Consulting
Engineers and
Scientists

Hydrogeological Investigation

Proposed Residential Development

157 Ardagh Road, Barrie, Ontario

Submitted to:
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1. Introduction

GEI Consultants (GEI) was retained by DataTamer Inc. to complete a hydrogeological investigation and report for the proposed residential development consisting of two semi-detached residential dwellings to be constructed at 157 Ardagh Road, in Barrie, Ontario. A site location plan is enclosed as Figure 1.

The existing 0.1-hectare property is rectangular in shape is 25 metres wide (east to west) and 40 metres long (north to south). The property is bounded by Ardagh Road to the north, and existing single family residential properties to the east, west and south. The property currently contains a detached garage, driveway and manicured lawn areas. The topography within the study area slopes down from south to north with a maximum difference in elevation, as measured at the borehole locations, of about 2.2 metres. An aerial image of the site from 2018 is provided on Figure 2.

GEI was provided the following document for review in preparation of this report:

- *"Zoning By-Law Amendment, Pre-Consultation Review, Planning Comments"* File: D28-058-2021, dated July 13, 2021, by the City of Barrie.

It is understood by email correspondence with the Innovative Planning Solutions, the Clients authorized representative, that the development will consist of two semi-detached residential dwellings. It is expected that the dwellings will be municipally serviced and that there is a possibility that the dwellings will have up to one basement level. Proposed site grades were not provided to GEI but there are not expected to be any significant grade changes to accommodate the development.

Based on the comments in a letter from Gary Matthie, Senior Development Services Technologist at the City of Barrie from July 9, 2021 as part of the pre-consultation application package, the following is required:

"*The Owner will be required to provide a geotechnical/hydrogeological investigation letter/report in support of this development. The report must address groundwater levels and any impact those levels may have on the proposed building foundation and recommendations for pavement structures (i.e., light, medium and heavy duty). The report will further confirm that the proposed development will not impact any wells within a 300 m radius of the subject property.*"

GEI completed a geotechnical investigation and report 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 for general metals, inorganics and nutrients, Petroleum Hydrocarbons (PHCs), Volatile Organic Compounds (VOCs), Polycyclic Aromatic Hydrocarbons (PAHs) with respect to the applicable Provincial Water Quality Objective (PWQO) 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 the 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) Utilization of the three (3) boreholes and three (3) monitoring wells completed as part of the concurrent Geotechnical Investigation;

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

e) Submit one (1) representative unfiltered groundwater sample for laboratory testing to compare against the PWQO for metals, inorganics, and nutrients, 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.

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) 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:

- <u>Construction Dewatering less than 50,000 L/day:</u> 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.
- <u>Construction Dewatering greater than 50,000 L/day and less than 400,000 L/day:</u> 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.
- <u>Construction Dewatering greater than 400,000 L/day:</u> 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 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 <u>is</u> located within a WHPA Zone C (Figure 3).
- Intake Protection Zone (IPZ): The site <u>is not</u> 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.

2. Site Setting

2.1 Physiography, Surficial and Bedrock Geology

The site is located within the physiographic region denoted as the Peterborough Drumlin Field (Chapman and Putnam, 1984). Physiographic landform mapping shows the site lies within the drumlinized till plains.

Quaternary geology mapping of the site by the Ontario Geological Survey indicate that the site is within an area mapped as glaciofluvial deposits comprising sand and gravel till. These findings are consistent with the subsurface soil conditions encountered in the boreholes advanced on site, as discussed in Section 4.1.

The bedrock in the general area consists of Lindsay limestone, and is part of the Simcoe Group. Bedrock is anticipated at depths greater than 120 m based on available drift thickness mapping for the Barrie Area (Ontario Division of Mines, Drift Thickness Series, Barrie Area Map P980).

2.2 Topography and Drainage

The existing site slopes gently from the south down to the north from a local elevation of approximately 103.6 metres at the southern site limit to local elevation of approximately 101.4 metres at the northern site limit (about 2.2 metres of topographic relief across the site). It is anticipated that the site will general drain northward towards existing catch-basins along Ardagh Road. Ultimately regional groundwater flow is anticipated to flow northeast towards Lake Simcoe.

No water bodies are located on the site. The closest surface water is Hotchkiss Creek, located approximately 200 m north of the site. The site is in the Barrie Creeks subwatershed, 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. Twenty (20) 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:

- Sixteen (16) of the records indicate domestic use.
- Two (2) of the records indicate monitoring use.

- Two (2) 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 sand with variable clay and gravel deposits were encountered. The noted domestic water supply wells were typically installed in a sand unit at depths of approximately 11.5 to 38.0 m below existing grade.

It is noted that City of Barrie municipal water supply well (W19) is located 1.7 km north of the site. The municipal water supply is one of several ground water wells utilized by the City of Barrie. The water supply well is screened at a depth of 83 to 92 m in a gravel unit. The pumping well was tested at a rate of 500 GPM for a duration of 48 hours and a total of 4.5 m of drawdown was noted at the end of the pumping test.

2.4 Visual Inspection of Site

A visual site inspection was carried out on September 9, 2021 by senior GEI staff to assess site drainage, topography and presence of surface water features.

The site is approximately 0.1 hectares in size and is bounded by Ardagh Road and residential lands to the south, east and west. The property currently contains a detached garage, driveway and manicured lawn areas.

The topography within the study area slopes down from south to north towards Ardagh Road.

3. Procedures and Methodology

GEI previously carried out a subsurface investigation as part of a geotechnical engineering investigation. Prior to the commencement of drilling activities, the locations of 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 September 9 and 13, 2021. A total of three boreholes (Boreholes 1 to 3) were advanced on site by a drilling subcontractor retained by GEI. The boreholes were advanced using a track-mounted drill, hollow stem augers and standard soil sampling equipment. All samples were collected as per ASTM D1586 to assess the strength characteristics of the substrate.

The boreholes were advanced to depths of 8.1 to 8.2 metres below existing grade (local Elev. 95.5 to 93.2 metres). The horizontal locations were laid out in the field by GEI prior to the drilling operations. Ground surface elevations of the boreholes were measured using survey equipment in relation to a temporary benchmark (top of catch basin, located in westbound lane of Ardagh Road adjacent to the subject property), with an assumed local elevation of 100.00 metres. GPS coordinates were measured with a handheld GPS unit and were referenced to the NAD 83 geodetic datum.

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 construction, and processed the recovered samples. Soil sampling was conducted at regular intervals for the full depth of the borehole. 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 and geotechnical laboratory testing for grain size was carried out with the results provided in Appendix C.

Three (3) monitoring wells were installed (one per borehole) by GEI on site to facilitate long-term groundwater monitoring. Monitoring well construction is shown on the borehole logs in Appendix B.

