	0.4
Cover	Cultivated Land	0.1
	Sum of Infiltration Factors	**0.6**

Appendix J

Phosphorous Budget Calculations

Preliminary Phosphorous Budget

Table 1 - Annual Phosphrous Loading

Site Area (ha)	Unit Loading for Site (kg/ha)		Total Annual Loading Rate (kg)
	Barrie Creeks	HID Residential	
0.14	1.32		0.18

Table 2 - Offsetting Compensation Plan without BMPs

Phosphorous Loading (kg)	Unit offsetting Compensation Fee ($/kg)	Total Offsetting Fee with 2.5 Factor ($)	With 15% Administration Fee ($)
0.18	35,770	16,526	19,005