GEI Consultants

Consulting Engineers and Scientists

Hydrogeological Investigation

Proposed Residential Apartment Building Development

447 to 455 Yonge Street, Barrie, Ontario

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1. Introduction

GEI Consultants (GEI) was retained by Barrie Yonge Developments GP Inc. to complete a subsurface investigation and provide a hydrogeological report for the proposed residential apartment building at 447 to 455 Yonge Street, in Barrie, Ontario. A site location plan is provided as Figure 1. A site location plan is provided as Figure 1. This revision of the report is being provided to address comments received from the City of Barrie and the Lake Simcoe Region Conservation Authority and to reflect the most recent plans provided to GEI.

The site consists of the residential properties of 447, 449, 451, 453 and 455 Yonge Street. Each of the residential properties currently contain a single-family residential dwelling, driveway, and grassed front yards and backyards. Assuming Yonge Street runs north to south, the property is approximately 90 metres long (north to south) by 60 metres wide (east to west) and is rectangular with an area of approximately 5,400 m^2 (0.54 hectares). The property is bounded by Yonge Street to the west, Maclaren Avenue to the north and residential properties to the south and east. At the time of the field work program, the residential dwellings were vacant. The existing site is relatively flat with an approximate elevation of 254 metres. An aerial image of the site from 2020 is provided on Figure 2A.

GEI was provided with the following documents for review in revising this report:

- *"Site Plan – 455 Yonge St, Barrie," dated February 26, 2024, by Architecture Unfolded.*
- *"Underground Parking Servicing Plan, Proposed Apartment and Retail Development, 447-455 Yonge Street, City of Barrie," dated May 2024 by Pinestone Engineering Limited.*
- *"Site Grading Plan, Proposed Apartment and Retail Development, 447-455 Yonge Street, City of Barrie," dated April 2024 by Pinestone Engineering Limited.*
- *"Site Servicing Plan, Proposed Apartment and Retail Development, 447-455 Yonge Street, City of Barrie," dated April 2024 by Pinestone Engineering Limited.*
- *"447-455 Yonge Street – City of Barrie, Apartment and Retail Development, Functional Servicing & Stormwater Management Report," dated May 9, 2024 by Pinestone Engineering Limited.*

Currently, it is proposed to construct a 7 storey apartment building in the southern half of the site and on-grade parking and roadways in the northern half of the site. Approximately half of the site will contain 1 level of underground parking (under the apartment building footprint) with additional at-surface parking. A site plan is provided as Figure 2B.

The development will be municipally serviced. A geotechnical report by GEI is provided under a separate cover.

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 generic construction scenario;

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

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

e) Complete a water balance (pre- and post-construction) in general accordance with Lake Simcoe Region Conservation Authority (LSRCA) requirements; and,

f) 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) Complete drilling of five (5) boreholes and install three (3) monitoring wells;

d) Revisit the site and measure groundwater levels, perform borehole permeability testing at selected monitoring wells, and retrieve a representative groundwater sample.

e) Submit one (1) representative unfiltered groundwater sample for laboratory testing to compare against the City of Barrie Sewer Use By-Law, PWQO for metals and O.Reg. 153/04, as amended, for Petroleum Hydrocarbons (PHCs), Volatile Organic Compounds (VOCs), and Polycyclic Aromatic Hydrocarbons (PAHs).

f) Submit one (1) representative filtered groundwater sample for laboratory testing to compare against the PWQO for metals and Total Suspended Solids (TSS).

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

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

i) Completed one (1) year of monthly groundwater level monitoring to establish the seasonal high groundwater table for the site.

j) Prepare a Hydrogeological Investigation report.

1.2 Regulatory Requirements

1.2.1 Water Taking – Temporary

The volume of water entering the excavation will be based on both ground water 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 do not require a hydrogeological report 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 Environmental Activity and Sector Registry (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 a PTTW from the MECP.

1.2.2 Source Water Protection

The site is within the jurisdiction of the Lake Simcoe Region Conservation Authority (LSRCA). The following documents should be used in determination of the regulatory requirements when it comes to maintaining hydrogeological function at this site:

- "*Lake Simcoe Protection Plan*", dated July 2009, by MOECC, MNR & LSRCA.
- "*Approved South Georgian Bay Lake Simcoe Source Protection Plan*", dated January 26, 2015, by LSRCA.
- *"Lake Simcoe Protection Plan Water Budget Policy for LSPP 4.8-DP and 6.40-DP,"* dated November 2018, by LSRCA.

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

- Wellhead Protection Area (WHPA): The site is not located within a WHPA Zone; however, is identified in area Q2 stress level low (Figure 3).
- Intake Protection Zone (IPZ): The site is not located within an IPZ 3 (Figure 4)
- Highly Vulnerable Aquifer (HVA): The site is not 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 or 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," is within a WHPA Zone Q2, not within an HVA, and is not within an SGRA, therefore SPP LUP 12 and DP-4.8d both 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 will likely be permitted for impervious areas such as roads and driveways for the residential development. Infiltration of runoff from vegetated areas and rooftops is always permitted.

1.2.3 City of Barrie Comments

The City of Barrie has provided the following comments about hydrogeologic information for the proposed development, which are provided below along with GEI's responses.

City Comment: Deep construction activities have the potential to impact or intercept the municipal supply aquifer (e.g. deep drilling, installation of deep foundation support, underground parking, dewatering, etc.), including development in areas of known or suspected groundwater contamination.

GEI Response: The City of Barrie is underlain by complex and extensive regional aquifers. The four major aquifers identified beneath Barrie include aquifer A1 (Appendix A, upper and mostly unconfined), A2 (intermediate) and A3 / A4 (lower) aquifers. Aquifer A1 is mostly unconfined, but A2 is typically confined by 5 to 20 metres of fine-grained deposits. The lower aquifers A3 and A4 typically consist of sands and gravels, and most of Barrie's groundwater is supplied by these deep aquifers. Active City Wells 3A, 5, and 12 are screened within aquifer A4, City Wells 7, 9, 11, 13, 14, 15, 17 and 18 are screened in both aquifers A3 and A4, and City Wells 4, 10 and 16 are screened in aquifer A3. In the Barrie area, the elevation of aquifer A3 ranges from approximately Elev. 150 to 195 m, and the elevation of aquifer A4 ranges from approximately Elev. 115 to 160 m .

Based on the site plans reviewed for this investigation, no foundations or servicing are expected to extend significantly greater than approximately 4 metres below proposed grade (Elev. 251.3 metres). The development therefore will not extend into the drinking water aquifers A3 or A4, which are an estimated 100 m or more below the deepest extent of the development. Similarly, dewatering activities are expected to be restricted to the upper unconfined Aquifer A1 only (not used for drinking water). Deep foundations (e.g. piles, caissons) are not expected to be required to support new structures at this site as discussed in the geotechnical report by GEI under a separate cover.

City Comment: The applicant is required to provide the following information to screen for risk management requirements:

i. **Anticipated Maximum Depth of Excavation**
ii. **Anticipated Maximum Depth of Foundation**
iii. **Anticipated Percentage of site to be developed**

GEI Response: This information is typically confirmed and provided by the architect or civil engineer.

City Comment: It is noted that based on the information provided above:

a. **A hydrogeological study may be required for the site in accordance with the Terms of Reference.**
b. **The hydrogeological study may require detailed risk management plans within the Mitigation Measures section of the report including a dewatering management plan, a contamination management plan, and/or a recharge management plant.**

GEI Response: This hydrogeological study has been prepared by GEI and follows *"Hydrogeological Assessment Submissions, Conservation Authority Guidelines for*

Development Applications" (June 2013) and City of Barrie Hydrogeological Study Terms of Reference (January 2019). Recommended mitigation measures are discussed in Section 5.2.4.

City Comment: Site plan drawings will need to clearly note proposed elevations of foundation supports. Building supports shall be designed to stay above the municipal supply aquifer.

GEI Response: Final site plans showing the foundation types and elevations are typically provided by the architect or structural engineer. As discussed above, the municipal supply aquifers A3 and A4 are located at or below Elev. 195 m in the Barrie area. GEI provided a geotechnical engineering report under a separate cover, and based on the subsurface conditions, the recommended foundation option was conventional spread and strip footings. The shallow foundations are expected to be made as deep as 4.5 metres below proposed grade (based on the most recent plans provided) and will not extend into aquifers A3 or A4. Deep foundations are not expected to be required.

City Comment: Deep drilling and the undertaking of deep construction activities (piles, caissons, excavations, underground parking etc.) can create a transport pathway for contaminant migration to the deep municipal supply aquifer. We request that no drilling or construction activities occur without formal consultation with the City to ensure a plan is in place to address the risks to the drinking water supply aquifer, and off-site contaminant migration.

GEI Response: GEI has advanced deeper boreholes across the site to confirm the deeper stratigraphy and groundwater conditions beneath the site. Based on current subsurface information and the understanding that Aquifer A2 is typically confined by 5 to 20 m of fine-grained deposits, the proposed development is not expected to penetrate into confined aquifer A2 and will not extend into the drinking water supply aquifers A3 and A4. There is very low to negligible risk that contaminants will be transported from the development into the drinking water supply aquifers. In addition, it is not expected that deep construction activities such as piles to support foundations or temporary shoring will be implemented at this site.

2. Site Setting

2.1 Physiography, Surficial and Bedrock Geology

The site is located within the physiographic region denoted as the Peterborough Drumlin field comprising beach deposits, and towards the northeastern portion of the site the Simcoe Lowlands comprising sand plans (Chapman and Putnam, 1984).

Surficial and bedrock geology mapping of the site by the Ontario Geological Survey indicate that the surficial site stratigraphy consists of stone-poor, sandy silt to silty sand-textured till on Paleozoic terrain. These findings are consistent with the subsurface soil conditions encountered in the boreholes advanced on site, as discussed in Section 4.2.

The bedrock in the general area consists of Verulam limestone and shale of the Simcoe Group. Bedrock was not encountered at the site and is anticipated at depths greater than 100 m below existing grade base on the Ontario Division of Mines preliminary Map P.980 Drift Thickness Series for the Barrie Area.

2.2 Topography and Drainage

The existing site slopes from the northwest (Elev. 254.2 metres) down to the southeast (Elev. 252.1 m), about 2 metres of topographic relief across the site. As such, the site will generally drain towards the southeast towards Tomlin Court. Based on City of Barrie GIS mapping showing storm linear infrastructure, it appears that the catch-basins drain southeast towards Lovers Creek which eventually outlets into Kempenfelt Bay. The Ontario Flow Assessment Tool (OFAT) was also reviewed and confirmed these drainage patterns.

No water bodies are located on the site. The closest surface water is Lovers Creek, located approximately 300 m east of the site which flows into Kempenfelt Bay, approximately 1.1 km north. The site is in the Lovers Creeks Watershed, in the jurisdiction of LSRCA.

2.3 MECP Water Well Records

MECP water well records were obtained within 500 metres of the site area to assess the general nature of the groundwater resource in near vicinity of the site, and historical/current uses of wells in the area. Thirty-nine (39) well records were found, the approximate MECP well locations are shown on Figure 7 and a well records summary table is included in Appendix A.

The wells were installed for the following uses:

- Twenty-three (23) of the records indicate domestic use.
- One (1) of the records indicate public supply use.
- Two (2) of the records indicate commercial use.

- Four (4) of the records indicate monitoring/test hole use.
- Three (3) of the records indicate "not in use".
- Six (6) of the records did not specify the use and are considered to be of unknown use.

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 that sands and silts deposits with variable clay and gravel contents were encountered. These conditions are relatively consistent with the aquifer and confining layer units located in this area of Barrie.

Where well screen information is available, the well records show that the domestic wells were primarily screened within the deeper confined sand deposits, at depths of 17 to 85 m below existing grade. Locally domestic wells were screened within the upper sand deposits at depths of 9 to 23 m below existing grade.

2.4 Visual Inspection of Site

A visual site inspection was carried out on February 18, 2022 by senior GEI staff to assess site drainage, topography and presence of surface water features.

The existing site is rectangular in shape and is approximately 5,560 m^2 (0.56 hectares). The site consists of the residential properties of 447, 449, 451, 453 and 455 Yonge Street. Assuming Yonge Street runs north to south, the property is approximately 90 metres long (north to south) and 60 metres wide (east to west). The property is bounded by Yonge Street to the west, Maclaren Avenue to the north and residential properties to the south and east.

The existing site is relatively flat with an approximate elevation of 254 m asl with little to visible variation in elevation across the site. The site is currently occupied by multiple single-family residential dwellings, driveways, and grassed front yards and backyards. It is understood that the existing dwellings will be demolished as part of the proposed site plans.

3. Procedures and Methodology

Borehole locations are shown on Figures 2A/2B, borehole logs are provided in Appendix B, and results from the geotechnical laboratory testing are provided in Appendix C.

Prior to the commencement of drilling activities, the locations of the boreholes were staked in the field by GEI. GPS coordinates were measured with a handheld GPS unit and were referenced to the NAD 83 geodetic datum. Ground surface elevations of the boreholes were originally measured using survey equipment in relation to a temporary benchmark (top of fire hydrant 1081 located along Yonge Street in front of 455 Yonge Street), with an assumed local elevation of 100.00 metres. This reference point was then surveyed to provide a geodetic elevation of 254.81 m. The underground utilities including natural gas, electrical, telephone, water, etc. were marked out by public and private utility locating companies.

The fieldwork for the drilling program was carried out on February 1 and 2, 2022. A total of five boreholes (Boreholes 201 to 205) were advanced on the site to depths of 10.4 to 10.7 metres below grade (Elev. 241.6 to 243.4 metres).

Drilling and sampling of the boreholes was completed using rubber tire mounted drill rig operated by a specialty drilling subcontractor retained and supervised by GEI. The boreholes were advanced to predetermined depths though the use of solid and hollow stem augers and sampling was conducted using a 51 mm O.D. Split Spoon (SS) sampler. Standard Penetration Test (SPT) “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 (“N” Values). Soil sampling was conducted at 0.75 metre intervals for the upper 3.0 metres of each borehole and at 1.5 metre intervals thereafter.

Monitoring wells were installed in three boreholes (BH/MW 202 to 204) to facilitate the measurement of stabilized groundwater levels across the site and for subsequent monitoring or testing purposes. All monitoring well installations were performed in accordance with Ontario Regulation (O.Reg.) 903.

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

In the laboratory, the samples were classified as to their visual and textural characteristics. All samples were submitted for moisture content determination. Five soil samples were submitted for grain size analysis and the results are provided in Appendix C.

3.1 Groundwater Monitoring

In addition to groundwater level readings measured at the completion of drilling (unstabilized) and during the hydrogeological field investigation, groundwater levels were also measured in the three (3) monitoring wells on a monthly basis to collect at least one (1) full year of data to establish the seasonally high groundwater levels.

The supplemental groundwater level monitoring report was issued on June 27, 2023 that consisted of 12 months of groundwater level and elevation monitoring results from the onsite monitoring wells. The data included in this letter was referenced to the same local elevation point as was used during the rest of the field investigation. This letter report was issued as a separate document.

A table of the groundwater and elevation data corrected to a geodetic elevation has been included in Appendix I.

3.2 Borehole Permeability Testing

Rising head tests were completed in the monitoring wells on February 18, 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 for several hours 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 plot for drawdown versus time for the tests are provided in Appendix D.

3.3 Ground Water Sampling

To establish baseline conditions and assess the suitability for discharge of pumped groundwater into City of Barrie sewer systems during potential dewatering activities, the following groundwater samples were collected from the BH/MW 202 on February 15, 2022 and tested relative to the City of Barrie Sewer Use Criteria, PWQO, and/or O.Reg.153/04, as amended, Table 1 SCSs (the most stringent SCSs):

- One (1) unfiltered groundwater sample was collected from BH103 and analyzed against The City of Barrie Storm and Sanitary Sewer Use Criteria, PWQO metals, O.Reg.153/04, as amended, PHCs, VOCs and PAHs.
- One (1) filtered groundwater sample was collected from BH103 and 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 run through a 75 µm filter. 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 General Overview

The soil conditions at the site generally consisted of topsoil and earth fill overlying silty sand to sand and silt glacial till. These soils were encountered throughout each of the boreholes to their respective termination depths. Bedrock was not encountered in the boreholes.

The borehole locations are shown on Figures 2A and 2B. Detailed soil profiles encountered in the GEI boreholes are indicated on the attached borehole logs in Appendix B, with the results of geotechnical laboratory testing included in Appendix C. A subsurface profile beneath the site is included as Figure 9 and the profile alignment is shown in plan view on 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.

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.

4.2 Stratigraphy

4.2.1 Topsoil, Asphalt and Earth Fill

Boreholes 201 and 203 to 205 encountered topsoil at ground surface that ranged in thickness from 200 to 450 mm.

Borehole 202 encountered a pavement structure at the ground surface that consisted of 50 mm of asphalt underlain by 100 mm of granular base material. The pavement was underlain by 300 mm of topsoil.

Underlying the topsoil in Boreholes 201, 202, 204 and 204, earth fill was encountered that extended to depths of 1.5 to 2.3 metres below grade (Elev. 252.7 to 249.8 metres). The earth fill consisted of sandy silt to silty sand, with trace to some clay and trace gravel, and appeared to consist of re-worked glacial till. The earth fill was brown and moist to wet, and trace amounts of organics were encountered in some locations. The SPT “N” Values ranged from 5 to 14, indicating a loose to compact relative density.

4.2.2 Native Soils

Underlying the earth fill in Boreholes 201, 202, 204 and 205, and underlying the topsoil in Borehole 203, a deposit of glacial till was encountered with a cohesionless matrix consisting of silty sand to sandy silt, with trace to some clay and gravel. Cobbles and boulders are likely embedded within the glacial till as evidenced by auger grinding during drilling. The upper 0.5 metres of the glacial till in Borehole 201 was weathered and contained trace organics. The glacial till extended beyond the vertical depth of exploration at 10.4 to 10.8 metres below grade (Elev. 243.4 to 241.4 metres), was brown, turning grey with depth, and moist to wet. The SPT "N" Values ranged from 9 to greater than 100 blows per 300 mm, indicating a loose to very dense relative density. The glacial till was uniformly very dense at 3 metres below grade and deeper.

The glacial till was interbedded with a deposit consisting of sand with trace to some silt and trace gravel in Boreholes 203 and 204 at depths of 2.6 to 4.6 metres below grade, extending to 3.1 to 6.1 metres below grade. The sand was wet and brown, and the measured "N" Values were 28 to greater than 100 blows per 300 mm of penetration, indicating a compact to very dense relative density.

4.3 Groundwater

4.3.1 Groundwater Levels

Unstabilized groundwater level measurements and borehole sloughing (caving) measurements were taken upon completion of drilling of each borehole. These measurements provide an estimate of possible excavation and temporary groundwater control issues that may arise during construction. The depth of caving in Boreholes 201 and 205 was 4.9 to 8.2 metres below grade, and the unstabilized water level ranged from 2.4 to 5.2 metres below grade. Caving and unstabilized water levels were not measured in the other boreholes due to the monitoring well installations.

Boreholes 202 to 204 were outfitted as monitoring wells with 50 mm diameter PVC standpipes and 3.0-metre-long screens.