3.1 Borehole Permeability Testing

Rising head tests were completed in BH/MW 3 on November 5, 2021. 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 logger was left in the monitoring well 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 test is provided in Appendix D.

3.2 Ground Water Sampling

To establish baseline conditions and assess the suitability for discharge of pumped groundwater during potential dewatering activities, the following groundwater samples were collected from BH/MW3 on November 8, 2021 and tested relative to the applicable PWQO and/or O.Reg.153/04, as amended, Table 1 SCSs:

- One (1) unfiltered sample was collected from BH/MW3 and analyzed against PWQO for metals, and O.Reg.153/04, as amended, Table 1 SCSs for inorganics and nutrients, PHCs, VOCs and PAHs.
- One (1) filtered sample was collected from BH/MW3 and analyzed against PWQO for metals only.

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

The borehole locations are shown on Figure 2 and detailed subsurface conditions are presented on the borehole logs in Appendix B. Geotechnical laboratory test results are included as Appendix C. It should be noted that the conditions indicated on the borehole logs are for specific locations only and can vary between and beyond the borehole 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.

4.1 Stratigraphy

The soil conditions encountered at the borehole locations are summarized below. A stratigraphic cross-section across the property as aligned on Figure 2, is included as Figure 8.

4.1.1 Topsoil and Earth Fill

All the boreholes encountered a nominal surficial topsoil layer ranging in thickness between 50 to 100 mm.

Earth fill was encountered underlying the topsoil layer in all three boreholes. The earth fill extended to depths of 2.3 to 2.6 metres below grade (local Elev. 101.3 to 98.8 metres). The earth fill ranged from sand & gravel, to sand, to silty sand with variable amounts of gravel. Trace organics were also encountered within the earth fill in some boreholes. The Standard Penetration Test (SPT) results (“N” Values) measured in the earth fill ranged from 2 to 20 blows per 300 mm of penetration, indicating a very loose to compact relative density, with an average value of 7 (loose).

4.1.2 Native Soils

Underneath the surficial topsoil layer, all three boreholes encountered a glacial till deposit comprising silty sand to silt & sand with trace gravel and trace to some clay. In general, the upper 0.5 to 1.5 metres of the glacial till contained some clay and was cohesive, and the lower zone of the glacial till contained trace clay and was cohesionless. The glacial till was encountered at depths of 2.3 to 2.6 metres below grade (local Elev. 101.3 to 98.8 metres) and extended to depths of 3.1 to 7.6 metres below grade (local Elev. 100.5 to 93.8 metres). The glacial till deposit was generally moist and brown, turning grey with depth. The measured SPT "N" Values ranged from 7 to 15 blows per 300 mm of penetration in the upper cohesive zone of the deposit, indicating a firm to very stiff consistency. Pocket penetrometer testing was used to approximate the undrained shear strength in this zone, and the measured values ranged from approximately 50 to 90 kPa. The SPT "N" Values measured in the lower cohesionless zone of the glacial till range from 32 to 36 blows per 300 mm of penetration, indicating a dense relative density. Although cobbles and boulders were not specifically encountered in the boreholes, their presence in the deposit should be anticipated. Two grain size distribution curves of this deposit are included in Appendix C.

Underlying the glacial till deposit in all boreholes, a deposit consisting of sand with trace to some gravel and trace silt was encountered. The sand deposit was encountered at depths of 3.1 to 7.6 metres below grade (local Elev. 100.5 to 93.8 metres) and extended beyond the vertical depth of investigation at depths of 8.1 to 8.2 metres below grade (local Elev. 95.5 to 93.2 metres). The sand was generally grey and wet, and the measured SPT "N" Values ranged from 21 to 40 blows per 300 mm of penetration, indicating a compact to dense relative density. One grain size distribution curve of this deposit is included in Appendix C.

4.2 Groundwater

4.2.1 Groundwater Levels

Unstabilized groundwater level measurements and cave measurements were taken upon completion of drilling of each borehole as shown on the borehole logs in Appendix B. These measurements provide a rough estimate of the possible excavation and temporary groundwater control constructability considerations that may arise. Unstabilized groundwater measurements taken ranged between 3.4 to 4.0 metres below existing grade. The boreholes remained open upon completion of drilling.

Monitoring wells were installed in all boreholes (Boreholes 1 to 3) to facilitate the measurements of stabilized groundwater levels. A 50 mm diameter PVC monitoring well with a 1.5-metre-long screen was installed in Borehole 1 and a 3.0-metre-long screen was installed in the remaining boreholes. Monitoring well construction and groundwater measurements are shown on the borehole logs in Appendix B, and the results are summarized in the table below.

Monitoring Well	Well Screen Location		Strata Screened	Depth / Local Elev. (m) of Groundwater Table
	Depth (m)	Local Elev. (m)		October 19, 2021
BH 1	5.9 to 7.4	95.4 to 93.9	Silty Sand to Silt & Sand Glacial Till; Possibly Sand	1.46 / 99.92
BH 2	4.6 to 7.6	97.9 to 94.9	Sand	2.56 / 99.92
BH 3	4.6 to 7.6	99.0 to 96.0	Sand	3.60 / 99.99

It is noted that the glacial till deposit increases in thickness from south to north across the site, and the depth to the underlying sand deposit also increases from south to north. The silty sand to silt & silt glacial till contains about 38 to 61% fines (based on the grain size analysis in Appendix C) and is considered to have a moderate to lower permeability, but will typically preclude the free flow of water. The deeper sand deposits encountered across the site or cohesionless earth fill are permeable and will allow for the free flow of water when wet.

The stabilized groundwater levels in the monitoring wells were measured to be at local Elev. 100.0 metres, which ranges from about 1.5 to 3.6 metres below grade. However, Monitoring Wells 2 and 3 were fully screened in the deeper sand deposit and Monitoring Well 1 likely extended partially into the deeper sand deposit (between sampling depths). It is expected that these water levels reflect the groundwater head within the permeable sand deposit, confined underneath the lower-permeability glacial till. This indicates that the deeper sands in Monitoring Wells 1 and 2 are pressurized with a groundwater head of approximately 2 to 6 metres above the top of the sand deposit.

Measured moisture contents and visual observations of the earth fill encountered in Borehole 1 (which extended to a depth of 2.6 metres below grade) indicate that the earth fill is moist, and groundwater was not encountered. This corroborates that the groundwater level measured to be 1.5 metres below grade at Borehole 1 reflects the head in the deep sands and does not represent the near-surface groundwater conditions. Excavations that penetrate through the glacial till deposit and into the deeper wet sands in the northern half of the site will encounter artesian groundwater conditions.

A perched groundwater condition was not encountered but may develop within the earth fill zone at the interface with the underlying glacial till during / after precipitation events or snowmelt. Groundwater levels are expected to show seasonal fluctuations and vary in response to prevailing climate conditions.

It is anticipated that the regional groundwater flow within the sand unit would be northeastward towards Lake Simcoe.

4.2.2 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 test is provided in Appendix D and are summarized in the table below.

Monitoring Well	Well Depth (m bgs)	Strata Screened	Hydraulic Conductivity (m/s)
BH/MW3	7.5	Sand	1.0×10^{-4}

In addition to in-situ testing, the hydraulic conductivity of selected soil samples was estimated using the grain size distribution determined by laboratory testing and an established empirical formula by Vukovic and Soro (1992). The grain size distribution curves are provided in Appendix C and the estimated K-values are summarized below:

Borehole	Sample	Depth (m)	Material Type	Estimated Hydraulic Conductivity (m/s)
1	7	6.1 to 6.6	Silty Sand Glacial Till	6.3×10^{-8}
2	4	2.6 to 3.1	Silt and Sand Glacial Till	1.4×10^{-9}
3	7	6.1 to 6.6	Sand	1.3×10^{-4}

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

- Silty Sand:	10^{-3} m/s to 10^{-7} m/s
- Sand:	10^{-2} m/s to 10^{-5} m/s

For design purposes, the hydraulic conductivity of the sand is 1.0×10^{-4} m/s and the silt and sand/silty sand glacial till is 6.0×10^{-8} m/s.

4.2.3 Baseline Groundwater Chemistry Testing

To establish baseline conditions and assess the suitability for discharge of pumped groundwater during potential dewatering activities, the following groundwater samples were collected from BH/MW3 on November 8, 2021 and tested relative to the applicable PWQO and/or O.Reg.153/04, as amended, Table 1 SCSs:

- One (1) unfiltered sample was collected from BH/MW3 and analyzed against PWQO for metals, and O.Reg.153/04, as amended, Table 1 SCSs for inorganics and nutrients, PHCs, VOCs and PAHs.
- One (1) filtered sample was collected from BH/MW3 and analyzed against PWQO for metals only.

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.

A summary of the results is presented in the table below for samples relative to the PWQO and/or O.Reg.153/04, as amended, Table 1 SCSs, the most stringent SCSs.

Sample Location	Parameters Tested	PWQO Exceedances	O.Reg.153/04, as amended, Exceedances
BH/MW3 (Unfiltered)	Metals, Inorganics, Nitrite/Nitrate, PHCs, VOCs and PAHs	Interim PWQO: Zinc, Lead, Copper, Cobalt PWQO: Iron	None
BH/MW3 (Filtered)	Metals	None	None

The unfiltered groundwater sample collected from BH/MW3 met PWQO and O.Reg.153/04, as amended, Table 1 SCSs with the exception of iron. Further zinc, lead, copper and cobalt were noted as exceedances with respect to the interim PWQO. The filtered groundwater samples collected from BH/MW 3 met the PWQO and interim PWQO for the parameters tested.

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 understood 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.

4.3 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 boreholes indicate silty sand/sand and silt glacial till soils were encountered near surface overlying sand soils. The Unified Soil Classification System classifications for the predominant soils encountered on-site are summarized below with the interpreted unfactored percolation rates (T-Time) and unfactored infiltration rates:

Unified Soil Classification System Classification	Unfactored Percolation Rate (T-Time) (mins/cm)	Unfactored Infiltration Rate (mm/hr)
S.M. Silty sands, sand-silt mixtures	8 to 20	30 to 75

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. If LID infiltration measures will be designed and constructed on site, GEI can further refine the infiltration rates by excavating test pits and conducting Guelph Permeameter tests in the exact footprints and elevations of the LID measures.

5. Discussion and Analysis

It is understood by email correspondence with IPS that the development will consist of two semi-detached residential dwellings. It is expected that the dwellings will be municipally serviced and that there is a possibility that the dwellings will have up to one basement level. Proposed site grades were not provided to GEI but there are not expected to be any significant grade changes to accommodate the development.

Preliminary utility plans and proposed residential building plans were not available to GEI, as such site servicing, and potential basement excavation depths have been assumed to extend to a depth of 3.0m below existing grade.

5.1 Temporary Construction Dewatering

The groundwater conditions at the site are discussed in Section 4.2. Although groundwater was measured in the monitoring wells at depths of 1.5 to 3.6 metres below grade (local Elev. 100.0 metres), this represents the groundwater head within the deeper confined sand deposit below the lower-permeability glacial till and does not reflect the near-surface groundwater conditions.

A perched groundwater condition was not encountered but may develop within the earth fill zone at the interface with the underlying glacial till during / after precipitation events or snowmelt. The upper 2.3- to 2.6-metre-thick zone of earth fill was moist (not wet) and unstabilized water was not encountered. Some minor perched water may also be present within the glacial till. Based on the drilling observations, moisture contents, and experience on previous construction sites along Ardagh Road within 250 metres of the site (which encountered similar subsurface conditions), it is expected that seepage entering excavations made into the earth fill and glacial till can be controlled using conventional sump pump systems.

On a preliminary basis, excavations are not expected to extend into the wet sand deposits underlying the silty sand/silt and sand glacial till. Any seepage from excavations within the upper fill and/or glacial till or runoff from precipitation events can be controlled using a conventional sump pump system.

If excavations are to extend into the lower wet sand deposits positive dewatering including well points and/or deep wells may be required. In particular, the lower sands in the northern half of the site are considered pressurized due to the confining glacial till deposit, and the sands will need to be dewatered and/or de-pressurized before excavations can feasibly extend beyond the upper glacial till. Dewatering and/or de-pressurization of the lower sand unit may also be required for excavations extending deeper than 1 metre into the glacial till in the northern half of the site to prevent basal heaving/blowout of the subgrade. The groundwater pressure head within the sands would need to be lowered to at least 0.5 metres below the bottom of a proposed excavation, or 0.5 metres below the bottom of the glacial till for excavations made deeper into the glacial till.

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.

Provided excavations for site servicing and potential basement excavation depths are limited to depths of 3.0 m below existing grade, it is not anticipated that dewatering volumes more than 50,000 L/day would take place as excavations would remain within the glacial till unit.

However, given the pressurized sand unit underlying the glacial till unit if excavation depths are to extend to depths greater than 3.0 m below existing grade a more detailed assessment of the dewatering and/or depressurization needs would be required.

5.2 Permanent Building Drainage

For new structures that will be slab on grade with no basement levels, perimeter and under-slab drainage at the foundation level is not required, provided that the underside of concrete slab is at least 200 mm above the prevailing grade of the site and the surrounding surfaces slope away from the building at a gradient of at least 2% to promote surface water run-off and to reduce groundwater infiltration adjacent to foundations. To minimize infiltration of surface water, the upper 150 mm of backfill could comprise relatively impervious compacted soil material.