GEI completed one (1) year of monthly groundwater level monitoring in order to establish the seasonal high groundwater level for the site. A summary of the seasonal high groundwater levels and elevations recorded for each monitoring well are presented below and a table summarizing all the results recorded during monitoring are included in Appendix I.

It should be noted that GEI summarized the findings of the extended groundwater monitoring program in a letter issued June 27, 2023, however, the groundwater elevations included in that document were measured to a local elevation benchmark instead of a geodetic benchmark.

Borehole	Well Screen Location		Strata Screened	Seasonal High Depth / Elev. (m) of Groundwater Table
	Depth (m)	Elev. (m)		
BH 202	7.5 to 10.5	246.7 to 243.7	Sandy Silt to Silt & Sand Glacial Till	2.1 / 252.0
BH 203	7.6 to 10.6	244.8 to 241.8		1.5 / 250.9
BH 204	6.8 to 9.8	246.6 to 243.6		1.9 / 251.5

Based on the stabilized groundwater measurements in the monitoring wells, the seasonal high groundwater table ranges between 1.5 to 2.1 metres below existing grade (Elev. 252.0 to 250.9 metres) for the proposed development area. Overall groundwater levels at the site ranged from 1.5 to 3.2 m below existing grade (Elev. 252.0 to 249.8 m) during the year-long monitoring period. It is expected that the groundwater table will fluctuate depending on seasonal and weather conditions.

The cohesionless silty sand to sand and silt glacial till soils at the site contain 30 to 52% fines and are moderately permeable but will generally resist the free flow of water when wet. Groundwater levels are expected to show seasonal fluctuations and vary in response to prevailing climate conditions. Some free-flowing water could be encountered from more permeable zones within the earth fill or from sand seams within the glacial till.

It is anticipated that the shallow groundwater flow will be southeasterly towards Lovers Creek. Local groundwater contours are shown on Figure 9.

4.3.2 In-Situ Permeability

A hydraulic conductivity value was calculated from the rising head data using Hvorslev's solution (1951). The semi-log plot for drawdown versus time for the tests are provided in Appendix C and are summarized in the table below.

Monitoring Well	Well Depth (m bgs)	Strata Screened	Hydraulic Conductivity (m/s)
BH/MW202	10.6	Silty Sand to Sand & Silt Glacial Till	5.0×10^{-6}
BH/MW203	10.6		1.8×10^{-6}
BH/MW204	9.8		5.9×10^{-6}

In addition to the above-noted permeability data, the hydraulic conductivity of the soils encountered on site was estimated from grain size distribution curves (as provided in Appendix E). According to Freeze and Cherry (1979), the typical hydraulic conductivity of the strata investigated are:

- Glacial Till: 10^{-6} m/s to 10^{-10} m/s
- Silt: 10^{-5} m/s to 10^{-9} m/s
- Silty Sand: 10^{-3} m/s to 10^{-7} m/s

The actual measured hydraulic conductivity of the deposits were within the expected range. The cohesionless silty sand to sand and silt glacial till soils at the site contain 30 to 52% fines and are moderately permeable but will generally resist the free flow of water when wet. Groundwater levels are expected to show seasonal fluctuations and vary in response to prevailing climate conditions.

For design purposes, the hydraulic conductivity of the glacial till deposits is 6.0×10^{-6} m/s.

4.3.3 Baseline Groundwater Chemistry Testing

To assess the suitability for discharge of pumped groundwater to the surface or the existing storm sewer system during dewatering activities, one (1) unfiltered and one (1) filtered groundwater samples were collected from BH/MW202 on February 15, 2022.

For the assessment purposes, the analytical results were compared to the City of Barrie Storm and Sanitary Sewer Use Criteria, PWQO, and/or the O.Reg.153/04, as amended, Table 1 SCSs.

The results of the groundwater chemistry are presented in the laboratory Certificates of Analysis provided in Appendix E and are summarized below.

Sample Location	Parameters Tested	City of Barrie Storm Sewer Use By-Law Criteria Exceedances	City of Barrie Sanitary/Combined Sewer Use By-Law Criteria Exceedances	PWQO	O.Reg 153/04 PHCs, VOCs and PAHs
BH202 Well (Unfiltered)	City of Barrie Storm and Sanitary Sewer Use Criteria, PWQO metals, and O.Reg.153/04, as amended, PHCs, VOCs and PAHs	TSS	None	PWQO: Iron Interim PWQO: Aluminum	None
BH202 Well (Filtered)	PWQO Metals, TSS	None	None	None	None

The unfiltered groundwater sample collected from BH/MW202 met the City of Barrie Sanitary Sewer Use By-Law Criteria, exceeded the City of Barrie Storm Sewer Use By-law for TSS, and met PWQO and O.Reg.153/04, as amended, Table 1 SCSs with the exception of iron. Further aluminum was noted as an exceedance with respect to the interim PWQO. The filtered groundwater samples met the PWQO for metals and TSS. If pumped groundwater will be discharged to surface 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).

The above chemical results suggest treatment of the dewatering discharge water by filtration will reduce the concentration of metals sufficiently to meet the applicable PWQO. 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 silt bag or sedimentation tank at a minimum before being discharged to surface.

4.4 Infiltration

Determination of percolation rates are based on the "*Ministry of Municipal Affairs and Housing (MMAH) Supplementary Guidelines SB-6, Percolation Time and Soil Descriptions, September 14, 2012*". The borehole logs indicate predominantly a silty sand to sand and silt glacial till, trace to some gravel, trace to some 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	75 to 30

This infiltration rate is not applicable below the groundwater table and is not applicable to the existing zones of earth fill across the site. 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.

Based on the high groundwater table encountered during the field investigation has made the installation of LID features impractical as indicated in the Functional Servicing & Stormwater Management Report by Pinestone Engineering Limited (2024). As such, no in-situ infiltration testing was conducted at the site. The client will be required to pay an offsetting fee to the LSRCA, in accordance with the Water Balance Recharge Offsetting Policy for the water balance deficit. That deficit is discussed further in Section 5.4.

5. Discussion and Analysis

5.1 Temporary Construction Dewatering

Currently, it is proposed to construct a 7 storey apartment building in the southern half of the site and on-grade parking and roadways in the northern half of the site. The majority of the site will contain 1 level of underground parking (under the apartment building footprint only) with additional at-surface parking.. A site plan is provided as Figure 2B.

The development will be municipally serviced. It has been assumed that excavations for utilities could extend to a depth of 4.0 m below existing grade, and that excavations for the proposed underground parking levels will extend to depths of up to 4.0 m below the entire footprint of the building based on the proposed construction of one level of underground parking. According to the site servicing plan, the deepest excavation will be required in the northeast corner of the site the deepest excavation will be required in the northeast corner of the site to connect to the existing downstream manhole on Maclaren Avenue (invert Elev. 249.35 m).

The stabilized groundwater level measurements were found to range from 1.5 to 3.2 metres below existing grade (Elev. 252.0 to 249.8 m), with a seasonal high of 1.5 m below existing grade (Elev. 252.0 m); however, the groundwater level will change based on seasonal fluctuations. 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 1.0 m below the proposed excavation depth. Based on the soil encountered during the borehole drilling program a conservative hydraulic conductivity of 6.0×10^{-6} m/s has 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 most recent plans provided to GEI.

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.

5.1.1 Construction Dewatering Flow Rate Assumptions

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

- Existing grades are at an elevation of 252.4 m and 254.1 meters based on the completed boreholes.
- Municipal servicing including watermain, and storm and sanitary sewers will require excavations as deep as 4.0 m below existing grade based on the site servicing plan.
- An excavation length of 65 m for servicing was selected as the longest stretch of servicing noted on the site servicing plan was 62.2 m.
- Underground parking for one level has been assessed assuming an excavation of 4.0 m below existing grade with dimensions of 90 m by 55 m.
- Groundwater levels should be lowered a minimum of 1.0 m below the excavation base.
- Based on the soil encountered during the borehole drilling program a conservative hydraulic conductivity of 6.0×10^{-6} m/s has been applied to the entire site.
- The highest groundwater level measured on-site was 1.5 m below existing grade (Elev. 252.0 m).
- It has been assumed that surface water/runoff, will be managed sufficiently such that all surface water is diverted around the proposed excavations and surface water entering the proposed excavation would be minimal.
- The dewatering contractor may use smaller dewatering zones, thus limiting the dewatering discharge rates.

5.1.2 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 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 is 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 and the hydraulic conductivity of 6.0 x 10^{-6} m/s, the ROI is approximately 26 to 36 m from the centre of the excavation for radial flow for site servicing, calculation details are provided in Appendix F, and the specific ROI's are summarized below:

Description	ROI (m)
Site Servicing	26.8
Seven Storey Residential Building with 1 Basement Level	36.0

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.

5.1.3 Temporary Dewatering Flow Rate Equation

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, and is expressed as follows:

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

Where:

Q_w = Rate of pumping (m^3/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 Dupuit-Forcheimer method for radial flow from an unconfined aquifer for a fully penetrating excavation was used to obtain a flow rate estimate for the proposed building and townhome excavations, and is expressed as follows:

$$Q = \frac{\pi K(H^2 - h^2)}{In\,{}^{R_0}/_{r_s}} + 2\left[\frac{xK(H^2 - h^2)}{2L}\right]$$

Where:

Q	= Rate of pumping (m^3/s)
x	= Length of excavation (m)
L	= Length of excavation (m)
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)
R_0	= Radius of Influence (m)
r_s	= well radius (m)

It is expected that the initial dewatering rate will be higher in order to remove groundwater from within the overburden formation. The dewatering rates are expected to decrease once the target water level is achieved in the excavation footprint as groundwater will have been removed locally from storage resulting in lower seepage rates into the excavation.

5.1.4 Construction Dewatering Estimates

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

Location	Construction Dewatering Flow Rate Without Safety Factor (L/day)	Construction Dewatering Flow Rate Including Safety Factor of 2 (L/day)	Construction Dewatering Flow Rate Including Safety Factor of 2 (L/day) Including a 10 mm Rain Event
Site servicing	54,200	108,400	110,350
One Level of Basement	141,200	282,400	331,900

The total construction dewatering flow rate includes a factor of safety of 2.0 to account for seasonal fluctuations in the groundwater table, flow from beddings of existing sewers, 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. Given that the predicted dewatering volume exceeds 50,000 L/day but remains below the 400,000 L/day limit, it is recommended that an EASR be obtained for the site.

Please note that it is the responsibility of the contractor to ensure dry conditions are maintained within the excavation at all times. Additional pumping capacity may be required to maintain dry conditions within the excavation during and following significant precipitation events.

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 estimate provided in this report are based on the proposed development information available at this time. 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.

It should be noted that due to inherent uncertainties, there is a potential for required dewatering discharge volumes to still exceed 400,000 L/day, thus violating the EASR requirements and necessitating a PTTW. Dewatering volumes will need to be closely monitored and if required dewatering activities may need to be staged such that dewatering discharge rates remain below the 400,000 L/day threshold.

In accordance with O.Reg.63/19 and the EASR registration requirements both a water taking and discharge plan completed by a Qualified Person are provided in Appendix G and H, accordingly. The water taking plan provides a summary of the dewatering ROI, estimated settlement, assessment of potential impact on other water users, and a dewatering monitoring program. The discharge plan provides details regarding expected dewatering discharge rate(s), location(s) of discharge, method of water taking, and erosion and settlement control measures.

No dewatering more than 50,000 L/day will take place until the proposed water taking is registered on the EASR registry.

5.2 Construction Dewatering Impact Assessment

5.2.1 Impacts to Nearby Groundwater Users

The City of Barrie is underlain by complex and extensive regional aquifers. The four major aquifers identified beneath Barrie include aquifer A1 (upper and mostly unconfined), A2 (intermediate) and A3 / A4 (lower) aquifers. Aquifer A1 is mostly unconfined, but A2 is typically confined by 5 to 20 metres of fine-grained deposits. The lower aquifers A3 and A4 typically consist of sands and gravels, and most of Barrie's groundwater is supplied by these deep aquifers. Active City Wells 3A, 5, and 12 are screened within aquifer A4, City Wells 7, 9, 11, 13, 14, 15, 17 and 18 are screened in both aquifers A3 and A4, and City Wells 4, 10 and 16 are screened in aquifer A3. In the Barrie area, the elevation of aquifer A3 ranges from approximately Elev. 150 to 195 metres, and the elevation of aquifer A4 ranges from approximately Elev. 115 to 160 metres.

There are no Wellhead Protection Areas near the site as shown on Figure 9a-1 in the Chapter 8 of the report, *"Approved Assessment Report: Lake Simcoe and Couchiching-Black River Source*

Protection Area, Part 1: Lake Simcoe Watershed" (January 2015). The closest municipal well is located 2.5 km northwest of the site towards Kempenfelt Bay.

The report, *"Barrie Creeks, Lovers Creek, and Hewitt's Creek Subwatershed Plan"* (LSRCA 2012) includes regional subsurface profiles and maps showing the extent of Aquifers A1 to A4 through the region. From Figure 2-23 in the report, it is estimated that surficial Aquifer A1 is approximately 20 to 40 metres thick in the project area and may contain a thin upper confining unit of glacial till. The boreholes advanced on site extended to a maximum depth of 11.1 metres and encountered silty sand to sand and silt glacial till., which are assumed to be the upper confining unit and Aquifer A1, respectively. No water will be taken from the deep drinking water Aquifers A3 or A4.

The site lies within a municipally serviced area of Barrie, as such water well users are not likely to be impacted.

As a precautionary measure even if impacts to the wells are not anticipated, if private well owners issue complaints regarding shortages or other interference with their water well, the complaints will be investigated, and if the problem is deemed to be an effect of the construction dewatering, a temporary supply of water will be made available to the well owner until ground water levels recover.

5.2.2 Natural Environment

Lovers Creeks lies approximately 300 m east of the site, which is outside of the anticipated ROI. Further the dewatering will be of short duration and the water removed will ultimately return to watershed after treatment and discharge. Therefore, it is not anticipated that the construction dewatering will negatively impact the groundwater flow to Lovers Creek.

5.2.3 Land Stability

For the assumed maximum groundwater drawdowns of up to 4.0 m in the vicinity of the proposed building and/or serving, settlement of the soil within the radius of influence must be calculated based on the increase in effective stress (10 kPa per metre of drawdown) from reducing the pore water pressures. 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.

The drawdown will occur within the generally dense to very dense glacial till. The maximum estimated settlement to occur adjacent to the dewatering system is approximately 2 mm or less, and negligible impacts are anticipated to the roadways or residential properties near the site.

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.

5.3 Monitoring, Mitigation, and Treatment Plan

Based on the results of the water quality analyses of the discharge, the following dewatering discharge options can be selected in the order of preference:

i. Discharge to existing City Storm Sewers, provided water quality results comply with City of Barrie Storm Sewer Use Criteria.

ii. Discharge to surface, provided water quality results comply with PWQO and/or O.Reg.153/04, as amended, Table 1 SCSs (strongly preferred option).

iii. Shut-down and re-evaluate treatment options.

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

The monitoring will be implemented both during a trial dewatering and during construction. The trial dewatering will be conducted for a short period of time once the dewatering wells, header pipes, and sediment control facilities (filtration bags, decantation tanks, sedimentation ponds, or the like) are installed to obtain a representative water sample from the outflow of the sediment control facility (the "discharge") for chemical analysis. The results of this water quality analysis will provide guidance in the selection of a discharge option and the discharge treatment requirements during construction dewatering.

5.3.1.1 Groundwater Level Monitoring

The groundwater level monitoring program is outlined on Table G-1. New monitoring wells will have to be installed if the old ones are found non-functional or are destroyed during the construction dewatering.

5.3.1.2 Settlement Monitoring

Settlement caused by a reduction in pore water pressure from dewatering is expected to be negligible and will not impact nearby buildings or infrastructure. Inspections should be carried out daily by the dewatering contractor around the dewatered area to confirm there are no visible signs of recent settlement or subsidence. If observed, this may indicate that fines are being pumped through the dewatering system, and dewatering must stop until corrective action can be taken to prevent the migration of fines through the system.

Settlement monitoring recommendations are outlined in Table G-1, appended.

5.3.1.3 Discharge Rate Monitoring

The total ground water volume pumped should be measured by the dewatering contractor using a flow measuring device, and the records are to be reported to the MECP through the water taking reporting system (WTRS).

The Contractor on behalf of Client will maintain a record of all water takings. This record will include the dates and duration of water takings, and the total measured volume of water pumped per day for each day that water is taken and will be updated and reported to the Client once each week. The Client will keep all the required records up to date and available at or near the site of the water taking and will produce the records immediately for inspection by a Provincial Officer upon his or her request.

5.3.1.4 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 City of Barrie Storm Sewer Use Criteria, PWQO and/or O.Reg.153/04, as amended, applicable SCSs 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. Short step pumping tests are recommended in order to confirm the aquifer conditions and the efficiency of each well or trench, if used.

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 his/her 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.

Once construction sequences are finalized, the contractor will identify the discharge locations, including UTM coordinates, a site plan, and the method of conveyance for normal operating conditions and also in the event of a 100-year storm event. This will include considerations to ensure temperature of the groundwater will not be increased during conveyance. The contractor

will provide details on the erosion and sediment control measures that will be used, such as filtration, silt fences, check dams, etc. Additional ESC supplies should be kept on the site for immediate remediation of any issues noted during construction, and restoration plans (e.g. re-vegetation) should also be provided by the contractor. Any material retained by the ESC measures (e.g. sediments) will be disposed once construction is completed.

Any application submitted to the MECP for renewal or technical amendment of the permit will be accompanied by all records required by the conditions of the permit. The records will be interpreted by a qualified person and submitted in the form of a report.

5.4 Permanent Building Drainage - Prohibited

The underground level proposed for the site will extend below the groundwater table. For this site, the City of Barrie has provided the following comment:

> *"Permanent dewatering is prohibited in accordance with the City of Barrie's Drinking Water Protection Policy… Site design shall consider that permanent dewatering is prohibited. This includes the application of sump pumps to dewater basements... Alternative design options (i.e., slab on grade construction or full foundation water proofing) are to be explored and implemented."*

Therefore, it is recommended that all underground levels constructed below the groundwater table be designed as fully waterproofed structures. The structures must be designed to resist hydrostatic pressures (including uplift). In this case, construction dewatering must continue until sufficient dead weight is available to resist the uplift pressures. Buoyancy calculations can be completed by GEI if requested.

There will be no impacts to the City drinking water aquifers, or other nearby water users from and where fully waterproofed structures are constructed.

5.5 Preliminary Water Balance

5.5.1 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 ground water 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.

- Precipitation (P): 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 6110557, Latitude 44.38 N, Longitude -79.69 W, Elevation 221 metres), which is located about 3 km northwest of the site.
- Storage (S): 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.
- Evapotranspiration/Evaporation (PET): 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.).
- Water Surplus (R + I): 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.

5.5.2 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 J, 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 to sand and silt glacial till), a soil moisture storage capacity of 75 mm was used for the site which is vegetated with shrubs, grasses and some trees. It is assumed that

post-construction permeable areas will be shallow urban vegetation and the same storage capacity was used post-development for the permeable areas.