Where basements are constructed, all basement foundation walls must be provided with damp-proofing provisions in conformance to the Ontario Building Code. Backfill along the foundation wall must consist of Granular ‘B’ Type 1 (OPSS 1010) for a minimum lateral distance of 600 mm out from the foundation wall. Alternatively, if a filtered cellular drainage media is provided adjacent to the foundation wall, the backfill may consist of common earth fill.

For buildings with basements, a perimeter drainage system must be installed that will remove any water that infiltrates into the building backfill, to ensure that any water does not infiltrate into the basement. The perimeter drains must consist of minimum 100 mm diameter perforated pipes wrapped in filter socks, sufficiently covered on all sides by 19 mm clear stone. Perimeter drains should be directed to the sump underneath the basement floor in solid pipes so as not to surcharge the underfloor drainage layer with water. All sump pumps should be on emergency power for redundancy in case of a power outage. A typical basement drainage detail is included in Appendix F.

If the dwelling will have a basement level, in conditions where there is a high groundwater level and relatively permeable soils coupled with a basement level as part of the proposed building design, it is common practice to set the basement level a minimum of 0.5 metres above the seasonally high groundwater level. If the basement level is set near or within the prevailing groundwater level, it is possible that perimeter drainage issues may occur in the future (e.g. sump pump failure, blockage of drainage pipes, etc.), which would lead to potential foundation cracking and basement flooding. Basements can be set below the groundwater table provided these risks are fully acknowledged and all obligations set by the governing bodies in the jurisdiction are met which stipulate minimum clearance distances between basement slab elevation and seasonal high groundwater table.

As noted in Section 5.1 the groundwater measured in the monitoring wells on-site represent the groundwater head within the deeper confined sand deposit underlying the glacial till and does not reflect the near surface groundwater conditions. As such, it is recommended to keep any potential basements at the site as high as possible above the wet sand deposit. Excavations that extend too deep into the glacial till in the northern half of the site may encounter basal heave due to the pressurized sands below the glacial till. This could also create issues for foundation construction as discussed in GEI's geotechnical report. GEI should be provided with site grading and basement plans when available for commentary.

5.3 Impact Assessment for Groundwater Control

On a preliminary basis, excavations are not expected to extend into the wet sand deposits underlying the silty sand/silt and sand glacial till. It is expected that sump pumps can control any minor seepage that occurs from the earth fill and glacial till, and basement levels (if constructed) are expected to remain above the wet sands and high groundwater level. As such, there will be no settlement impacts to nearby structures or utilities related to water taking.

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

The MECP Well Records within 500 metres of the site typically indicate sand with variable clay and gravel deposits were encountered. The noted domestic water supply wells were typically installed in a sand unit at depths of approximately 11.5 to 38.0 m below existing grade. It is noted that City of Barrie municipal water supply well (W19) is located 1.7 km north of the site. The municipal water supply is one of several ground water wells utilized by the City of Barrie. The water supply well is screened at a depth of 83 to 92 m in a gravel unit. The development at 157 Ardagh Road is not expected to extend into the wet sand unit underlying the glacial till, and as such, there will be no impacts to any nearby domestic or municipal water supply wells on a temporary or permanent basis.

No water bodies are located on the site. The closest surface water is Hotchkiss Creek, located approximately 200 m north of the site. No impacts are to baseflow into the creek are expected because the development is not anticipated to extend into the prevailing groundwater table, and there are City of Barrie sewers and utilities beneath Ardagh Road that will intercept any perched water within the upper earth fill or glacial till from reaching the creek.

5.4 Preliminary Water Balance

5.4.1 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 northeast 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.

5.4.2 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 G, 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 (sand/sandy silts), 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 80% of the 0.1-hectare lands would comprise impermeable components (e.g. houses, driveways and sidewalks). 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 G 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.

5.4.3 Pre and Post Development Water Balance

The detailed water balance calculations are included in Appendix G. 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 0.1 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	70% (vegetated area)	30% (Paved areas, garage)	312.4	182.2
Post-Development Land Use (Preliminary Plan)	20% (Green space, parks, lawns)	80% (Buildings, paved areas)	647.2	52.1

These calculations suggest that, without mitigation such as low impact development (LID) measures, the proposed development will decrease average infiltration by about 130 m^3/year (71% decrease). The proposed development will increase runoff by about 335 m^3/year (107% increase). This means about 130 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.

5.5 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.

5.5.1 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.

5.5.2 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 be minimized by using appropriate stormwater management and using LID measures to promote infiltration. These measures can be implemented on-site.

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

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

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

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

Details and designs for LID measures will be provided in a stormwater management report for the site (by others). This includes demonstrating through plans and sections (including all dimensions, materials used and including the seasonal high groundwater level) how this infiltration deficit will be mitigated.

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

If the water balance cannot be fully maintained due to low soil permeability and higher 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 water supply instead of domestic wells.
- Groundwater recharge and baseflow to creeks is anticipated to be low due to the existing City of Barrie stormwater management systems.

5.5.3 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 infiltration or 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 or infiltrating water into the ground.

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

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

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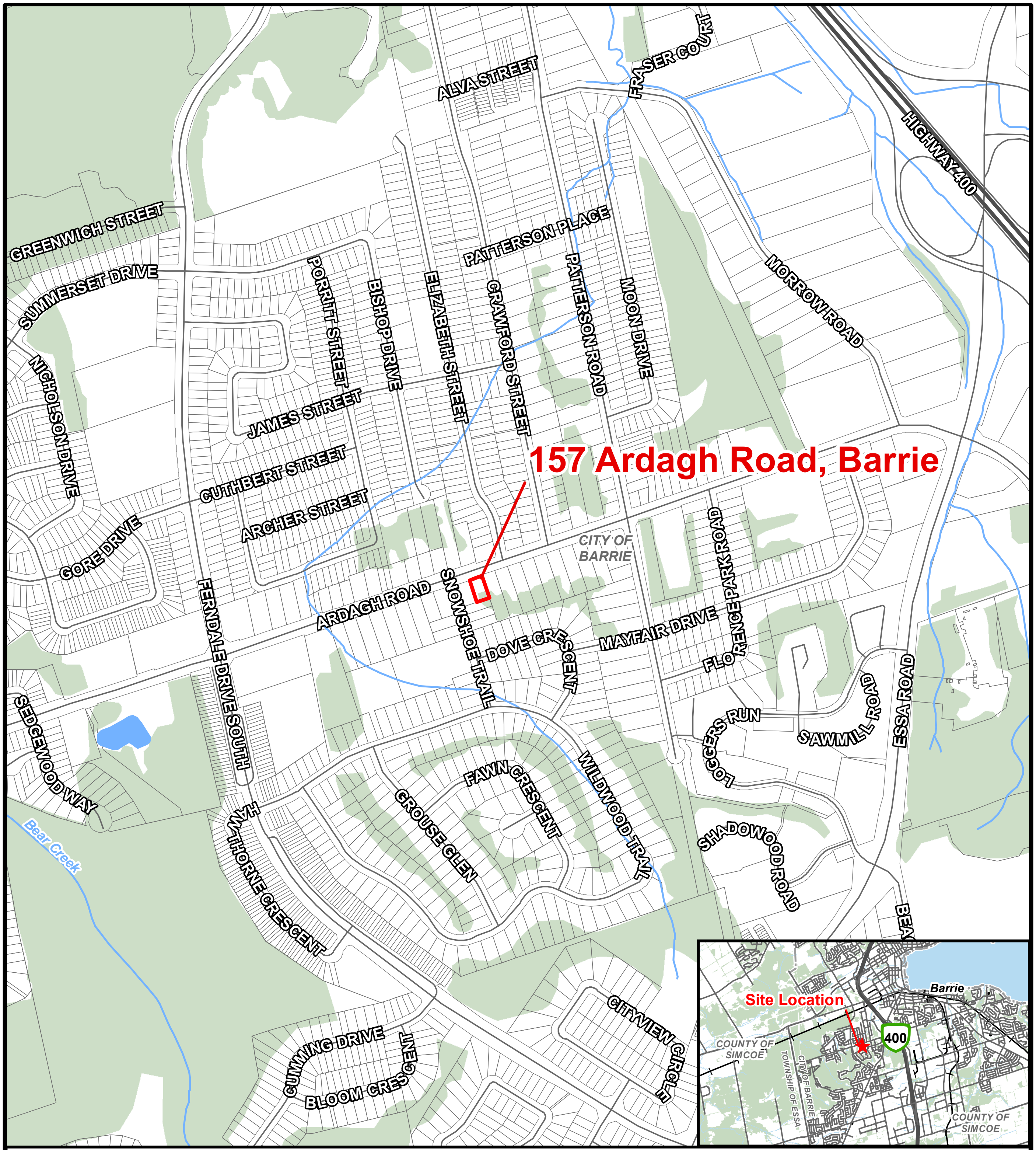
Figures



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, 2021.
3. Parcels: City of Barrie 'Tax Parcels' Feature Service, 2021.

Legend

🟥 Site Location	┼ Railway
☐ Parcels	Watercourse
⬚ Municipal Boundary, Lower/Single Tier	🟦 Waterbody
⬚ Municipal Boundary, Upper Tier	🟩 Wooded Area

N

0 125 250 m

1:10,000

157 Ardagh Road
Barrie, ON

DataTamer Inc.

GEI Consultants

Project: 2103057

SITE LOCATION PLAN

October 2021

Fig. 1

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Orthoimagery © First Base Solutions, 2021.
Imagery taken in 2020.

Legend

🟥 Approximate Property Boundary

⊕ Approximate Borehole/Monitoring Well Location

↔ Cross Section Location

[xx.xx] Groundwater Level (masl) (October 19, 2021)

N

0 3.5 7 m
1:300

157 Ardagh Road
Barrie, ON

DataTamer Inc.

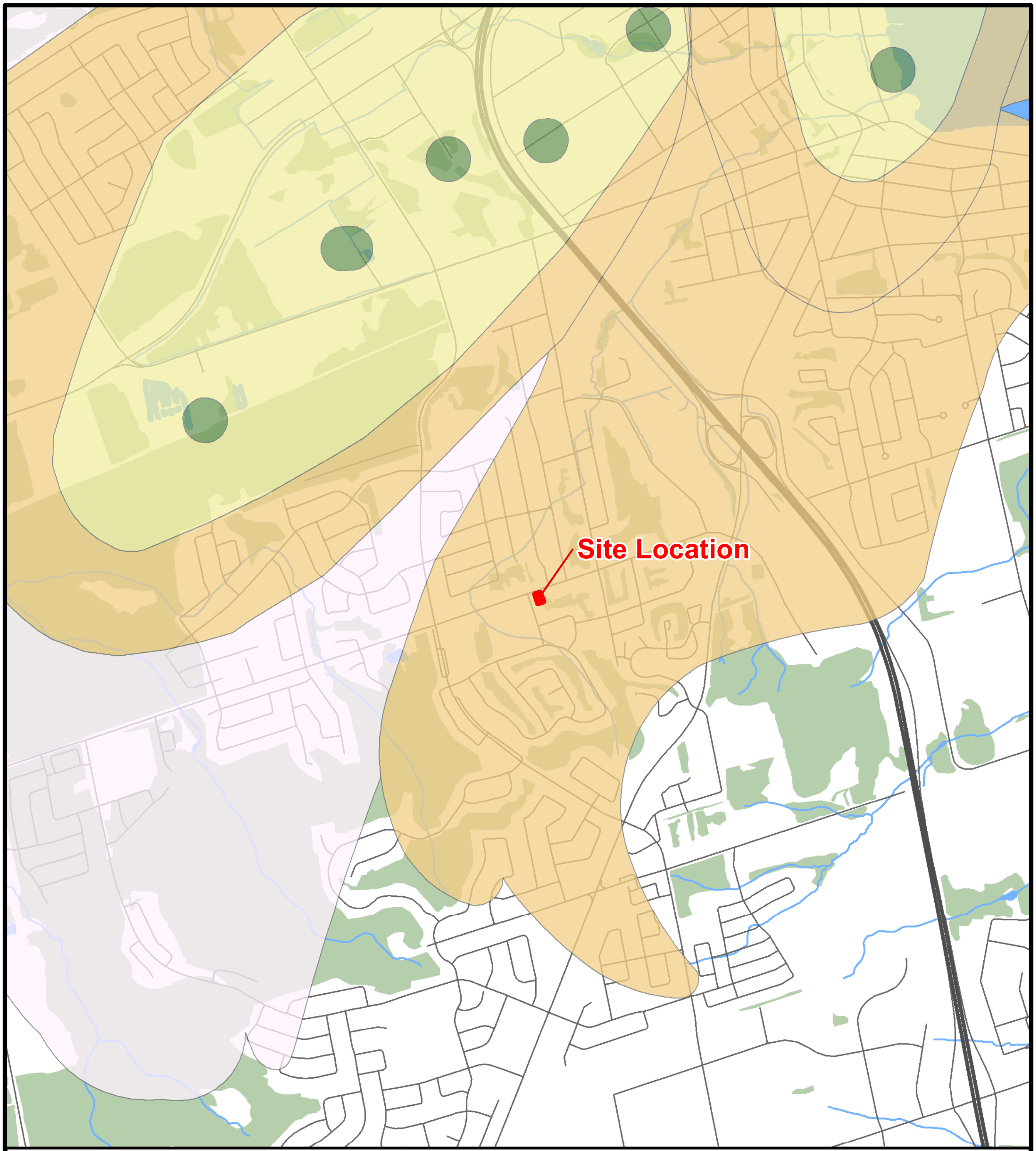
GEI Consultants

Project: 2103057

BOREHOLE LOCATION PLAN
(AERIAL)

November 2021

Fig. 2



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, 2021.
3.Source Water Protection Mapping: LAKE SIMCOE REGION CONSERVATION AUTHORITY, (2021). All Rights Reserved
4. Site is within a Wellhead Protection Area (Zone

Legend

🟥	Site Location	━	Highway
─	Watercourse	─	Road
🟦	Waterbody		
🟩	Wooded Area		

Wellhead Protection Areas (LSRCA 2021)

Zone

🟩	A
🟨	B
🟧	C
⬜	D

N

0 310 620
m
1:25,000

157 Ardagh Road
Barrie, ON

DataTamer Inc.