- 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 was 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 post-development water balance scenario was estimated based on the assumption that 65% of the 0.56-hectare lands would comprise impermeable components (e.g. residential building and parking lots), estimated from the conceptual site plan. 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 J 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.

5.5.3 Pre and Post Development Water Balance

The detailed water balance calculations are included in Appendix J. The pre and post development calculations are 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 for the 0.56 hectares of the site being developed.

Condition	Permeable Areas	Impermeable Areas	Average Annual Runoff Volume (m^3/year)	Average Annual Infiltration Volume (m^3/year)
Pre-Development Land Use	75% (vegetated area)	25% (houses, driveways, sheds	1,889.5	787.3

Condition	Permeable Areas	Impermeable Areas	Average Annual Runoff Volume (m^3/year)	Average Annual Infiltration Volume (m^3/year)
Post-Development Land Use (Preliminary Plan)	22% (Green space)	78% (7 Storey apartment, parking lots)	3,669.9	230.9

These calculations suggest that, without mitigation such as low impact development (LID) measures, the proposed development will decrease average infiltration by about 556.3 m^3/year (71% decrease). The proposed development will increase runoff by about 1,780.4 m^3/year (94% increase). This means about 556 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.

5.6 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.

5.6.1 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.

5.6.2 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 normally be minimized by using appropriate stormwater management and using low impact development (LID) measures to promote infiltration. For sites where the groundwater table is close to ground surface, this may not be a feasible option and maintaining infiltration may not be possible.

In these cases, there is the option to pay an offsetting fee to LSRCA to help fund them in providing an alternative infiltration feature at another location within the watershed. This fee would be required in accordance with the Water Balance Recharge Offsetting Policy for the identified water balance deficit, with confirmation from LSRCA.

Despite the inability to maintain the water balance onsite, due to the high groundwater levels, minimal impacts are expected for the following reasons:

- The site is not within a Significant Groundwater Recharge Area.
- Future development of the land surrounding the site is expected to be serviced by City / Region water supply instead of domestic wells.
- Groundwater recharge and baseflow to creeks is known to be low in the area of the site due to the existing City of Barrie stormwater management system.

5.6.3 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 conveying the flows off the site, especially when a treatment train approach is taken for stormwater management. The stormwater management facilities (to be designed by others) must be designed such that the water quality is maintained or improved prior to discharging water from the site.

Runoff from residential developments (e.g., rooftops, landscaped areas) is considered “clean” and can be collected an infiltrated where possible. Based on Table 2 in *“Lake Simcoe Protection Plan Water Budget Policy for LSPP 4.8-DP and 6.40-DP,”* infiltration-based practices will

likely be permitted for impervious areas such as roads and driveways for the residential development.

Since only clean (including runoff from residential developments - e.g., rooftops, landscaped areas) or pre-treated runoff can be discharged offsite, the groundwater quality will not be degraded and will not impact nearby domestic wells, the watercourse or other nearby environmental features. The surficial aquitard present across the site also limits the amount of water infiltrating deeper below grade as recharge.

6. Limitations and Conclusions

6.1 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 prepared by GEI for the account of Barrie Yonge Developments GP Inc.. 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.

6.2 Conclusion

It is recognized that municipal/regional governing bodies, in their capacity as the planning and building authority under Provincial statues, will make use of and rely upon this report, cognizant of the limitations thereof, both as are expressed and implied.

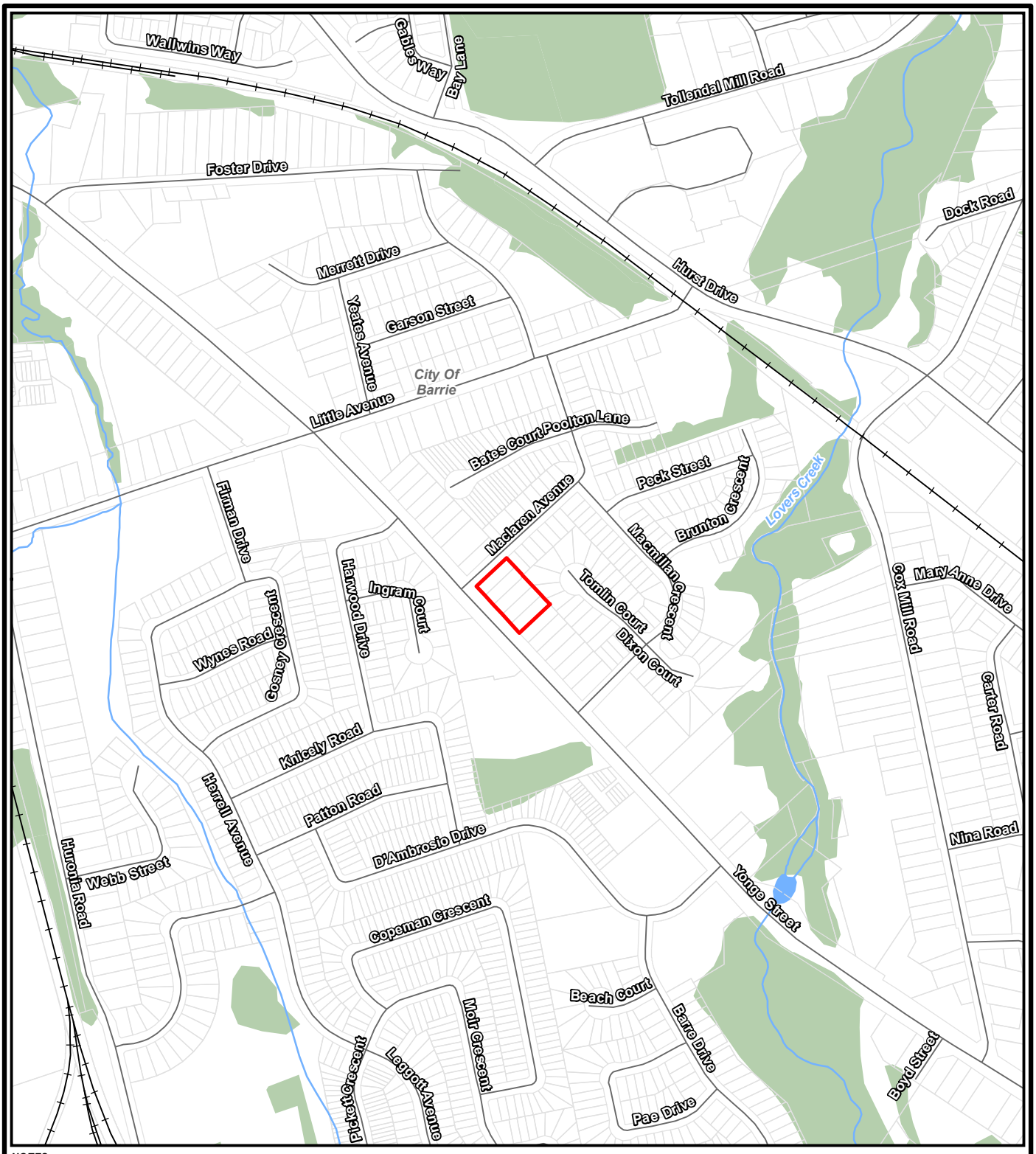
We trust this report is complete within our terms of reference, and the information presented is sufficient for your present purposes. If you have any questions, or when we may be of further assistance, please do not hesitate to contact our office.

Yours Truly,

GEI Consultants

Prepared By:	**Reviewed By:**
Kimberly Gilder, P.Geo. Senior Hydrogeologist	Alexander Winkelmann, P.Eng. Geotechnical and Earth Sciences Manager
PROFESSIONAL GEOSCIENTIST KIMBERLY GILDER (K.G.) PRACTISING MEMBER 2417 ONTARIO	LICENSED PROFESSIONAL ENGINEER A.WINKELMANN 100150146 May 30, 2024 PROVINCE OF ONTARIO

Figures



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, 2022.
3. Parcels from 'Tax Parcels', City of Barrie, AGOL. Accessed March 2022.

Legend

- Site Location
- Road
- Railway
- Watercourse
- Waterbody
- Wooded Area
- Parcels

N

0 80 160 m

1:8,000

447-455 Yonge Street
Barrie, Ontario

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Project 2200334

SITE LOCATION PLAN

May 2022 Fig. 1

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, 2022.
3. Orthoimagery © First Base Solutions, 2022. Imagery taken in 2020.

Legend

- Site Limit
- Approximate Borehole/Monitoring Well Location
- Approximate Borehole Location
- Cross Section Location

N

0 6 12 m

1:600

447-455 Yonge Street
Barrie, Ontario

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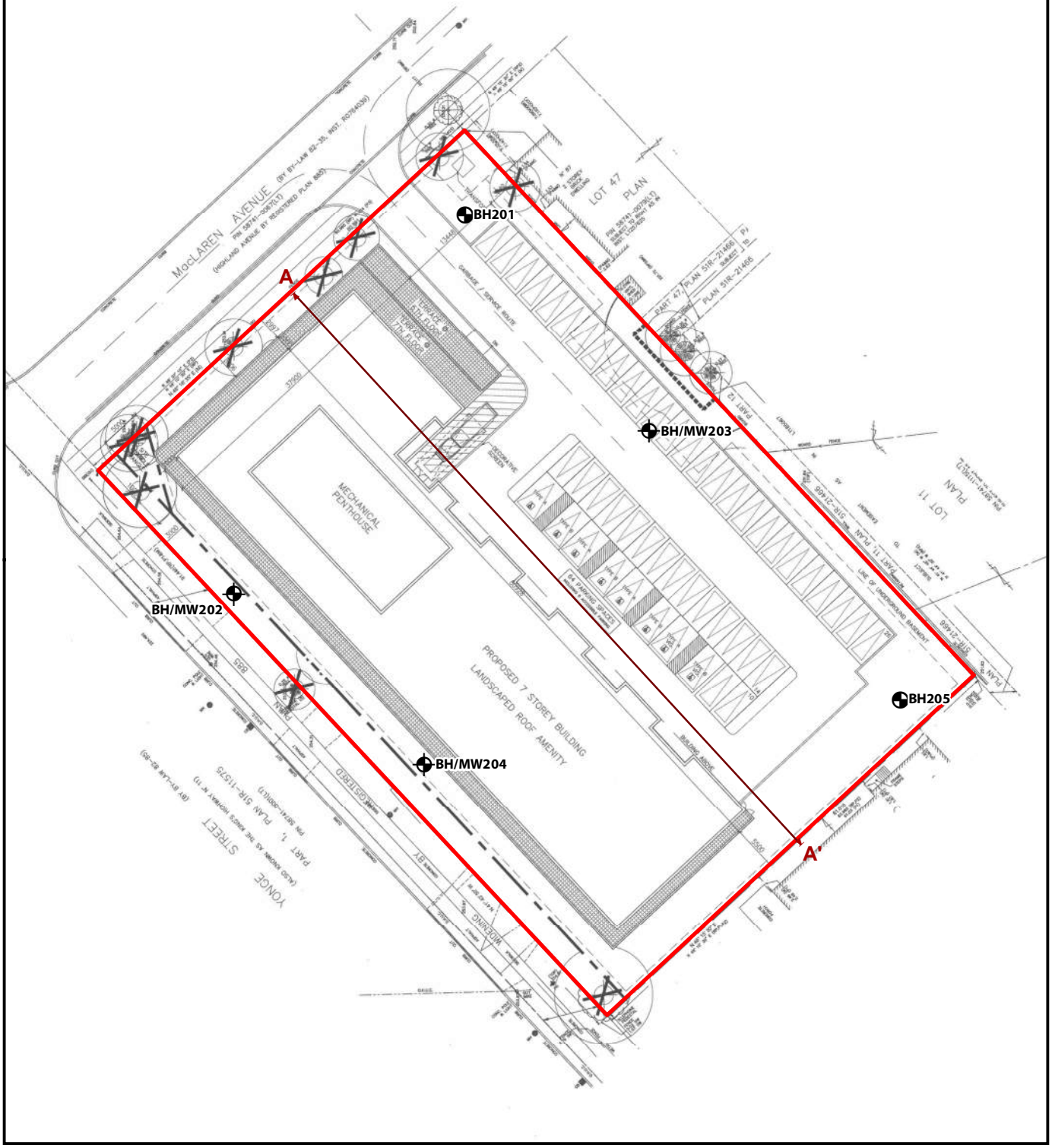
BOREHOLE LOCATION PLAN (AERIAL)

Project 2200334 | May 2022 | Fig. 2A



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, 2022.

Legend

- Site Location
- Approximate Borehole/Monitoring Well Location
- Approximate Borehole Location
- Cross Section Location

N

0 7 14 m

1:700

447-455 Yonge Street
Barrie, Ontario

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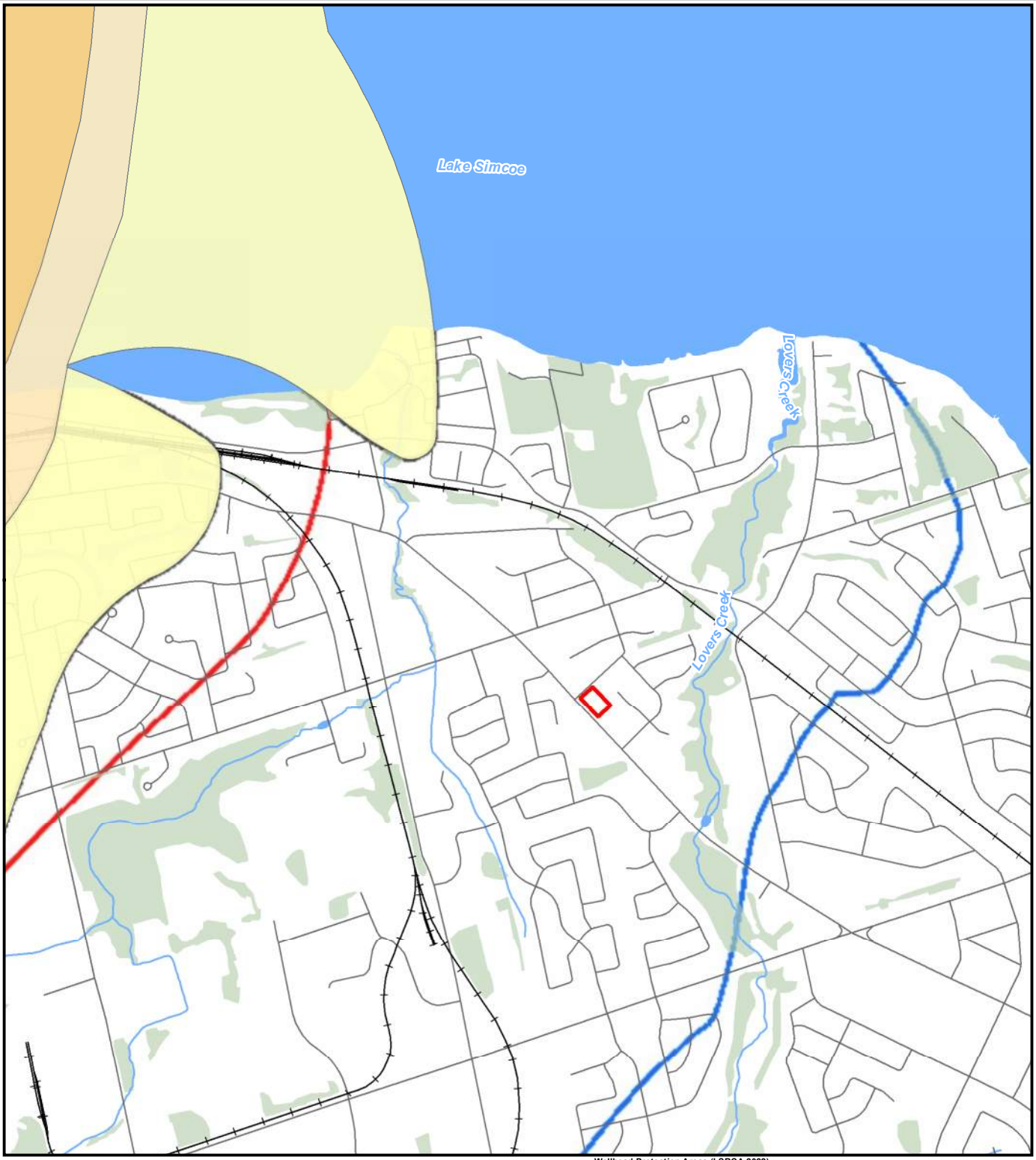
BOREHOLE LOCATION PLAN
(PROPOSED SITE PLAN)

Project 2200334 | September 2022 | Fig. 2B



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, 2022.
3. LSRCA data from MECP Source Protection Information Atlas Image (Approximate). Accessed March 2022.

Legend

- Site Location
- Road
- Railway
- Watercourse
- Waterbody
- Wooded Area

Wellhead Protection Areas (LSRCA 2022)

Zone

- B
- C
- D
- Q1
- Q2

N

0 200 400 m

1:20,000

447-455 Yonge Street
Barrie, Ontario

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WELLHEAD PROTECTION AREA

Project 2200334 | May 2022 | Fig. 3

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, 2022.
3. Intake Protection Zones from from LSRCA open data (data.lsrca.on.ca).

Legend

- Site Location
- Road
- Railway
- Watercourse
- Waterbody
- Wooded Area

Intake Protection Zone (LSRCA 2022)

Zone
- 2
- 3

N

0 200 400 m

1:20,000

447-455 Yonge Street
Barrie, Ontario

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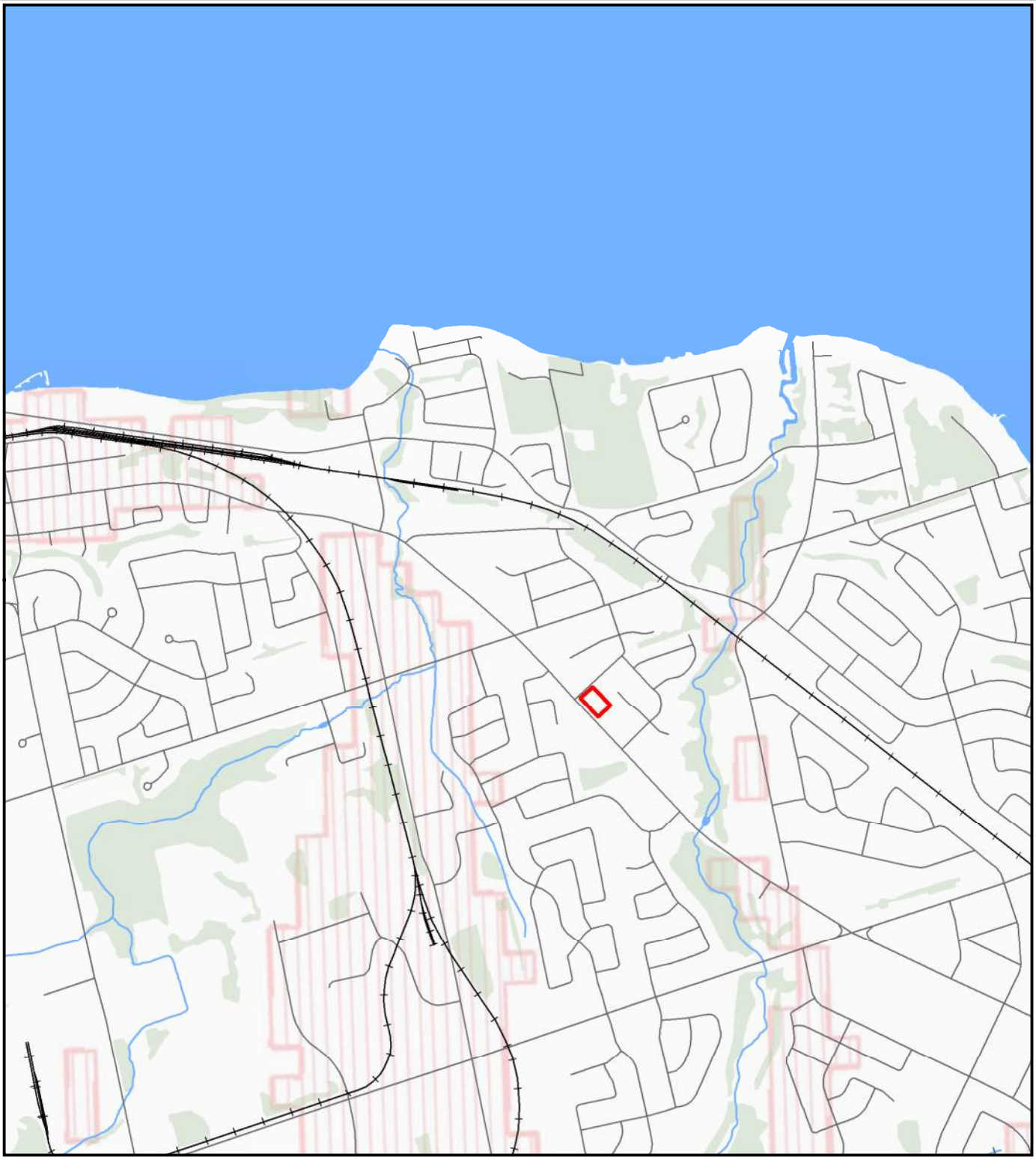
INTAKE PROTECTION ZONES

Project 2200334

May 2022

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, 2022.
3. LSRCA data from MECP Source Protection Information Atlas Image, Approximate. Accessed March 2022.