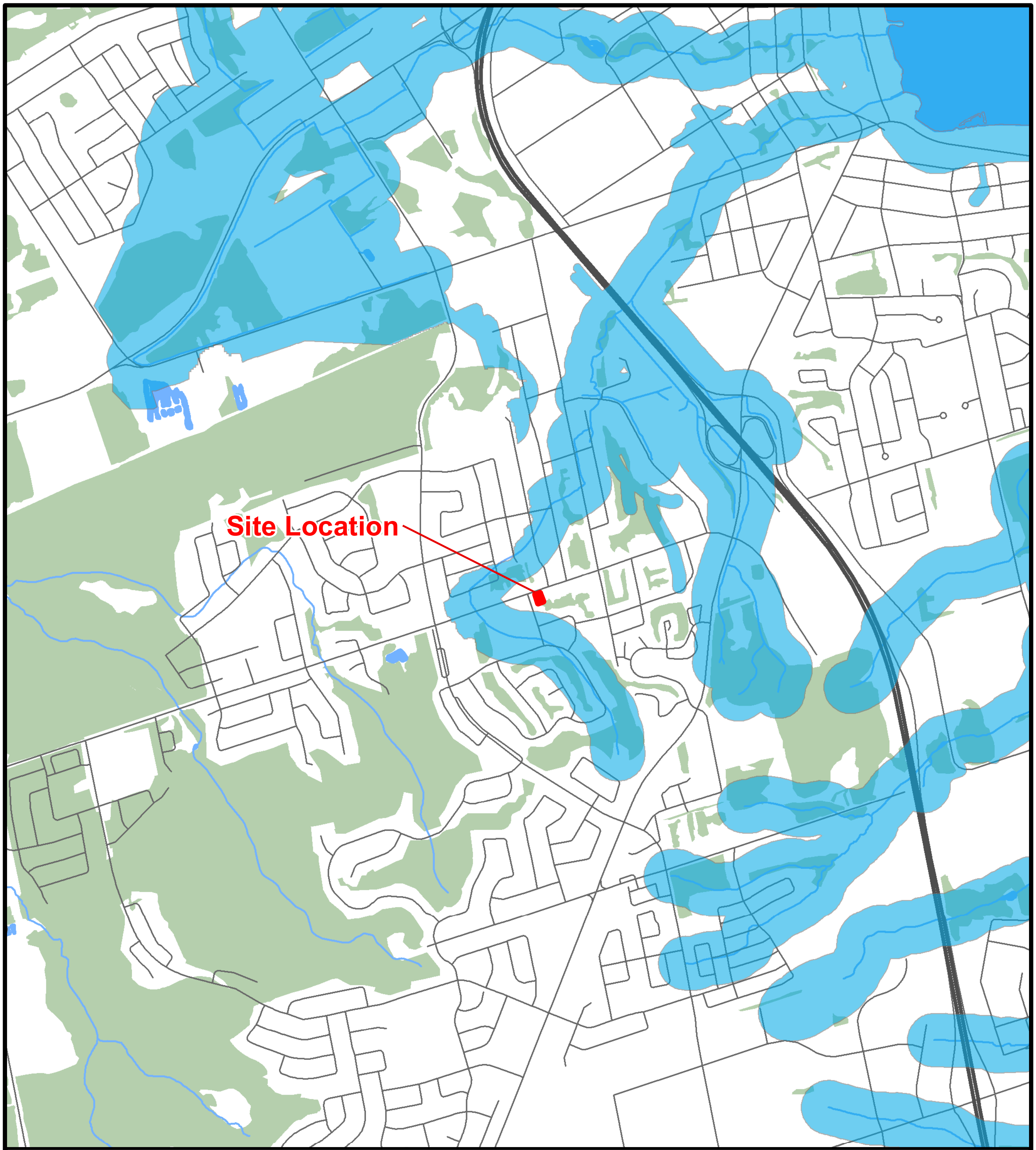
GEI
Consultants

WELLHEAD PROTECTION AREAS

Project: 2103057

October 2021

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, 2021.
3. Source Water Protection Mapping: LAKE SIMCOE REGION CONSERVATION AUTHORITY, (2021). All Rights Reserved
4. Site is not within an intake protection zone.

Legend

- ▭ Site Location
- 🟦 Intake Protection Zone (LSRCA 2021)
- — Watercourse
- 🟦 Waterbody
- 🟩 Wooded Area
- ━ Highway
- — Road

N

0 310 620 m

1:25,000

157 Ardagh Road
Barrie, ON

DataTamer Inc.