Legend

- Site Location
- Road
- Railway
- Watercourse
- Waterbody
- Wooded Area
- Highly Vulnerable Aquifer (LSRCA 2022)

N

0 200 400 m

1:20,000

447-455 Yonge Street
Barrie, Ontario

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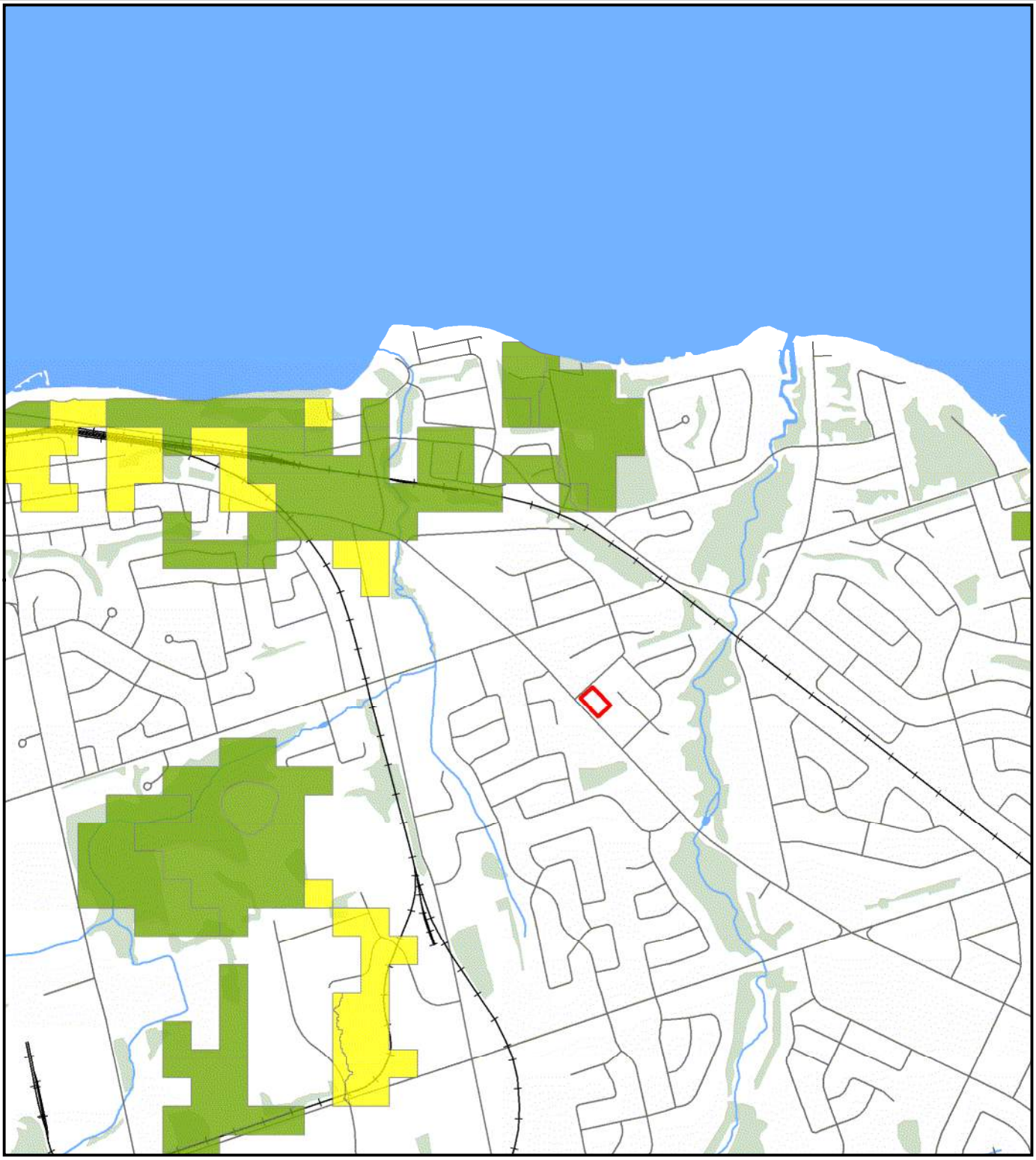
Project 2200334

HIGHLY VULNERABLE AQUIFER

May 2022 Fig. 5



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, 2022.
3. Significant Groundwater Recharge Areas from LSRCA open data (data.lsrca.on.ca).

Legend

- Site Location
- Road
- Railway
- Watercourse
- Waterbody
- Wooded Area

Significant Groundwater Recharge Area (LSRCA 2022)

- 2
- 4
- 6

N

0 200 400 m

1:20,000

447-455 Yonge Street
Barrie, Ontario

Innovative Planning Solutions

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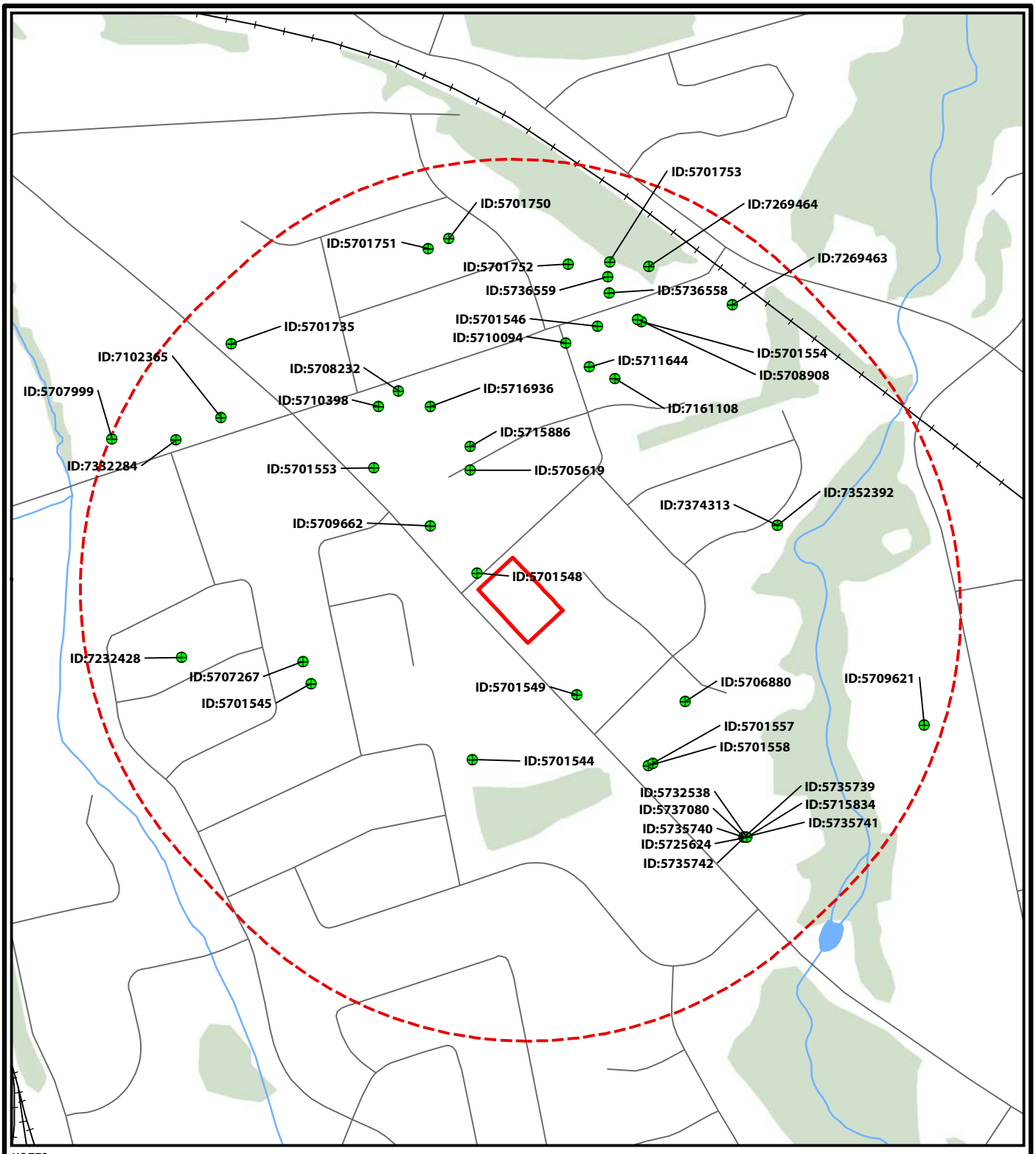
SIGNIFICANT GROUNDWATER RECHARGE AREAS

Project 2200334 | May 2022 | 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, 2022.

Legend

- Site Location
- Site Location +500m
- MECP Well Water Records Within 500m of Site Location
- Road
- Railway
- Watercourse
- Waterbody
- Wooded Area

N

0 70 140 m

1:7,000

447-455 Yonge Street
Barrie, Ontario

Innovative Planning Solutions

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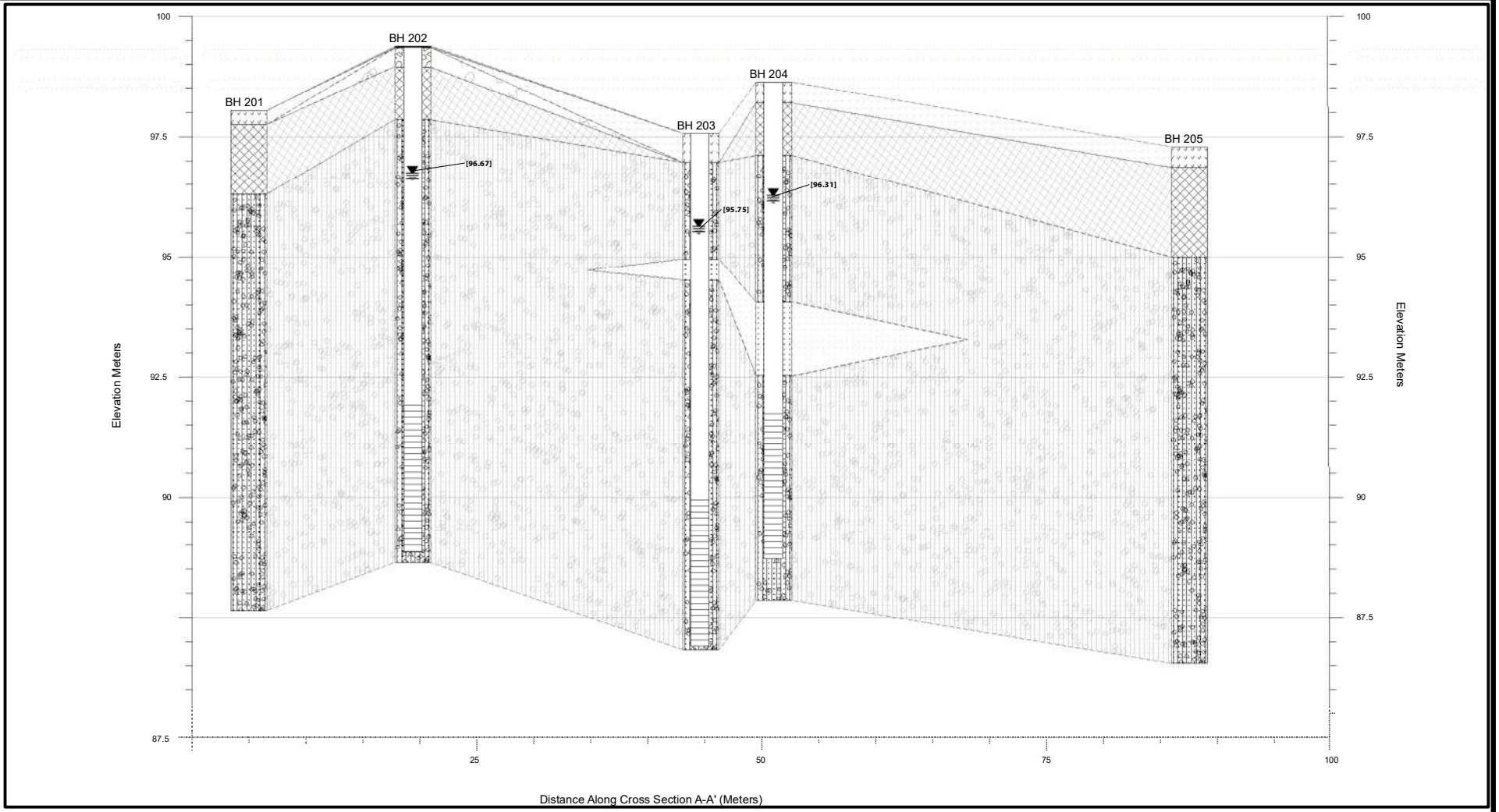
MECP WELL RECORD LOCATIONS

Project 2200334 | May 2022 | Fig. 7



Legend

Water Level In Monitoring Well

Strata

Asphalt

Topsoil

Earth Fill

Granular

Silty Sand to Sand and Silt Glacial Till

Sand

[ ] Groundwater level (m bgs), measured February 18, 2022

NOTES:

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

447-455 Yonge Street
Barrie, Ontario

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GEOLOGICAL CROSS SECTION A-A'

Project 2200334

May 2022

Fig. 8

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, 2024.
3. Orthoimagery © First Base Solutions, 2024. Imagery taken in 2021.

Legend

- Site Limit
- Cross Section Location
- Groundwater Contour
- Approximate Borehole/Monitoring Well Location
- Approximate Borehole Location
- [xx.xx] Groundwater Level (m asl) (February 18, 2022)
- Interpreted Direction of Groundwater Flow

N

0 6 12 m

1:600

447-455 Yonge Street
Barrie, Ontario

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GROUNDWATER CONTOUR MAP

Project 2200334 | May 2024 | Fig. 9

Appendix A

MECP Well Record Summary Table

GEI Consultants

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
BARRIE CITY	17 606451 4913460 W	2008/02 7314	1.97	FR 0006		NU	0005 10	7102365 (Z59752) A066226	GREY FILL LOOS 0005 BRWN FILL SNDY 0015 SILT
BARRIE CITY (INNISFI	17 606395 4913431 W	6946						7332284 (C44700) A262885 P	
INNISFIL TOWNSHIP	17 607094 4913601 W	2016/06 7190	4 2	UT 0015 UT 0020		MO	0015 10	7269463 (Z228567) A156734	BRWN LOAM SOFT 0002 BRWN SAND GRVL HARD 0010 GREY SILT SAND GRVL 0020 GREY SILT LYRD 0025
INNISFIL TOWNSHIP	17 606402 4913158 W	2014/08 7360						7232428 (C25999) A167912 P	
INNISFIL TOWNSHIP	17 606946 4913508 W	2011/02 7391	2	UT 0012	20///:	MO	0010 10	7161108 (Z117440) A098195	BLCK HARD 0000 BRWN SAND GRVL DNSE 0002 BRWN SAND STNS DNSE 0005 GREY SAND FSND DNSE 0008 BRWN SAND CSND DNSE 0010 GREY SILT WBRG DNSE 0012 BRWN SILT WBRG DNSE 0020
INNISFIL TOWNSHIP CON 13	17 607150 4913324 W	6946	2			MO	0034 6	7352392 (Z318028) A285740	BRWN CLAY SAND GRVL 0040
INNISFIL TOWNSHIP CON 13 011	17 606554 4913153 W	1970/03 2514	6	FR 0275	73/207/9/1:30	DO	0275 3	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 606767 4913030 W	1962/08 2514	6	FR 0267	85/145/10/6:0	PS	0267 8	5701544 ()	PRDG 0020 MSND GRVL CLAY 0052 BLUE CLAY 0098 GREY FSND CLAY 0250 GREY FSND 0265 MSND 0276
INNISFIL TOWNSHIP CON 13 011	17 606564 4913125 W	1963/05 2514	6	FR 0026	24/37/2/2:30	DO	0026 3	5701545 ()	BRWN CLAY 0019 BRWN CLAY STNS 0024 CSND 0028 BRWN CLAY MSND GRVL 0036 BLUE CLAY 0040
INNISFIL TOWNSHIP CON 13 012	17 606914 4913523 W	1974/09 2514	6 6	FR 0067	58/65/6/1:0	DO		5711644 ()	LOAM DKCL LOOS 0002 GREY CLAY SOFT 0011 GREY HPAN BLDR HARD 0043 GREY CLAY SAND GRVL 0067 YLLW SAND GRVL SILT 0072
INNISFIL TOWNSHIP CON 13 012	17 606884 4913553 W	1973/08 1204	5	FR 0045	40/70/2/1:0	DO	0071 3	5710094 ()	BLCK CLAY 0003 GREY CLAY 0047 GREY GRVL CLAY 0052 GREY SAND GRVL 0077
INNISFIL TOWNSHIP CON 13 012	17 606649 4913473 W	1973/09 2514	6	FR 0094	16/89/7/3:0	DO		5710398 ()	BRWN CLAY SAND BLDR 0043 GREY CLAY GRVL BLDR 0094 GREY SAND GRVL CLAY 0096
INNISFIL TOWNSHIP CON 13 012	17 606974 4913583 W	1972/04 2514	6	FR 0067 FR 0076	39/70/25/1:0	DO	0073 3	5708908 ()	LOAM 0001 BRWN CLAY SAND GRVL 0067 YLLW FSND CSND 0076
INNISFIL TOWNSHIP CON 13 012	17 606674 4913493 W	1971/08 1637	6	FR 0090	74/90/2/3:30	DO		5708232 ()	CLAY LOAM 0012 CLAY STNS 0038 GRVL 0063 HPAN 0090 GRVL STNS CLAY 0096
INNISFIL TOWNSHIP CON 13 012	17 607034 4913103 W	1969/12 4608	30	FR 0007 FR 0014	6/12/3/1:0	DO		5706880 ()	GREY MSND STNS 0014
INNISFIL TOWNSHIP CON 13 012	17 606714 4913323 W	1973/01 1204	5	FR 0073	8/70/1/1:0	DO		5709662 ()	PRDG 0015 GREY CLAY SAND 0073 GREY SAND GRVL CLAY 0075