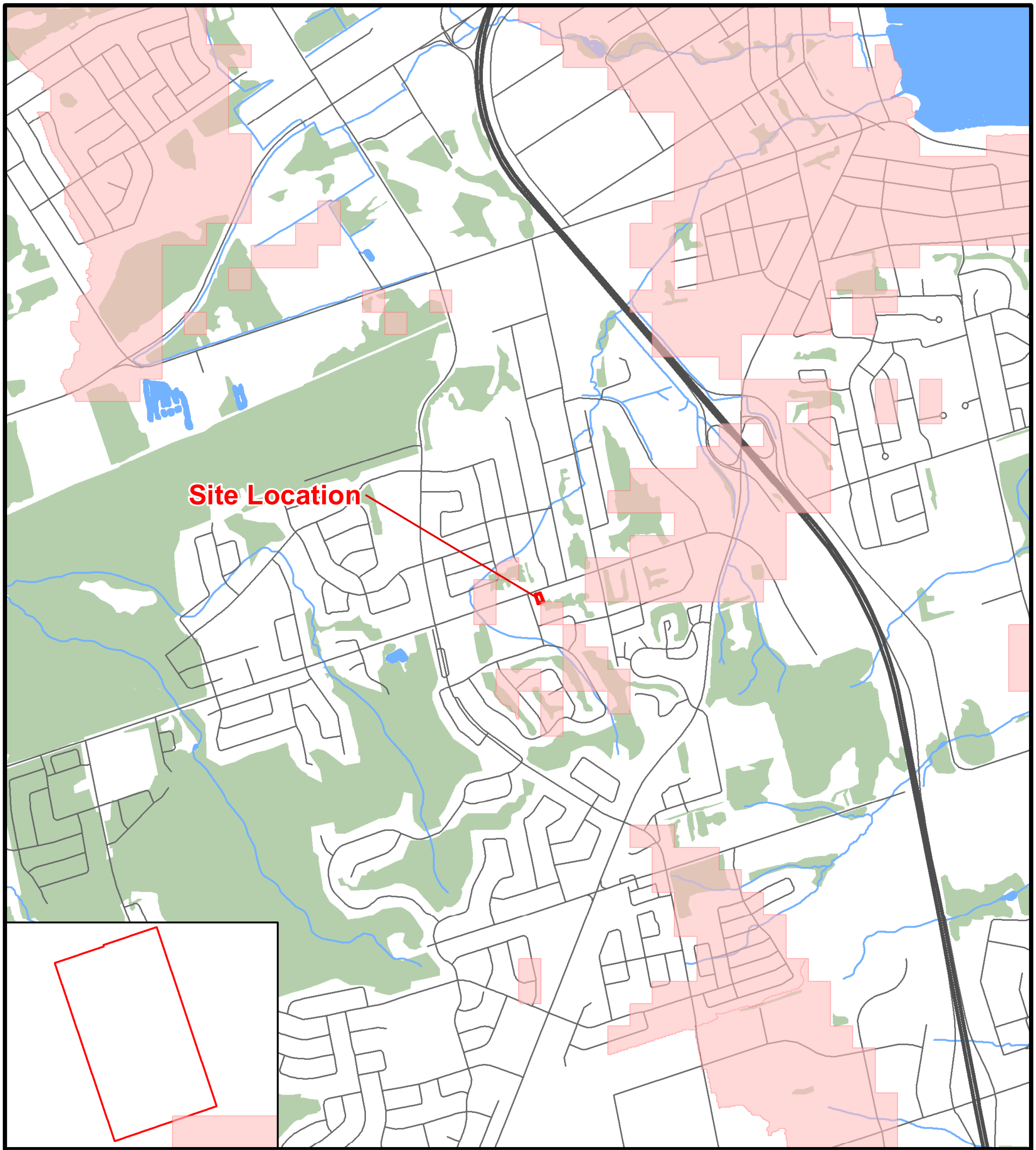
GEI Consultants

Project: 2103057

INTAKE PROTECTION ZONE

October 2021

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, 2021.
3. Source Water Protection Mapping: LAKE SIMCOE REGION CONSERVATION AUTHORITY, (2021). All Rights Reserved
4. Site is partially within a Highly Vulnerable Aquifer.

Legend

☐ Site Location	🟩 Wooded Area
🟥 Highly Vulnerable Aquifers (LSRCA 2021)	━ Highway
— Watercourse	— Road
🟦 Waterbody	

N

0 310 620 m

1:25,000

157 Ardagh Road
Barrie, ON

DataTamer Inc.

GEI Consultants

Project: 2103057

HIGHLY VULNERABLE AQUIFERS

October 2021

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, 2021.
3. Source Water Protection Mapping: LAKE SIMCOE REGION CONSERVATION AUTHORITY, (2021). All Rights Reserved
4. Site is not within a significant groundwater recharge area.

Legend

- □ Site Location
- 🟧 Significant Groundwater Recharge Areas (LSRCA 2021)
- — Watercourse
- 🟦 Waterbody
- 🟩 Wooded Area
- ━ Highway
- — Road

N

0 310 620 m

1:25,000

157 Ardagh Road
Barrie, ON

DataTamer Inc.

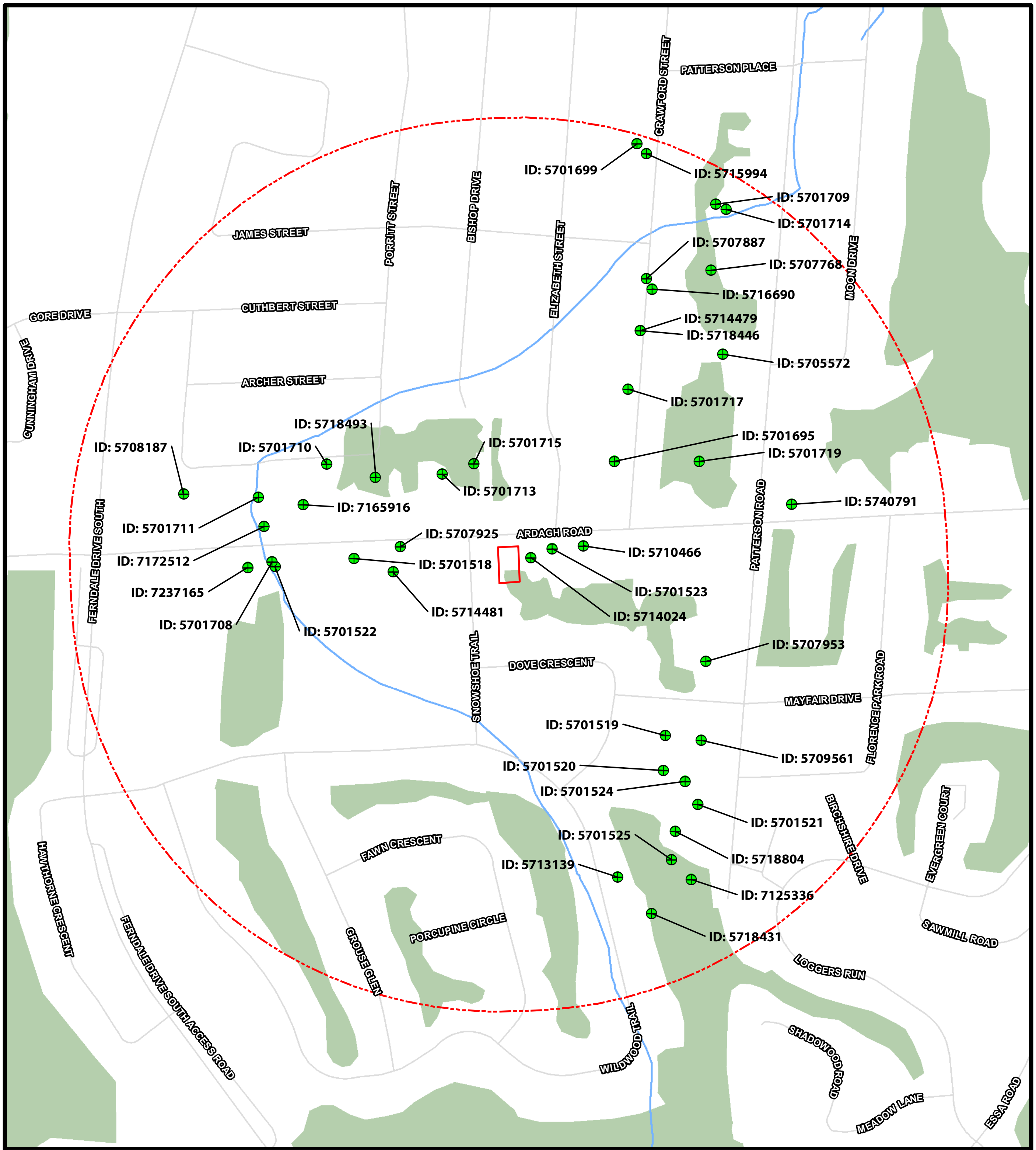
GEI Consultants

Project: 2103057

SIGNIFICANT GROUNDWATER RECHARGE AREAS

October 2021

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, 2021.