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
INNISFIL TOWNSHIP CON 13 012	17 606764 4913423 W	1979/01 3135	5	FR 0248	106/132/9/2 :30	CO	0250 4	5715886 ()	LOAM 0001 BRWN CLAY SAND GRVL 0023 GREY CLAY SAND GRVL 0167 GREY CLAY 0228 GREY SILT 0248 GREY FSND 0254
INNISFIL TOWNSHIP CON 13 012	17 606714 4913473 W	1980/05 1222	5	FR 0171	82/153/9/1: 30	DO	0171 3	5716936 ()	BLCK LOAM 0002 BRWN CLAY STNS 0009 BRWN CLAY SAND 0051 GREY CLAY SAND 0083 GREY CLAY SAND SILT 0101 GREY CLAY 0171 GREY FSND 0174
INNISFIL TOWNSHIP CON 13 012	17 606773 4913264 W	1961/02 2514	6	FR 0039	18/56/2/2:0	DO	0041 15	5701548 ()	PRDG 0004 BLUE CLAY 0039 BRWN CLAY MSND GRVL 0056 BLUE CLAY 0132 GREY FSND 0167
INNISFIL TOWNSHIP CON 13 012	17 606643 4913396 W	1965/01 2514	6	FR 0070	44/51/7/2:0	DO		5701553 ()	PRDG 0044 MSND GRVL 0060 MSND CLAY 0069 MSND GRVL 0071
INNISFIL TOWNSHIP CON 13 012	17 606898 4913111 W	1962/12 2514	6	FR 0046	5/44/2/3:30	DO		5701549 ()	LOAM 0001 BRWN CLAY STNS 0020 CLAY MSND 0025 BLUE CLAY GRVL 0046 GRVL 0047
INNISFIL TOWNSHIP CON 13 012	17 606924 4913574 W	1957/09 2514	6	FR 0084	59/71/13/5: 0	DO		5701546 ()	LOAM 0001 BRWN CLAY 0012 BLUE CLAY 0078 MSND GRVL 0084
INNISFIL TOWNSHIP CON 13 012	17 606979 4913580 W	1965/01 2514	6	FR 0066	20/62/4/3:0	DO		5701554 ()	PRDG 0020 BRWN CLAY MSND 0060 MSND GRVL CLAY 0066 MSND GRVL 0070
INNISFIL TOWNSHIP CON 13 012	17 606988 4913022 W	1967/09 4608	30	FR 0010	5//2/:	DO		5701558 ()	LOAM 0001 FILL 0003 BRWN CLAY STNS 0017
INNISFIL TOWNSHIP CON 13 012	17 606993 4913025 W	1966/10 4608	30	FR 0010	10//2/:	CO		5701557 ()	BRWN CLAY MSND STNS 0020
INNISFIL TOWNSHIP CON 13 012	17 606764 4913393 W	1968/06 2514	6	FR 0256	70/193/18/2 :30	DO	0256 8	5705619 ()	LOAM 0001 BRWN CLAY MSND BLDR 0014 BLUE CLAY MSND BLDR 0080 BLUE CLAY 0240 GREY CLAY FSND 0256 FSND MSND 0264
INNISFIL TOWNSHIP CON 14 011	17 606434 4913712 W	2016/02 7215	2				0006 10	7266838 (Z229920) A202941	BRWN SILT 0016
INNISFIL TOWNSHIP CON 14 011	17 606314 4913433 W	1971/04 3203	5	FR 0089	25/70/6/1:3 0	DO	0108 3	5707999 ()	BRWN LOAM 0001 BRWN MSND 0012 GREY CLAY MSND 0046 GREY CLAY 0089 GREY FSND 0111
INNISFIL TOWNSHIP CON 14 011	17 606464 4913552 W	1959/03 1637	4	FR 0215	47/125/1/:	DO		5701735 ()	BRWN CLAY 0018 BLDR CLAY 0028 GRVL CLAY 0074 CLAY 0090 QSND CLAY 0213 MSND GRVL 0215
INNISFIL TOWNSHIP CON 14 011	17 606397 4913623 W	1962/06 4102	30	FR 0012	12//2/:	DO		5701737 ()	MSND 0020
INNISFIL TOWNSHIP CON 14 012	17 606989 4913649 W	2016/06 7190	4 2			MO	0015 10	7269464 (Z213658) A156738	BRWN LOAM SOFT 0003 BRWN SILT SAND HARD 0015 GREY SILT SAND HARD 0025
INNISFIL TOWNSHIP CON 14 012	17 606937 4913636 W	2001/10 2801				NU		5736559 (232027) A	

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
INNISFIL TOWNSHIP CON 14 012	17 606939 4913616 W	2001/10 2801				NU		5736558 (232028) A	
INNISFIL TOWNSHIP CON 14 012	17 606814 4913823 W	1978/10 2801						5715729 ()	BRWN CLAY BLDR GRVL 0063 GREY CLAY GRVL 0171 GREY GRVL SAND CLAY 0191 GREY SAND GRVL CLAY 0220 GREY SAND GRVL LMSN 0232 GREY GRVL SAND CLAY 0290 GREY CLAY SAND GRVL 0394
INNISFIL TOWNSHIP CON 14 012	17 606737 4913684 W	1959/05 2801	5					5701750 ()	LOAM 0001 MSND SILT 0008 MSND GRVL BLDR 0034 BLDR 0036
INNISFIL TOWNSHIP CON 14 012	17 606656 4913798 W	1966/09 4608	30	FR 0022	22//2/:	DO		5701754 ()	GRVL 0002 BRWN CLAY STNS 0032
INNISFIL TOWNSHIP CON 14 012	17 606939 4913655 W	1966/03 2514	6	FR 0060	46/58/20/2: 0	DO	0063 4 0067 3	5701753 ()	LOAM 0002 CLAY MSND BLDR 0060 YLLW CSND 0070
INNISFIL TOWNSHIP CON 14 012	17 606711 4913672 W	1959/05 2801	5					5701751 ()	LOAM 0001 MSND SILT 0008 MSND GRVL BLDR 0036 CLAY GRVL BLDR 0083 BLUE CLAY GRVL BLDR 0153 BLUE CLAY 0281 CLAY MSND 0311 BLUE CLAY GRVL 0334 BLUE CLAY GRVL BLDR 0346 LMSN 0347
INNISFIL TOWNSHIP CON 14 012	17 606887 4913652 W	1965/04 2514	6	FR 0057	49/62/40/48 :0	DO	0058 3 0061 3	5701752 ()	LOAM 0001 BRWN CLAY STNS 0018 BRWN CLAY MSND GRVL 0057 CSND GRVL 0065 BLUE CLAY 0099

Appendix B

Borehole Logs

RECORD OF BOREHOLE No. 201

Project Number: **2200334**
Project Client: **Barrie Yonge Developments GP Inc.**
Project Name: **447 - 455 Yonge Street**
Project Location: **Barrie, Ontario**
Drilling Location: **See Borehole Location Plan**
Local Benchmark:

Drilling Method: **Solid Stem Augers** Drilling Machine: **CME 85, Buggy**
Logged By: **SP** Northing: **4913274** Date Started: **Feb 3/22**
Reviewed By: **AB** Easting: **606818** Date Completed: **Feb 3/22**

Geodetic	Description	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Depth (m)	Elevation (m)	SPT "N" Value	Water Content (%)	Instrumentation Installation	GR	SA	SI	CL
0.0 / 252.8	TOPSOIL: 300 mm					0	252							
0.3 / 252.5	EARTH FILL: Sandy silt, trace to some clay, trace gravel, moist, brown loose	SS	1	75	7			7	7					
		SS	2	100	7	1.5		5	35					
1.7 / 251.1	WEATHERED: Trace organics, trace gravel, wet, loose	SS	3	100	5		250.5		7					
2.3 / 250.5	SILTY SAND to SAND & SILT GLACIAL TILL: Trace to some gravel, trace to some clay, brown, moist, very dense	SS	4	100	52	3	249	52	7		16	55	24	5
		SS	5	100	84	4.5	247.5	84	6					
		SS	6	100	100+	6	246	100+	11					
	- - - Grey - - -	SS	7	100	100+	7.5	244.5	100+	9					
		SS	8	100	100+	9	243	100+	8					
		SS	9	100	100+	10.5		100+	7					
10.8 / 242.0		SS	10	100	100+			100+	8		Augers grinding			
	Borehole Terminated at 10.8 m													

Groundwater depth encountered on completion of drilling: 2.4 m. Cave depth after auger removal: 4.9 m.
Groundwater depth observed on: Groundwater Elevation:

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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. 202

Project Number: **2200334**
Project Client: **Barrie Yonge Developments GP Inc.**
Project Name: **447 - 455 Yonge Street**
Project Location: **Barrie, Ontario**
Drilling Location: **See Borehole Location Plan**
Local Benchmark:

Drilling Method: **Solid Stem Augers** Drilling Machine: **CME 85, Buggy**
Logged By: **SP** Northing: **4913227** Date Started: **Feb 4/22**
Reviewed By: **AB** Easting: **606789** Date Completed: **Feb 4/22**

Geodetic	Depth (m)	Description	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Elevation (m)	Instrumentation Installation	GR	SA	SI	CL
254.2	0.0											
254.1	0.2	PAVEMENT: 50mm asphalt, 100mm granular	SS	1	100	48	253.5					
253.7	0.5	TOPSOIL: 300 mm										
		EARTH FILL: Sandy silt, trace to some clay, trace gravel, trace organics, dark brown to brown, moist, loose	SS	2	100	8						
252.7	1.5	SANDY SILT to SAND & SILT GLACIAL TILL: Trace to some clay, trace gravel, brown, moist to wet, compact	SS	3	100	21	252					
		- - - Very dense, moist - - -	SS	4	45	54						
	3		SS	5	50	52	250.5		13	43	35	9
	4.5		SS	6	100	100+	249					
	6		SS	7	100	100+	247.5					
	7.5		SS	8	100	100+	246					
	9	- - - Grey - - -	SS	9	100	100+	244.5					
243.4	10.8		SS	10	100	100+	10.5					
		Borehole Terminated at 10.8 m										

FIELD TESTING: Shear Strength Testing (kPa) — Other Test; Pocket Penetrometer; Field Vane (Intact); Field Vane (Remolded); 40 80 120 160. Penetration Testing — SPT; DCPT; 10 20 30 40.

LAB TESTING: Combustible Organic Vapour (ppm); Combustible Organic Vapour (%LEL); Total Organic Vapour (ppm); 100 200 300 400. Atterberg Limits — PL; LL. Water Content (%); 10 20 30 40.

Groundwater depth encountered on completion of drilling:

Groundwater depth observed on: Feb 18/22 at depth of: 2.7 m. Groundwater Elevation: 251.5 m

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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**

RECORD OF BOREHOLE No. 203

Project Number: **2200334**
Project Client: **Barrie Yonge Developments GP Inc.**
Project Name: **447 - 455 Yonge Street**
Project Location: **Barrie, Ontario**
Drilling Location: **See Borehole Location Plan**
Local Benchmark:

Drilling Method: **Solid Stem Augers** Drilling Machine: **CME 85, Buggy**
Logged By: **SP** Northing: **4913248** Date Started: **Feb 3/22**
Reviewed By: **AB** Easting: **606840** Date Completed: **Feb 3/22**

Geodetic	Description	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Depth (m)	Elevation (m)	GR	SA	SI	CL
0.0						0	252.4				
0.2	TOPSOIL: 200 mm						252.2				
	SILTY SAND to SAND & SILT GLACIAL TILL: Trace to some clay, trace to some gravel, brown, moist, loose to compact	SS	1	100	5						
		SS	2	100	13	1.5	250.5				
	- - - Wet - - -	SS	3	100	9						
2.6		SS	4	100	28		249.8				
3.0	SAND: Some silt, trace gravel, brown, wet, compact					3	249.3				
	SANDY SILT to SILT & SAND GLACIAL TILL: Trace to some clay, trace to some gravel, brown, moist to wet, very dense	SS	5	90	69						
	- - - Grey, moist - - -	SS	6	100	50	4.5	247.5				
		SS	7	100	100+	6	246				
		SS	8	100	100+	7.5	244.5				
		SS	9	100	100+	9	243	8	49	34	9
10.8		SS	10	100	100+	10.5	241.6				
	Borehole Terminated at 10.8 m										

FIELD TESTING: Shear Strength Testing (kPa) — Other Test; Pocket Penetrometer; Field Vane (Intact); Field Vane (Remolded); 40 80 120 160. Penetration Testing: SPT, DCPT; 10 20 30 40.

LAB TESTING: Combustible Organic Vapour (ppm); Combustible Organic Vapour (%LEL); Total Organic Vapour (ppm); 100 200 300 400. Atterberg Limits: PL, LL. Water Content (%); 10 20 30 40.

Instrumentation Installation

COMMENTS & GRAIN SIZE DISTRIBUTION (%)

Groundwater depth encountered on completion of drilling:

Groundwater depth observed on: Feb 18/22 at depth of: 1.8 m. Groundwater Elevation: 250.6 m

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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**

RECORD OF BOREHOLE No. 204

Project Number: **2200334**
Project Client: **Barrie Yonge Developments GP Inc.**
Project Name: **447 - 455 Yonge Street**
Project Location: **Barrie, Ontario**
Drilling Location: **See Borehole Location Plan**
Local Benchmark:

Drilling Method: **Solid Stem Augers** Drilling Machine: **CME 85, Buggy**
Logged By: **SP** Northing: **4913207** Date Started: **Feb 4/22**
Reviewed By: **AB** Easting: **606813** Date Completed: **Feb 4/22**

Geodetic	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING (Shear Strength Testing (kPa); Penetration Testing: SPT ○, DCPT ●)	LAB TESTING (Combustible Organic Vapour (ppm) △, Combustible Organic Vapour (%LEL) ▲, Total Organic Vapour (ppm) ◇; Atterberg Limits PL–LL; Water Content (%) ○)	Instrumentation Installation	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
0.0	TOPSOIL: 450 mm					0								
0.5		SS	1	80	6			6, 5	17, 17					
	EARTH FILL: Silty sand, trace to some clay, trace organics, brown, moist to wet, loose	SS	2	100	5									
1.5						1.5	252							
	SILTY SAND to SAND & SILT GLACIAL TILL: Trace to some clay, trace to some gravel, brown, moist to wet, compact	SS	3	75	13			13	9					
	- - - Dense - - -	SS	4	100	36			36	8					
	- - - Very dense - - -	SS	5	100	58	3	250.5	58 →	8					
4.6						4.5	249							
	SAND: Trace silt, brown, wet, very dense	SS	6	100	100+			100+ →	14					
6.1						6	247.5							
	SANDY SILT to SILT & SAND GLACIAL TILL: Trace to some clay, trace to some gravel, grey, moist to wet, very dense	SS	7	100	100+			100+ →	13					
		SS	8	90	100+	7.5	246	100+ →	15		4	44	39	13
	- - - Moist - - -	SS	9	100	100+	9	244.5	100+ →	8					
10.8		SS	10	100	100+	10.5	243	100+ →	8					
	Borehole Terminated at 10.8 m													

Groundwater depth encountered on completion of drilling:
Groundwater depth observed on: Feb 18/22 at depth of: 2.3 m. Groundwater Elevation: 251.1 m

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

RECORD OF BOREHOLE No. 205

Project Number: **2200334**
Project Client: **Barrie Yonge Developments GP Inc.**
Project Name: **447 - 455 Yonge Street**
Project Location: **Barrie, Ontario**
Drilling Location: **See Borehole Location Plan**
Local Benchmark:

Drilling Method: **Solid Stem Augers** Drilling Machine: **CME 85, Buggy**
Logged By: **SP** Northing: **4913215** Date Started: **Feb 2/22**
Reviewed By: **AB** Easting: **606871** Date Completed: **Feb 2/22**

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Lithology Plot	DESCRIPTION	Geodetic	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Shear Strength Testing (kPa) / Penetration Testing (SPT, DCPT)	LAB TESTING: Combustible Organic Vapour (ppm), Combustible Organic Vapour (%LEL), Total Organic Vapour (ppm), Atterberg Limits, Water Content (%)	Instrumentation Installation	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
	TOPSOIL: 450 mm	0.0 252.1					0	252							
	0.5 251.6		SS	1	100	11			11	10					
	EARTH FILL: Sand and silt, trace to some clay, trace to some gravel, trace organics, brown, moist, compact		SS	2	90	14			14	10		11	44	37	8
							1.5	250.5							
			SS	3	100	14			14	13					
	2.3 249.8														
	SILTY SAND to SAND AND SILT GLACIAL TILL: Trace to some clay, trace to some gravel, brown, moist, dense		SS	4	100	49			49	10					
	- - - Very dense - - -		SS	5	100	79	3	249	79	8					
			SS	6	100	100+	4.5	247.5	100+	4					
	- - - Grey - - -		SS	7	100	100+	6	246	100+	8		Auger grinding			
			SS	8	100	100+	7.5	244.5	100+	5					
			SS	9	100	100+	9	243	100+	6					
	10.8 241.3		SS	10	100	100+	10.5	241.5	100+	7					
	Borehole Terminated at 10.8 m														

Groundwater depth encountered on completion of drilling: 5.2 m. Cave depth after auger removal: 7.6 m.
Groundwater depth observed on: Groundwater Elevation:

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

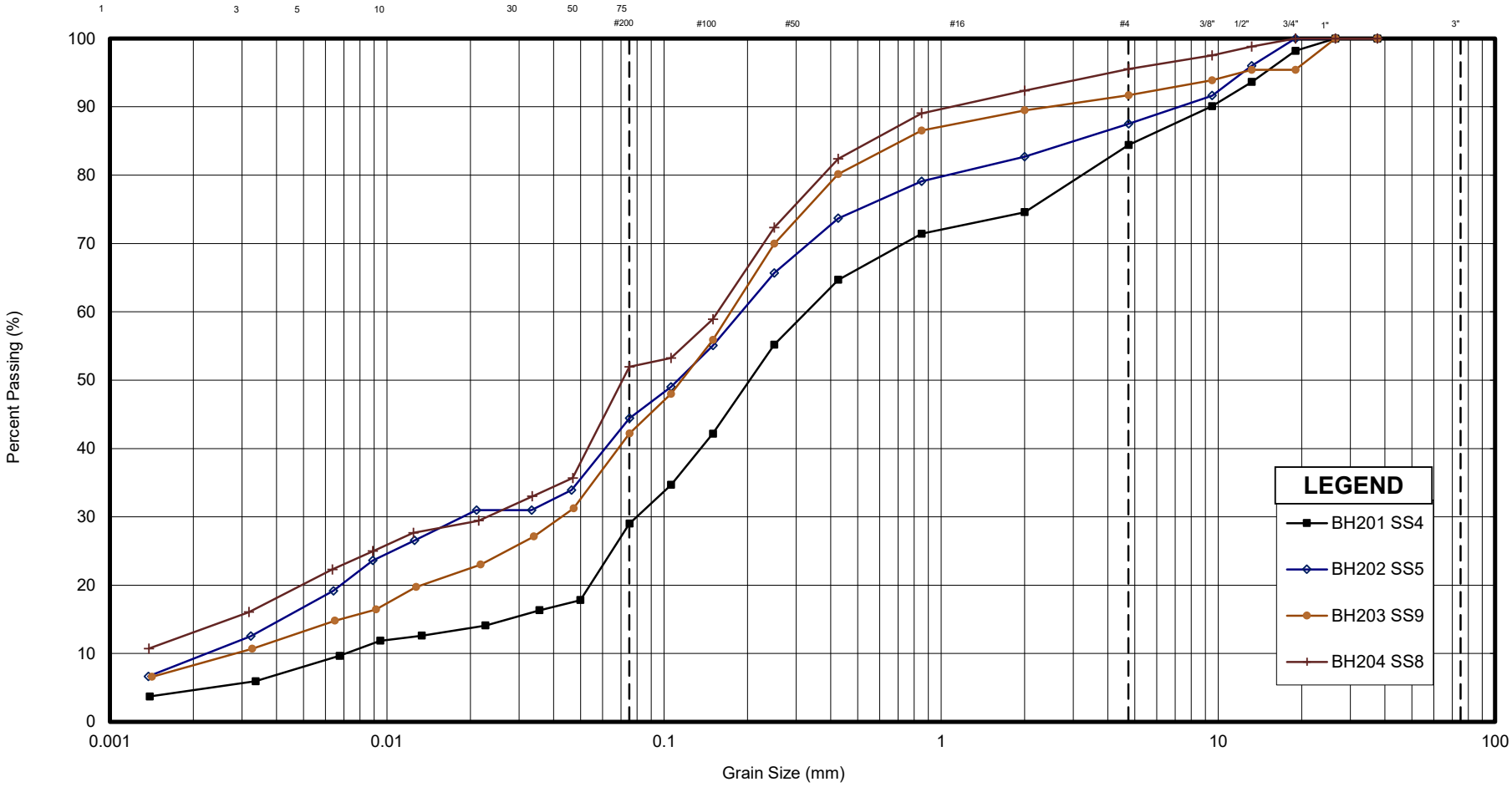
Appendix C

Geotechnical Laboratory Results

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

GRAIN SIZE IN MICROMETERS — SIEVE DESIGNATION (IMPERIAL)



Sample	Description	Gr.	Sa.	Si.	Cl.	D_{10}	D_{30}	D_{60}	C_u	C_c
BH201 SS4	SILTY SAND GLACIAL TILL, Some Gravel, Trace Clay	16	55	24	5	0.007	0.080	0.327	46.7	2.8
BH202 SS5	SAND AND SILT GLACIAL TILL, Some Gravel, Trace Clay	13	43	35	9	0.002	0.019	0.190	95.0	1.0
BH203 SS9	SILTY SAND GLACIAL TILL, Trace Clay, Trace Gravel	8	49	34	9	0.003	0.043	0.174	58.0	3.5
BH204 SS8	SAND AND SILT GLACIAL TILL, Some Clay, Trace Gravel	4	44	39	13	-	0.023	0.156	-	-

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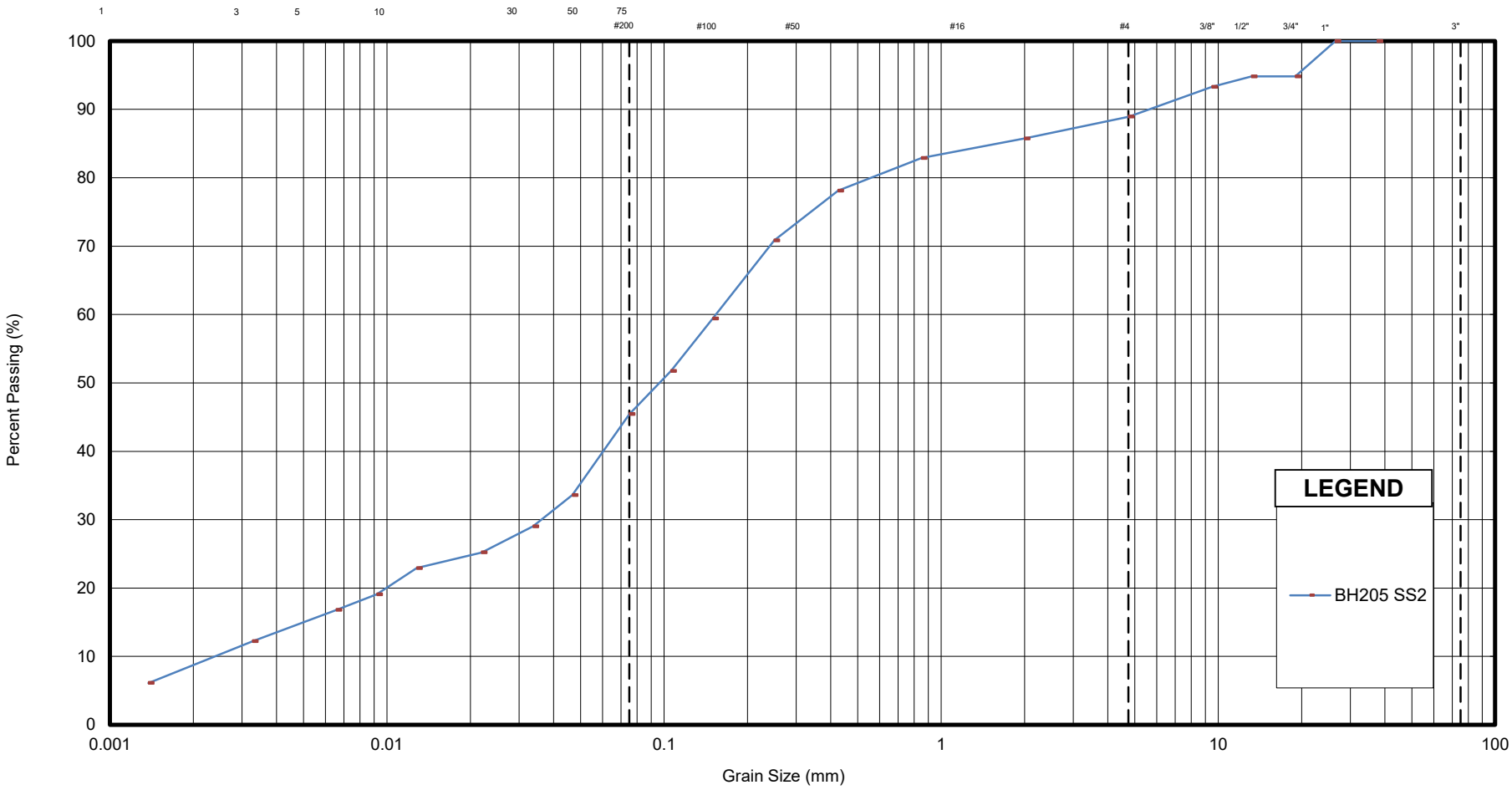
GRAIN SIZE DISTRIBUTION - 447 to 455 Yonge Street, Barrie

SILTY SAND TO SAND AND SILT GLACIAL TILL

FIGURE No.	BH 201-204 Graph
REF. No.	2200334
DATE	April 2022

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



Sample	Description	Gr.	Sa.	Si.	Cl.	D_{10}	D_{30}	D_{60}	C_u	C_c
BH205 SS2	EARTH FILL: Sand and Silt, Some Gravel, Trace Clay	11	44	37	8	0.002	0.036	0.154	77.0	4.2

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GRAIN SIZE DISTRIBUTION - 447 to 455 Yonge Street, Barrie

EARTH FILL (RE-WORKED GLACIAL TILL)

FIGURE No.	BH 205 Graph
REF. No.	2200334
DATE	April 2022

Appendix D

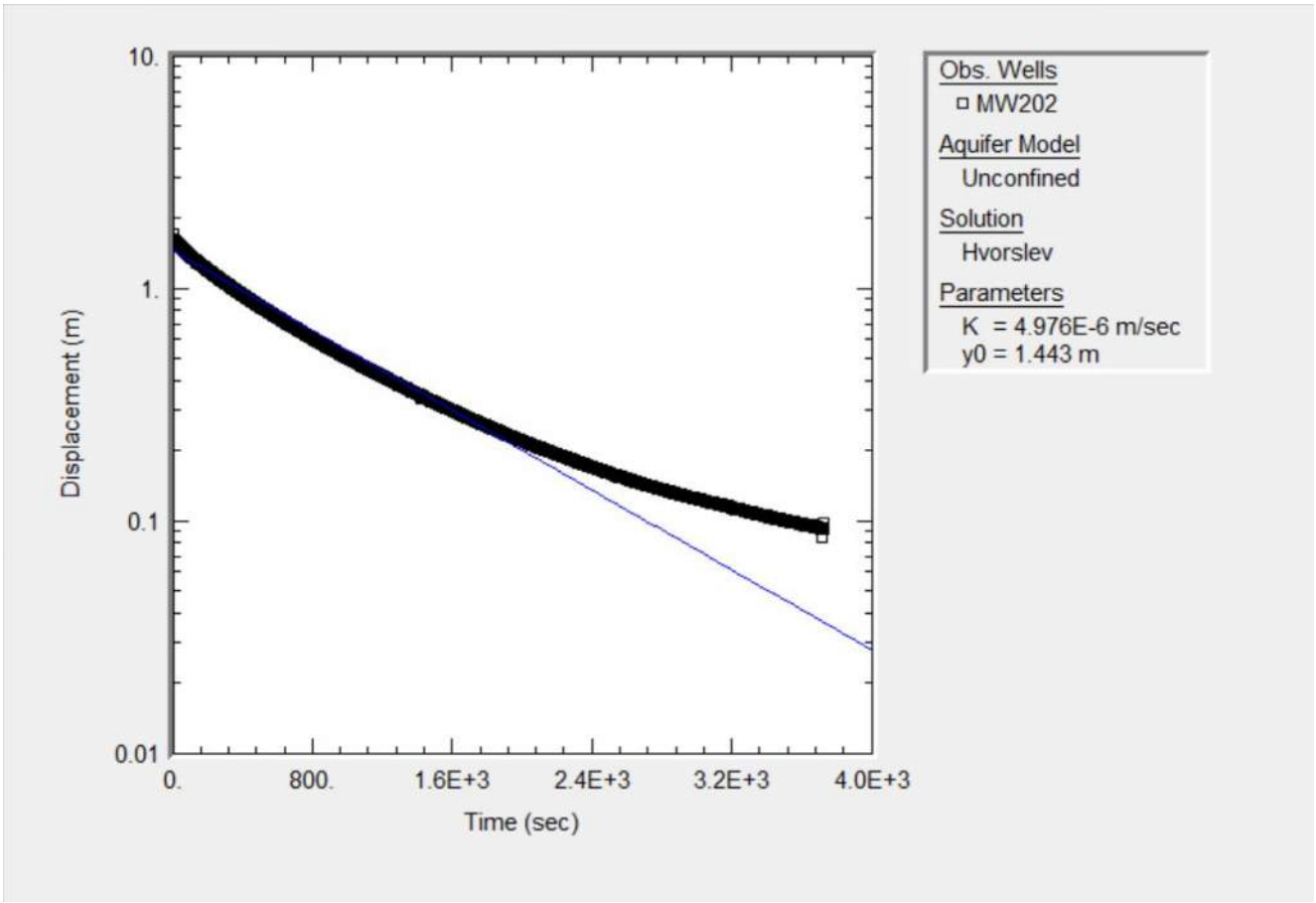
Rising Head Test Results

GEI Consultants

Estimation of K by Slug Test, based on Horslev equation

Date:	February 18, 2022
Conducted by:	S. Patrick

Well Number:	BH/MW202	
Well Screen Bottom:	10.60	mbgs
Top of Pipe:	0.10	mbgs
Well Casing Diameter:	5.08	cm
Well Elevation:	99.38	mbgs
Static Water Level:	2.62	mbgs
$K = r^2\ln(L/R)/(2LTo)$ =	**$5.0x10^{-6}$**	m/s



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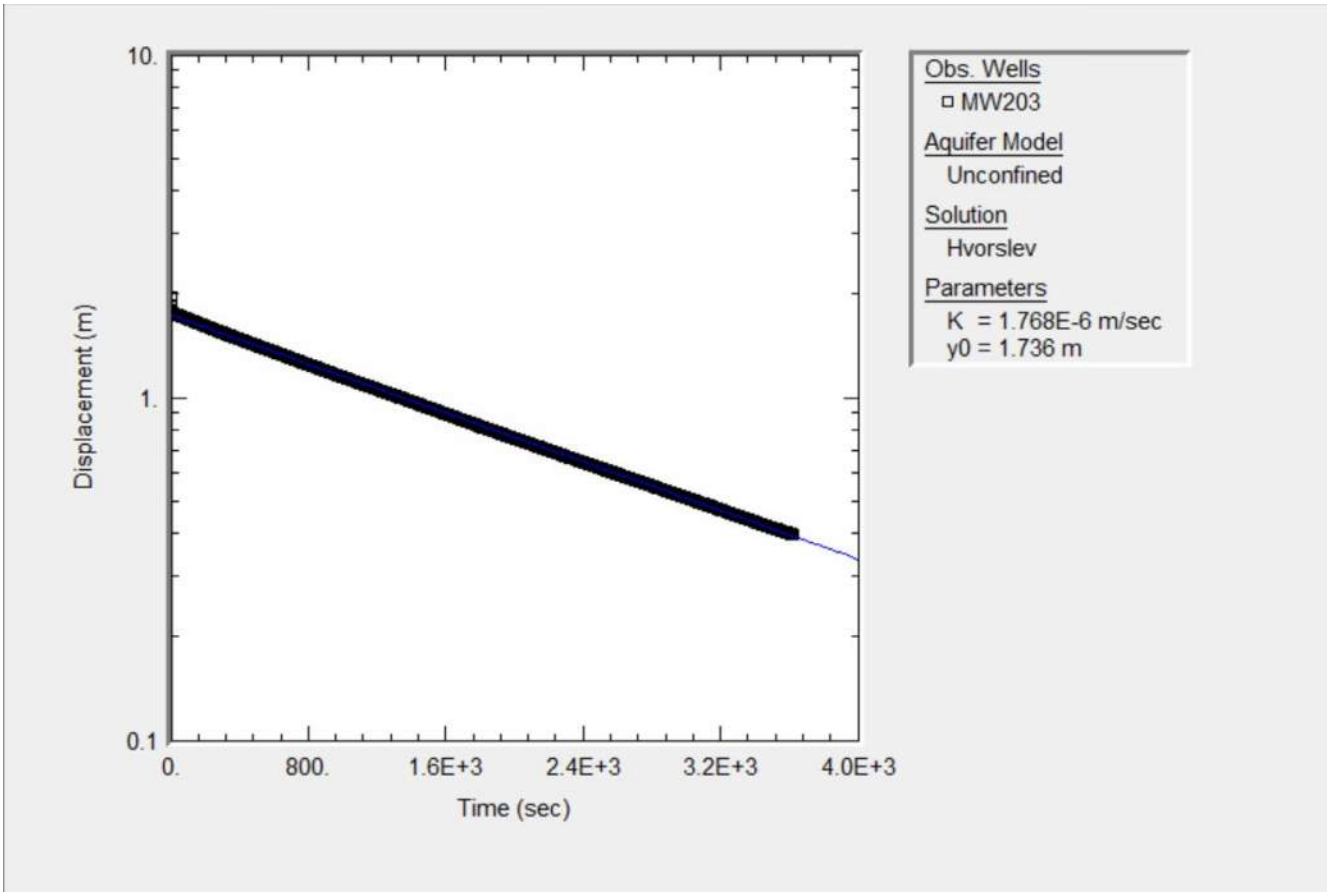
Estimation of K by Slug Test, based on Horslev equation

Date:	February 18, 2022
Conducted by:	S. Patrick

Well Number:	BH/MW203	
Well Screen Bottom:	10.60	mbgs
Top of Pipe:	0.86	mags
Well Casing Diameter:	5.08	cm
Well Elevation:	97.57	mbgs
Static Water Level:	2.69	mbgs
$K = r^2\ln(L/R)/(2LTo)$ =	**$1.8x10^{-6}$**	m/s

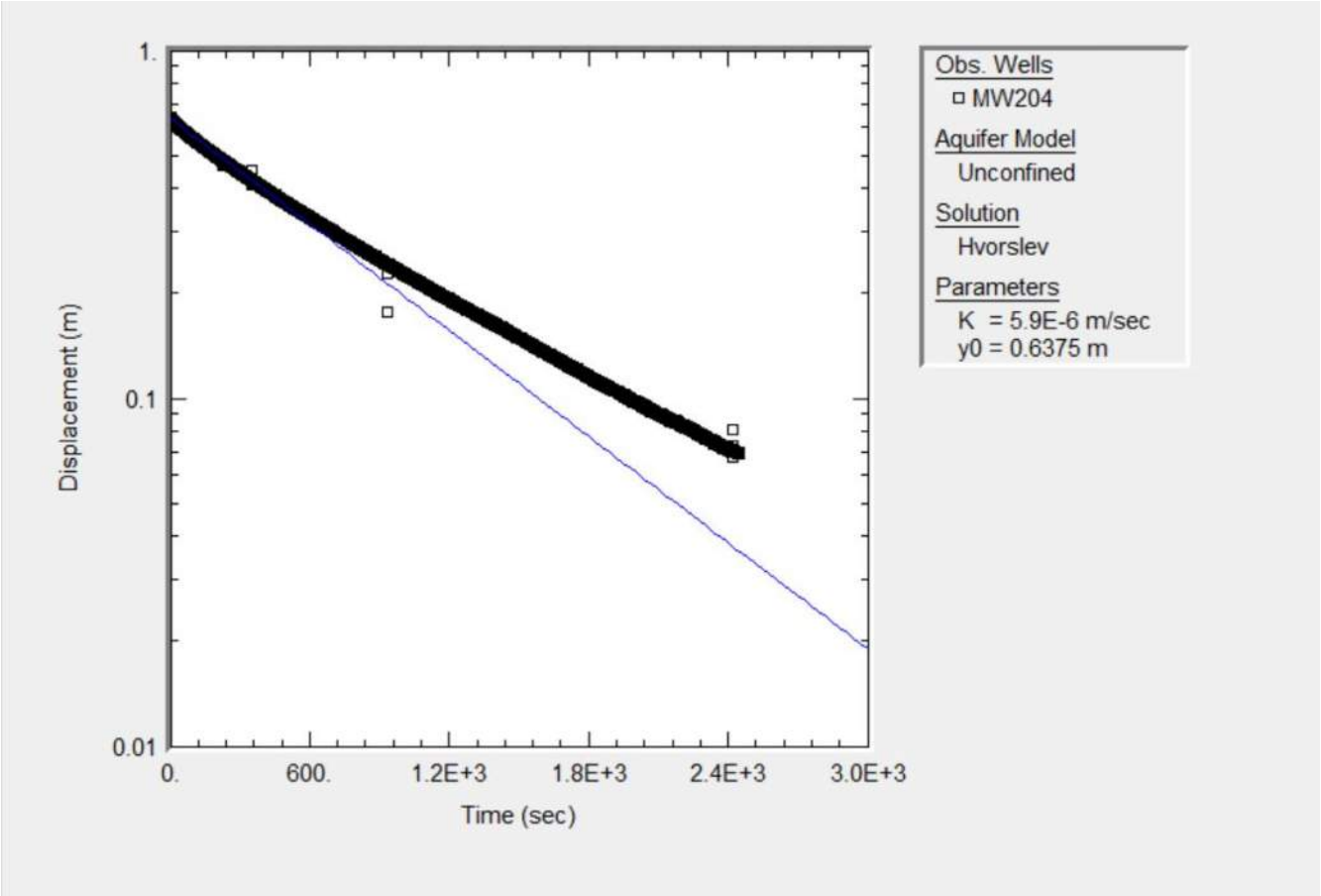


GEI Consultants

Estimation of K by Slug Test, based on Horslev equation

Date:	February 18, 2022
Conducted by:	S. Patrick

Well Number:	BH/MW204	
Well Screen Bottom:	10.60	mbgs
Top of Pipe:	0.88	mags
Well Casing Diameter:	5.08	cm
Well Elevation:	98.63	mbgs
Static Water Level:	3.20	mbgs
$K = r^2\ln(L/R)/(2LTo)$ =	**$5.9x10^{-6}$**	m/s



Appendix E

Groundwater Chemistry Certificates of Analysis

CADUCEON ENVIRONMENTAL LABORATORIES
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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G104295 **REPORT No. B22-04523 (i)**

Report To:

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

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

DATE RECEIVED: 16-Feb-22
DATE REPORTED: 23-Feb-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:

P.O. NUMBER: 2200334
WATERWORKS NO.

Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
Cyanide	1	Kingston	kwe	23-Feb-22	A-CN-001 (k)	SM 4500CN
A - Wet Chem	1	Kingston	TK	17-Feb-22	A-COD K	SM5220C
Anions	1	Holly Lane	pcu	18-Feb-22	A-IC-01 (o)	SM4110C
pH	1	Holly Lane	SYL	17-Feb-22	A-PH-01 (o)	SM 4500H
Sulphide	1	Kingston	TK	17-Feb-22	A-S2	SM4500-S2
A - Wet Chem	1	Kingston	ach	17-Feb-22	A-TPTKN-001 (N)(k)	E3516.2
A - Wet Chem	1	Kingston	ach	17-Feb-22	A-TPTKN-001 (P)(k)	E3516.2
Total Suspended Solids	2	Kingston	bbr	17-Feb-22	A-TSS-001 (k)	SM2540D
BOD	1	Kingston	JWF	17-Feb-22	C-BOD-001 (k)	SM 5210B
SVOC	1	Kingston	sge	22-Feb-22	C-NAB-W-001 (k)	EPA 8270
Oil & Grease	1	Kingston	aso	18-Feb-22	C-O&G-001 (k)	SM 5520
Phenolics (4-aap)	1	Kingston	kwe	18-Feb-22	C-PHEN-01 (k)	MOEE 3179
Chromium (VI)	2	Holly Lane	ST	22-Feb-22	D-CRVI-01 (o)	MOE E3056
Mercury	2	Holly Lane	PBK	22-Feb-22	D-HG-02 (o)	SM 3112 B
Metals - ICP-OES	2	Holly Lane	AHM	18-Feb-22	D-ICP-01 (o)	SM 3120
Metals-ICP-MS	2	Holly Lane	TPR	23-Feb-22	D-ICPMS Dissolved 7800	EPA 200.8
Metals - ICP-MS	2	Holly Lane	TPR	18-Feb-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

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

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G104295 **REPORT No. B22-04523 (i)**

Report To:

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

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

DATE RECEIVED: 16-Feb-22
DATE REPORTED: 23-Feb-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2200334
WATERWORKS NO.

	Client I.D.		MW202	MW202 - F			Barrie Sanitary	
	Sample I.D.		B22-04523-1	B22-04523-2			Barrie-Sanitary/Combined	Barrie-Storm Sewer
	Date Collected		15-Feb-22	15-Feb-22				
Parameter	**Units**	**R.L.**						
pH @25°C	pH Units		7.77				9.5	9.5
BOD(5 day)	mg/L	3	< 3				300	15
COD	mg/L	5	< 5				600	
Total Kjeldahl Nitrogen	mg/L	0.1	0.3				100	
Total Suspended Solids	mg/L	3	120	4			350	15
Oil and Grease-Mineral	mg/L	1.0	< 1.0				15	
Oil and Grease-Anim/Veg.	mg/L	1.0	< 1.0				150	
Phosphorus-Total	mg/L	0.01	0.10				10	
Cyanide (Total)	mg/L	0.005	< 0.005				1.2	
Chloride	mg/L	0.5	114				1500	
Fluoride	mg/L	0.1	< 0.1				10	
Sulphate	mg/L	1	50				1500	
Aluminum (total)	mg/L	0.01	0.61	0.07			50	
Antimony	mg/L	0.0001	0.0003	0.0004			5.0	
Arsenic	mg/L	0.0001	0.0002	0.0002			1.0	
Barium	mg/L	0.001	0.124	0.116			5.0	
Beryllium	mg/L	0.002	< 0.002	< 0.002				
Boron	mg/L	0.005	0.059	0.062				
Bismuth	mg/L	0.02	< 0.02	< 0.02			5.0	
Cadmium	mg/L	0.000015	< 0.000015	< 0.000015			0.7	0.001
Chromium	mg/L	0.001	0.001	< 0.001			2.0	0.08
Chromium (VI)	mg/L	0.001	< 0.001	< 0.001 [1]				
Cobalt	mg/L	0.0001	0.0007	0.0005			5.0	
Copper	mg/L	0.0001	0.0022	0.0017			2.0	0.01

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

Christine Burke
Lab Manager

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

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CERTIFICATE OF ANALYSIS

Final Report

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Attention: Alicia Kimberley

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

DATE RECEIVED: 16-Feb-22
DATE REPORTED: 23-Feb-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2200334
WATERWORKS NO.

	Client I.D.		MW202	MW202 - F			Barrie Sanitary	
	Sample I.D.		B22-04523-1	B22-04523-2			Barrie-Sanitary/Combined	Barrie-Storm Sewer
	Date Collected		15-Feb-22	15-Feb-22				
Parameter	**Units**	**R.L.**						
Gold	mg/L	0.0007	< 0.0007	< 0.0007			5.0	
Hexachlorobenzene	mg/L	0.0001	< 0.0001				0.0001	
Iron	mg/L	0.005	0.989	0.102			50	
Lead	mg/L	0.00002	0.00034	0.00005			0.7	0.05
Manganese (Total)	mg/L	0.001	0.073	0.056			5.0	
Mercury	mg/L	0.00002	0.00003	< 0.00002			0.01	
Molybdenum	mg/L	0.01	< 0.01	< 0.01			5.0	
Nickel	mg/L	0.0002	0.0035	0.0040			2.0	0.05
Total PAH	mg/L	0.0001	< 0.0001				0.005	
Acenaphthene	µg/L	0.05	< 0.05					
Acenaphthylene	µg/L	0.05	< 0.05					
Anthracene	µg/L	0.05	< 0.05					
Benzo(a)anthracene	µg/L	0.05	< 0.05					
Benzo(a)pyrene	µg/L	0.01	< 0.01					
Benzo(b+k)fluoranthene	µg/L	0.1	< 0.1					
Benzo(g,h,i)perylene	µg/L	0.05	< 0.05					
Dibenzo(a,h)anthracene	µg/L	0.05	< 0.05					
Chrysene	µg/L	0.05	< 0.05					
Fluoranthene	µg/L	0.05	< 0.05					
Fluorene	µg/L	0.05	< 0.05					
Indeno(1,2,3,-cd)pyrene	µg/L	0.05	< 0.05					
Methylnaphthalene,1-	µg/L	0.05	< 0.05					
Methylnaphthalene,2-	µg/L	0.05	< 0.05					
Naphthalene	µg/L	0.05	< 0.05					

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

Christine Burke
Lab Manager

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CADUCEON ENVIRONMENTAL LABORATORIES
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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G104295 **REPORT No. B22-04523 (i)**

Report To:

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

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

DATE RECEIVED: 16-Feb-22
DATE REPORTED: 23-Feb-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2200334
WATERWORKS NO.

	Client I.D.		MW202	MW202 - F			Barrie Sanitary	
	Sample I.D.		B22-04523-1	B22-04523-2			Barrie-Sanitary/Combined	Barrie-Storm Sewer
	Date Collected		15-Feb-22	15-Feb-22				
Parameter	**Units**	**R.L.**						
Phenanthrene	µg/L	0.05	< 0.05					
Pyrene	µg/L	0.05	< 0.05					
Phenolics	mg/L	0.001	< 0.001				0.1	
Platinum	mg/L	0.00004	< 0.00004	< 0.00004			5.0	
Rhodium	mg/L	0.00002	< 0.00002	< 0.00002			5.0	
Selenium	mg/L	0.001	< 0.001	< 0.001			1.0	
Silver	mg/L	0.0001	< 0.0001	< 0.0001			0.4	
Strontium	mg/L	0.001	0.266	0.277				
Sulphide	mg/L	0.01	0.07				1.0	
Thallium	mg/L	0.00005	< 0.00005	< 0.00005				
Tin	mg/L	0.05	< 0.05	< 0.05			5.0	
Titanium	mg/L	0.005	0.050	< 0.005				
Tungsten	mg/L	0.01	< 0.01	< 0.01				
Uranium	mg/L	0.00005	0.00093	0.00085				
Vanadium	mg/L	0.005	< 0.005	< 0.005			5.0	
Zinc	mg/L	0.005	0.007	< 0.005			2.0	0.04
Zirconium	mg/L	0.003	< 0.003	< 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

Christine Burke
Lab Manager

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

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G104295 **REPORT No. B22-04523 (i)**

Report To:

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

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

DATE RECEIVED: 16-Feb-22
DATE REPORTED: 23-Feb-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2200334
WATERWORKS NO.

Summary of Exceedances

Storm Sewer Guidelines		
MW202	Found Value	Limit
Total Suspended Solids (mg/L)	120	15

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

R.L. = Reporting Limit
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Christine Burke
Lab Manager

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Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
Chromium (VI)	2	Holly Lane	ST	22-Feb-22	D-CRVI-01 (o)	MOE E3056
Mercury	2	Holly Lane	PBK	22-Feb-22	D-HG-02 (o)	SM 3112 B
Metals - ICP-OES	2	Holly Lane	AHM	18-Feb-22	D-ICP-01 (o)	SM 3120
Metals - ICP-MS	2	Holly Lane	TPR	18-Feb-22	D-ICPMS-01 (o)	EPA 200.8

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

Christine Burke
Lab Manager

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2200334
WATERWORKS NO.

	Client I.D.		MW202	MW202 - F			PWQO	
	Sample I.D.		B22-04523-1	B22-04523-2			Interim PWQO	PWQO
	Date Collected		15-Feb-22	15-Feb-22				
Parameter	**Units**	**R.L.**						
Aluminum	µg/L	10	**610**	70			75	
Antimony	µg/L	0.1	0.3	0.4			20	
Arsenic	µg/L	0.1	0.2	0.2			5	5
Barium	µg/L	1	124	116				
Beryllium	µg/L	2	< 2	< 2				11
Boron	µg/L	5	59	62			200	
Bismuth	µg/L	20	< 20	< 20				
Cadmium	µg/L	0.015	< 0.015	< 0.015			0.1	0.2
Chromium	µg/L	1	1	< 1				
Chromium (VI)	µg/L	1	< 1	< 1 [1]				1
Cobalt	µg/L	0.1	0.7	0.5			0.9	
Copper	µg/L	0.1	2.2	1.7			5	
Iron	µg/L	5	**989**	102				300
Lead	µg/L	0.02	0.34	0.05			1	5
Manganese (Total)	µg/L	1	73	56				
Mercury	µg/L	0.02	0.03	< 0.02				0.2
Molybdenum	µg/L	10	< 10	< 10			40	
Nickel	µg/L	0.2	3.5	4.0				25
Selenium	µg/L	1	< 1	< 1				100
Silver	µg/L	0.1	< 0.1	< 0.1				0.1
Strontium	µg/L	1	266	277				
Thallium	µg/L	0.05	< 0.05	< 0.05			0.3	0.3
Tin	µg/L	50	< 50	< 50				
Titanium	µg/L	5	50	< 5				

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

Christine Burke
Lab Manager

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2200334
WATERWORKS NO.

	Client I.D.		MW202	MW202 - F			PWQO	
	Sample I.D.		B22-04523-1	B22-04523-2			Interim PWQO	PWQO
	Date Collected		15-Feb-22	15-Feb-22				
Parameter	**Units**	**R.L.**						
Tungsten	µg/L	10	< 10	< 10			30	
Uranium	µg/L	0.05	0.93	0.85			5	
Vanadium	µg/L	5	< 5	< 5			6	
Zinc	µg/L	5	7	< 5			20	30
Zirconium	µg/L	3	< 3	< 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

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2200334
WATERWORKS NO.

Summary of Exceedances

Interim PWQO

MW202	Found Value	Limit
Aluminum (µg/L)	610	75

Provincial Water Quality Objectives

MW202	Found Value	Limit
Iron (µg/L)	989	300

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

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:

P.O. NUMBER: 2200334
WATERWORKS NO.

Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
PHC(F2-F4)	1	Kingston	KPR	17-Feb-22	C-PHC-W-001 (k)	MOE E3421
VOC's	1	Richmond Hill	JE	17-Feb-22	C-VOC-02 (rh)	EPA 8260
PHC(F1)	1	Richmond Hill	JE	17-Feb-22	C-VPHW-01 (rh)	MOE E3421

O. Reg. 153 - Soil, Ground Water and Sediment Standards
Tbl. 1 - GW (µg/L) - Table 1 - Ground Water

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2200334
WATERWORKS NO.

	Client I.D. / Sample I.D. / Date Collected		MW202 B22-04523-1 15-Feb-22				O. Reg. 153 Tbl. 1 - GW (µg/L)	
Parameter	**Units**	**R.L.**						
Acetone	µg/L	30	< 30				2700	
Benzene	µg/L	0.5	< 0.5				0.5	
Bromodichloromethane	µg/L	2	< 2				2	
Bromoform	µg/L	5	< 5				5	
Bromomethane	µg/L	0.5	< 0.5				0.89	
Carbon Tetrachloride	µg/L	0.2	< 0.2				0.2	
Monochlorobenzene (Chlorobenzene)	µg/L	0.5	< 0.5				0.5	
Chloroform	µg/L	1	< 1				2	
Dibromochloromethane	µg/L	2	< 2				2	
Dichlorobenzene,1,2-	µg/L	0.5	< 0.5				0.5	
Dichlorobenzene,1,3-	µg/L	0.5	< 0.5				0.5	
Dichlorobenzene,1,4-	µg/L	0.5	< 0.5				0.5	
Dichlorodifluoromethane	µg/L	2	< 2				590	
Dichloroethane,1,1-	µg/L	0.5	< 0.5				0.5	
Dichloroethane,1,2-	µg/L	0.5	< 0.5				0.5	
Dichloroethylene,1,1-	µg/L	0.5	< 0.5				0.5	
Dichloroethene, cis-1,2-	µg/L	0.5	< 0.5				1.6	
Dichloroethene, trans-1,2-	µg/L	0.5	< 0.5				1.6	
Dichloropropane,1,2-	µg/L	0.5	< 0.5				0.5	
Dichloropropene, cis-1,3-	µg/L	0.5	< 0.5					
Dichloropropene, trans-1,3-	µg/L	0.5	< 0.5					

O. Reg. 153 - Soil, Ground Water and Sediment Standards
Tbl. 1 - GW (µg/L) - Table 1 - Ground Water

Christine Burke
Lab Manager

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2200334
WATERWORKS NO.

	Client I.D.	MW202				O. Reg. 153	
	Sample I.D.	B22-04523-1				Tbl. 1 - GW (µg/L)	
	Date Collected	15-Feb-22					
Parameter	**Units**	**R.L.**					
Dichloropropene 1,3-cis+trans	µg/L	0.5	< 0.5			0.5	
Ethylbenzene	µg/L	0.5	< 0.5			0.5	
Dibromoethane,1,2-(Ethylene Dibromide)	µg/L	0.2	< 0.2			0.2	
Hexane	µg/L	5	< 5			5	
Methyl Ethyl Ketone	µg/L	20	< 20			400	
Methyl Isobutyl Ketone	µg/L	20	< 20			640	
Methyl-t-butyl Ether	µg/L	2	< 2			15	
Dichloromethane (Methylene Chloride)	µg/L	5	< 5			5	
Styrene	µg/L	0.5	< 0.5			0.5	
Tetrachloroethane,1,1,1,2-	µg/L	0.5	< 0.5			1.1	
Tetrachloroethane,1,1,2,2-	µg/L	0.5	< 0.5			0.5	
Tetrachloroethylene	µg/L	0.5	< 0.5			0.5	
Toluene	µg/L	0.5	< 0.5			0.8	
Trichloroethane,1,1,1-	µg/L	0.5	< 0.5			0.5	
Trichloroethane,1,1,2-	µg/L	0.5	< 0.5			0.5	
Trichloroethylene	µg/L	0.5	< 0.5			0.5	
Trichlorofluoromethane	µg/L	5	< 5			150	
Vinyl Chloride	µg/L	0.2	< 0.2			0.5	
Xylene, m,p-	µg/L	1.0	< 1.0				
Xylene, o-	µg/L	0.5	< 0.5				

O. Reg. 153 - Soil, Ground Water and Sediment Standards
Tbl. 1 - GW (µg/L) - Table 1 - Ground Water

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Parameter	**Units**	**R.L.**						
Xylene, m,p,o-	µg/L	1.1	< 1.1				72	
PHC F1 (C6-C10)	µg/L	25	< 25				420	
PHC F2 (>C10-C16)	µg/L	50	< 50				150	
PHC F3 (>C16-C34)	µg/L	400	< 400				500	
PHC F4 (>C34-C50)	µg/L	400	< 400				500	

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Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
SVOC	1	Kingston	sge	22-Feb-22	C-NAB-W-001 (k)	EPA 8270

O. Reg. 153 - Soil, Ground Water and Sediment Standards
Tbl. 1 - GW (µg/L) - Table 1 - Ground Water

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	Client I.D. / Sample I.D. / Date Collected		MW202 B22-04523-1 15-Feb-22				O. Reg. 153 Tbl. 1 - GW (µg/L)	
Parameter	**Units**	**R.L.**						
Acenaphthene	µg/L	0.05	< 0.05				4.1	
Acenaphthylene	µg/L	0.05	< 0.05				1	
Anthracene	µg/L	0.05	< 0.05				0.1	
Benzo(a)anthracene	µg/L	0.05	< 0.05				0.2	
Benzo(a)pyrene	µg/L	0.01	< 0.01				0.01	
Benzo(b+k)fluoranthene	µg/L	0.1	< 0.1					
Benzo(g,h,i)perylene	µg/L	0.05	< 0.05				0.2	
Dibenzo(a,h)anthracene	µg/L	0.05	< 0.05				0.2	
Chrysene	µg/L	0.05	< 0.05				0.1	
Fluoranthene	µg/L	0.05	< 0.05				0.4	
Fluorene	µg/L	0.05	< 0.05				120	
Indeno(1,2,3,-cd)pyrene	µg/L	0.05	< 0.05				0.2	
Methylnaphthalene,1-	µg/L	0.05	< 0.05				2	
Methylnaphthalene,2-	µg/L	0.05	< 0.05				2	
Naphthalene	µg/L	0.05	< 0.05				7	
Phenanthrene	µg/L	0.05	< 0.05				0.1	
Pyrene	µg/L	0.05	< 0.05				0.2	

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GENERAL SAMPLE SUBMISSION FORM

CADUCEON ENVIRONMENTAL LABORATORIES
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SAMPLES SUBMITTED TO: Kingston ☐ Ottawa ☐ Richmond Hill ☐ Barrie ☑ London ☐ Windsor ☐

TESTING REQUIREMENTS

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

REPORT NUMBER (Lab Use): B22-04523

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	Address: 647 Welham Rd, Barrie, ON L4N 9A1	Invoicing Address (if different):
Contact: Alicia Kimberley		
Tel: 705 795 Fax: 9351		
Email: Akimberley@geiconsultants.com	Quote #:	Project Name/#: [redacted] ZZ00334
Additional Info (email, cell, etc): Spatrick@geiconsultants.com	P.O. #:	Additional Info:

ANALYSES REQUESTED

Barrie Storm Sewer	Metals (PWQO)	PHC (153/04)	VOC (153/04)	PAH (153/04)	Metals/TSS filtered	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	Barrie Storm Sewer	Metals (PWQO)	PHC (153/04)	VOC (153/04)	PAH (153/04)	Metals/TSS filtered	X	Field pH	Field Temp.	# Bottles/ Sample	Field Filtered Y/N
1	MW 202		GW	15-Feb-22		X	X	X	X	X					14	N
2	MW202-F		GW	↓							X				4	Y

#1
1L Lead (HNO_3) + 3 1L Ambers (2 O.G., 1 unpreserved) + Gen chem + nutrients + ~~#1~~ JE #1 phenols (Split in lab) JE
→ S^2 + ~~Chromium~~ + CN → K
#1+2 Gen chem + #1+2 mercury + metals + chromium + (filtered metals + chromium) → O
→ (1 filtered)
Vials → RH

SAMPLE SUBMISSION INFORMATION

	Sampled by:	Submitted by:
Print:	SCOTT PATRICK	SCOTT PATRICK
Sign:		
Date (yy-mm-dd)/Time:	~~22~~ 15-Feb-22	15-Feb-22

SHIPPING INFORMATION

Courier (Client account)	☐	Invoice
Courier (Caduceon account)	☐	
Drop Off AH	☒	# of Pieces
Caduceon (Pick-up)	☐	

REPORTING / INVOICING

Report by Fax	☐
Report by Email	☒
Invoice by Email	☒
Invoice by Mail	☐

SAMPLE RECEIVING INFORMATION (LABORATORY USE ONLY)

Received By (print):	Ellie	Signature:	ES
Date Received (yy-mm-dd):	22-02-16	Time Received:	8:00
Laboratory Prepared Bottles:	☑ Yes ☐ No		
Sample Temperature °C:	7.4	Labeled by:	JE

Comments: Some bottles are silty.

Page 1 of 1

G 104295

Appendix F

Construction Dewatering Estimates

GEI Consultants

Construction Dewatering Rate Estimate

447-455 Yonge Street, Barrie, Ontario - Site Servicing

Temporary Construction Dewatering Rate Estimates

Description	Symbol	Values	Unit	Explanation
Input Data				
Lowest Ground Elevation		252.1	m bgs	Borehole 205
Highest Groundwater Elevation		252.0	m	BH/MW202 groundwater elevation taken on February 14, 2023
Lowest Proposed Excavation		249.4	m bgs	Lowest invert elevation on site servicing plan (manhole connection)
Aquifer Bottom		247.4	m bgs	Assume 2.0 m below excavation
Hydraulic Conductivity	K	6.0E-06	m/s	Geometric mean K
Length of Excavation	x	65.0	m	Longest segment noted on site servicing plan
Width of Excavation	a	3.0	m	Based on site servicing plan
Output				
Top of Aquifer		252.0	m asl	Average measured groundwater level
Target Water Level		248.4	m asl	Assume 1.0 m below lowest proposed excavation
Water Level above aquifer bottom before dewatering	H	4.7	m	
target water level above above aquifer bottom	h	1.0	m	
Radius of Influence	L (R_0)	26.8	m	Sichardt Equation
Precipitation		1,950.0	L/day	10 mm rain event
Construction Dewatering Flow Rate - Steady State	Q	54.2	m^3/day	Construction Dewatering Flow - Dupuit Equation
Maximum Construction Flow Rate (safety factor of 2)	2Q	108.4	m^3/day	

Construction Dewatering Flow Rate - Steady State	Q	**54,200**	L/day
Maximum Construction Flow Rate (safety factor of 2)	2Q	**108,400**	L/day
Maximum Construction Flow Rate (safety factor of 2) with 10 mm rainfall event	2Q	**110,350**	L/day

GEI Consultants

Construction Dewatering Rate Estimate

447-455 Yonge Street, Barrie, Ontario - Underground Parking 1 Level

Temporary Construction Dewatering Rate Estimates

Description	Symbol	Values	Unit	Explanation
Input Data				
Lowest Ground Elevation		252.1	m bgs	Borehole 205
Highest Groundwater Elevation		252.0	m	BH/MW202 groundwater elevation taken on February 14, 2023
Lowest Proposed Excavation		248.1	m bgs	Assume 4.0 m trench 1 levels of underground parking
Aquifer Bottom		246.1	m bgs	Assume 2.0 m below excavation
Hydraulic Conductivity	K	6.0E-06	m/s	Geometric mean K
Length of Excavation	x	130.0	m	Based on site plan
Width of Excavation	a	20.0	m	Based on site plan
Output				
Top of Aquifer		252.0	m asl	Average measured groundwater level
Target Water Level		247.1	m asl	Assume 1.0 m below lowest proposed excavation
Water Level above aquifer bottom before dewatering	H	5.9	m	
target water level above above aquifer bottom	h	1.0	m	
Radius of Influence	L (R_0)	36.0	m	Sichardt Equation
Precipitation		26,000.0	L/day	10 mm rain event
Construction Dewatering Flow Rate - Steady State	Q	146.0	m^3/day	Construction Dewatering Flow - Dupuit Equation
Maximum Construction Flow Rate (safety factor of 2)	2Q	292.1	m^3/day	

Construction Dewatering Flow Rate - Steady State	Q	**146,000**	L/day
Maximum Construction Flow Rate (safety factor of 2)	2Q	**292,000**	L/day
Maximum Construction Flow Rate (safety factor of 2) with 10 mm rainfall event	2Q	**318,000**	L/day

Appendix G

Water 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.

Location	Radius Of Influence (ROI) (m)	Construction Dewatering Flow Rate Without Safety Factor (L/day)	Construction Dewatering Flow Rate Including Safety Factor of 2 (L/day)	Construction Dewatering Flow Rate Including Safety Factor of 2 (L/day) Including a 10 mm Rain Event
Site servicing	26.8	54,200	108,400	110,350
One Level of Basement	36.0	141,200	282,400	331,900

Potential Settlement and Monitoring

Settlement Estimate

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

For the assumed maximum groundwater drawdowns of 2.1 to 2.2 m in the vicinity of the proposed building and/or serving, settlement of the soil within the radius of influence must be calculated based on the increase in effective stress (10 kPa per metre of drawdown) from reducing the pore water pressures. 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.

The drawdown will occur within the generally dense to very dense glacial till. The maximum estimated settlement to occur adjacent to the dewatering system is approximately 2 mm or less, and negligible impacts are anticipated to the roadways or residential properties near the site.

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.

Potential Impact on Other Water Users

Since the proposed development consist of shallow works and the site is located within an area that is municipally serviced it is not anticipated that the temporary dewatering activities will 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 Barrie Creeks watershed, it is not anticipated that the proposed construction dewatering activity will negatively impact the groundwater flow to Lovers Creek.

Water Quantity, Quality and Ground Water Level Monitoring Program

If the dewatering discharge water is treated by filtration (a silt bag at a minimum) to remove sediment and fines, the water quality is expected to improve to meet the Barrie Storm Sewer Use By-Law Criteria.

Discharge Options

Based on the groundwater quality analysis to date dewatering discharge will be directed to surface and/or existing municipal storm sewers along Yonge Street provided groundwater quality during dewatering activities continues to comply the Barrie Storm Sewer Use By-Law Criteria and/or Provincial Water Quality Objectives (PWQO) for select paraments.

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 storm sewer system is outlined on Table G-1.

Ground Water Level Monitoring Program

The ground water level monitoring program is outlined on Table G-1.

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

Kimberly Gilder, P.Geo.

Ms. Kimberly Gilder is a senior hydrogeologist with twenty years of experience specializing in hydrogeological investigations and dewatering assessments and permitting.

Her background includes hydrogeological investigations, construction dewatering assessments, Permit To Take Water and EASR applications and renewals, Class EA investigations, groundwater under influence of surface water investigations, Source Water Protection studies, groundwater supply explorations, large-scale groundwater monitoring programs, and water balances.

Alexander Winkelmann, P.Eng.

Mr. Alexander Winkelmann, P.Eng., is a senior geotechnical engineer with 15 years of interdisciplinary professional experience Mr. White specializes in geotechnical engineering, with experience in geoenvironmental project, hydrogeological projects and support for materials inspection and testing.

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 May 30, 2024.

TABLE G-1

WATER QUALITY MONITORING PLAN FOR DEWATERING DISCHARGE TO A STORM SEWER OR SURFACE[1,2]

Period	Monitoring Location	Parameters[3]	Monitoring Frequency	Trigger For Mitigation	Mitigation Measures / Comments
Trial Dewatering	Dewatering discharge	○ Barrie Storm Sewer ○ PWQO Metals ○ O.Reg. 153/04, as amended, PHCs, VOCs, and PAHs	Once during trial dewatering	Exceeds the Barrie Storm and/or PWQO	Modify treatment method and/or shut down.
	On-Site Monitoring Wells	○ Groundwater Levels		NA	Establish baseline conditions
During Construction	Dewatering discharge	○ Barrie Storm Sewer ○ PWQO MetalsO.Reg. 153/04, as amended, PHCs, VOCs, and PAHs	Weekly then every four weeks after 3 consecutive weekly compliant samples[3]	Exceeds the Barrie Storm and/or PWQO	Change treatment method and/or shut down.
		○ Turbidity	Daily until stable (minimum 5 samples) then weekly[3]	Exceeds 15 NTU.	
	Discharge point	○ Impact Assessment	At each sampling event	Sedimentation, erosion	Reduce pumping and/or improve sediment/erosion control measures
		○ Settlement/Subsidence of nearby land	Daily	Visual indication of settlement/subsidence	Reduce pumping and consult both dewatering contractor and geotechnical engineer
	On-Site Monitoring Wells	○ Groundwater Levels	Every two weeks	Groundwater level more than 3 m or less than 1 m below excavation level	Reduce pumping and consult dewatering contractor.
Post Construction	On-Site Monitoring Wells	○ Groundwater Levels	Every two weeks for four weeks, then every four weeks until 90% recovery	Water level recovery less than 90% of baseline level	Continue monitoring

Notes:
(1) It is recommended that discharge be treated by a sediment control facility such as a decantation tank or 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.

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	Radius Of Influence (ROI) (m)	Construction Dewatering Flow Rate Without Safety Factor (L/day)	Construction Dewatering Flow Rate Including Safety Factor of 2 (L/day)	Construction Dewatering Flow Rate Including Safety Factor of 2 (L/day) Including a 10 mm Rain Event
Site servicing	26.8	54,200	108,400	110,350
One Level of Basement	36.0	141,200	282,400	331,900

Proposed Discharge Method and Location

It is understood that the preferred discharge location would be to the ground surface and/or existing storm sewers. Dewatering discharge will be directed to the ground surface and/or existing storm sewers by hose or pipe from the dewatering system to any pre-treatment systems (i.e. silt bag and/or 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 and/or existing storm sewers 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

Kimberly Gilder, P.Geo.

Ms. Kimberly Gilder is a senior hydrogeologist with twenty years of experience specializing in hydrogeological investigations and dewatering assessments and permitting.

Her background includes hydrogeological investigations, construction dewatering assessments, Permit To Take Water and EASR applications and renewals, Class EA investigations, groundwater under influence of surface water investigations, Source Water Protection studies, groundwater supply explorations, large-scale groundwater monitoring programs, and water balances.

Alexander Winkelmann, P.Eng.

Mr. Alexander Winkelmann, P.Eng., is a senior geotechnical engineer with 15 years of interdisciplinary professional experience Mr. White specializes in geotechnical engineering, with experience in geoenvironmental project, hydrogeological projects and support for materials inspection and testing.

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 May 30, 2024.

Appendix I

Groundwater Levels and Elevations

Hydrogeological Investigation
447-455 Yonge Street, Barrie, Ontario
Project No. 2200334, May 2024

Table of Groundwater Levels and Elevations

Date: 2022-02-18

BH/MW	Elevation @ TOP	Elevation @ GS	Water Level	GW Elevation
BH/MW202	255.08	255.17	2.713	252.46
BH/MW203	254.23	253.36	1.827	251.54
BH/MW204	255.30	254.42	2.320	252.10

Date: 2022-04-28

BH/MW	Elevation @ TOP	Elevation @ GS	Water Level	GW Elevation
BH/MW202	255.08	255.17	2.430	252.65
BH/MW203	254.23	253.36	1.597	251.77
BH/MW204	255.30	254.42	2.046	252.37

Date: 2022-05-06

BH/MW	Elevation @ TOP	Elevation @ GS	Water Level	GW Elevation
BH/MW202	255.08	255.17	2.480	252.60
BH/MW203	254.23	253.36	1.647	251.72
BH/MW204	255.30	254.42	2.106	252.31

Date: 2022-06-06

BH/MW	Elevation @ TOP	Elevation @ GS	Water Level	GW Elevation
BH/MW202	255.08	255.17	2.880	252.20
BH/MW203	254.23	253.36	2.067	251.30
BH/MW204	255.30	254.42	2.526	251.89

Date: 2022-07-04

BH/MW	Elevation @ TOP	Elevation @ GS	Water Level	GW Elevation
BH/MW202	255.08	255.17	2.960	252.12
BH/MW203	254.23	253.36	2.187	251.18
BH/MW204	255.30	254.42	2.636	251.78

Date: 2022-08-03

BH/MW	Elevation @ TOP	Elevation @ GS	Water Level	GW Elevation
BH/MW202	255.08	255.17	3.230	251.85
BH/MW203	254.23	253.36	2.427	250.94
BH/MW204	255.30	254.42	2.886	251.53

Date: 2022-09-14

BH/MW	Elevation @ TOP	Elevation @ GS	Water Level	GW Elevation
BH/MW202	255.08	255.17	3.240	251.84
BH/MW203	254.23	253.36	2.597	250.77
BH/MW204	255.30	254.42	3.076	251.34

Date: 2022-10-18

BH/MW	Elevation @ TOP	Elevation @ GS	Water Level	GW Elevation
BH/MW202	255.08	255.17	3.190	251.89
BH/MW203	254.23	253.36	2.437	250.93
BH/MW204	255.30	254.42	2.916	251.50

Date: 2022-11-17

BH/MW	Elevation @ TOP	Elevation @ GS	Water Level	GW Elevation
BH/MW202	255.08	255.17	3.180	251.90
BH/MW203	254.23	253.36	2.337	251.03
BH/MW204	255.30	254.42	2.876	251.54

Hydrogeological Investigation
447-455 Yonge Street, Barrie, Ontario
Project No. 2200334, May 2024

Table of Groundwater Levels and Elevations

Date: 2022-12-16

BH/MW	Elevation @ TOP	Elevation @ GS	Water Level	GW Elevation
BH/MW202	255.08	255.17	2.930	252.15
BH/MW203	254.23	253.36	2.017	251.35
BH/MW204	255.30	254.42	2.536	251.88

Date: 2023-01-11

BH/MW	Elevation @ TOP	Elevation @ GS	Water Level	GW Elevation
BH/MW202	255.08	255.17	2.230	252.85
BH/MW203	254.23	253.36	1.557	251.81
BH/MW204	255.30	254.42	2.006	252.41

Date: 2023-02-14

BH/MW	Elevation @ TOP	Elevation @ GS	Water Level	GW Elevation
BH/MW202	255.08	255.17	2.110	252.97
BH/MW203	254.23	253.36	1.457	251.91
BH/MW204	255.30	254.42	1.916	252.50

Date: 2023-03-13

BH/MW	Elevation @ TOP	Elevation @ GS	Water Level	GW Elevation
BH/MW202	255.08	255.17	2.510	252.57
BH/MW203	254.23	253.36	1.687	251.68
BH/MW204	255.30	254.42	2.126	252.29

Appendix J

Preliminary Water Balance

File No. 2200334

Water Balance - 447-455 Yonge Street, Barrie, Ontario

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 (^{o}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 Daily 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^{o})	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	94.0	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)	41.3	30.9	29.1	16.9	3.7	0.0	0.0	0.0	0.0	0.0	30.2	36.8	188.8
	Potential Surface Water Runoff (mm)	41.3	30.9	29.1	16.9	3.7	0.0	0.0	0.0	0.0	0.0	30.2	36.8	188.8
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	5560.0	75%	4170.0	787.3	787.3	94%
	Impervious Area (house, walkway and driveway, sheds)		25%	1390.0	1102.2	0.0	**Infiltration Decrease Pre to Post**
	TOTAL	-	100%	5560.0	1889.5	787.3	-71%
Proposed Land Use (Post-Development)	Pervious Area	5560.0	22%	1223.2	230.9	230.9	**Infiltration Required to Meet Pre-Development Conditions (m^3)**
	Impervious Area (Residential apartment, roadways, townhomes, walways)		78%	4336.8	3438.9	0.0	
	TOTAL	-	100%	5560.0	3669.9	230.9	556

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 (75mm)
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

		1780.4	556.3
Infiltration Criteria	**Site Description**	**Infiltration Factor**	
Topography	Rolling Land - Average Slope 2.8 to 3.8 m/km	0.2	
Soils	Medium Combinations of Clay and Loam	0.2	
Cover	Cultivated Land	0.1	
	Sum of Infiltration Factors	**0.5**	