Legend

🟥	Site Location
⬚	Site Location +500m
⊕	MECP Well Record (WWIS 2021)
—	Road
—	Watercourse
🟩	Wooded Area

N

0 80 160 m

1:6,500

157 Ardagh Road
Barrie, ON

DataTamer Inc.

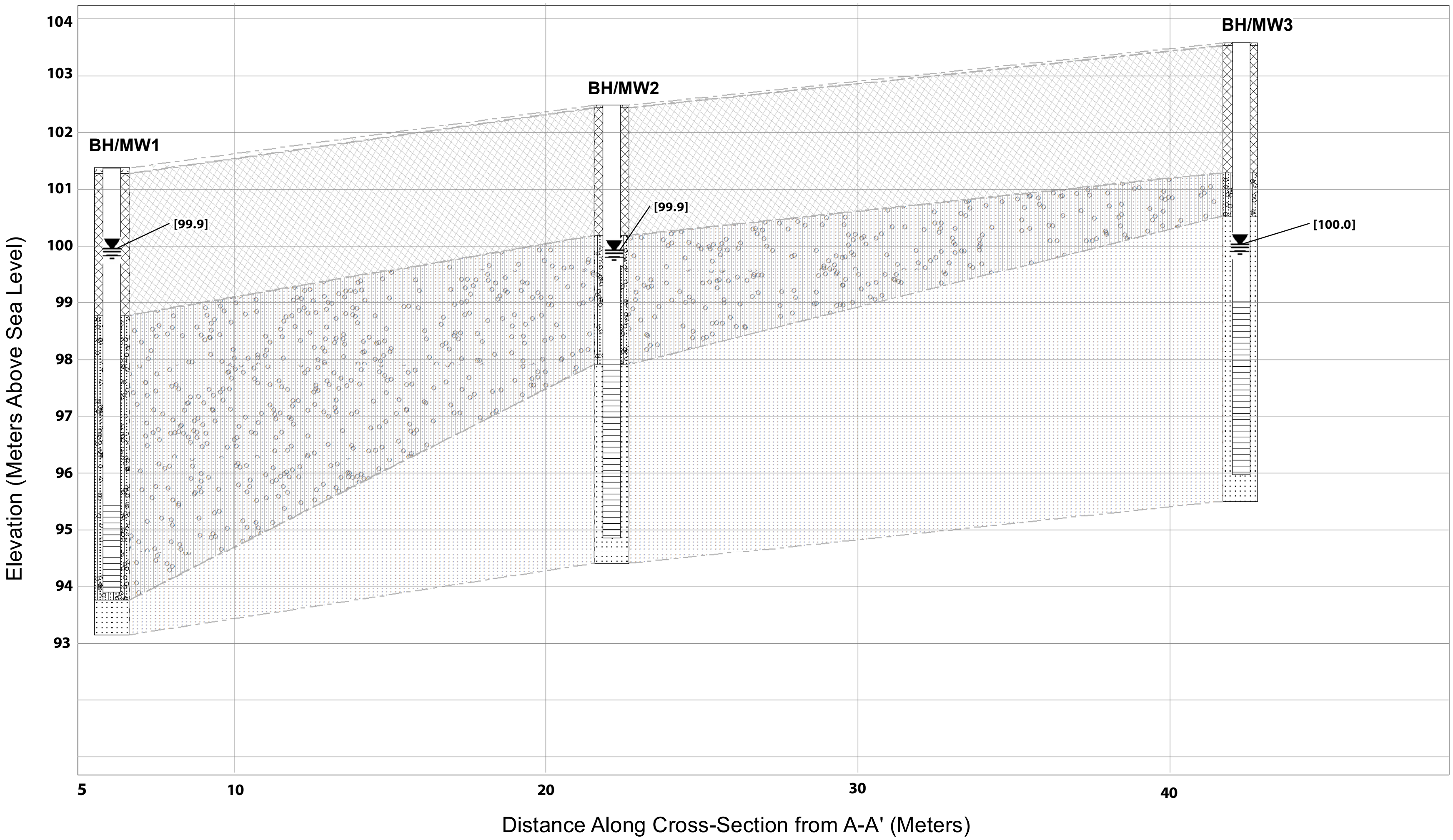
GEI Consultants

Project: 2103057

MECP WELL RECORD LOCATIONS

October 2021

Fig. 7



Legend

Water Level In Monitoring Well

[xx.xx] Groundwater Level (masl), Measured Oct19, 2021.

Strata symbols

▨ Topsoil	▨ Silty Sand to Silt and Gravel Glacial Till
▨ Fill	▨ Sand

NOTES:
1. Subsurface conditions known only at borehole locations.

157 Ardagh Road
Barrie, ON

DataTamer Inc.

GEI Consultants

Project: 2103057

Geological Cross Section A-A’

November 2021

Fig. 8

Appendix A

MECP Well Record Summary Table

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
BARRIE CITY (INNISFI	17 602605 4912182 W	2011/08 4645	36					7172512 (Z135377) A	
BARRIE CITY (INNISFI	17 602642 4912219 W	2011/07 4645	36					7165916 (Z135367) A	
INNISFIL TOWNSHIP	17 602600 4912131 W	7314		6		MO		7237165 (Z77113) A139479	BRWN SAND SILT FILL 0007 BRWN SILT SAND 0010 GREY SILT SAND 0020
INNISFIL TOWNSHIP CON 13 005	17 602764 4912173 W	1977/08 3660	5	FR 0060	11/30/15/1:0	DO	0060 3	5714481 ()	BRWN SAND 0018 BRWN SAND CLAY 0055 GREY GRVL CLAY 0060 BRWN CSND GRVL 0063
INNISFIL TOWNSHIP CON 13 005	17 602914 4912233 W	1976/10 2514	6	FR 0058	11/45/10/1:0	DO		5714024 ()	BRWN SAND SILT BLDR 0058 BRWN FGVL 0058
INNISFIL TOWNSHIP CON 13 005	17 602764 4912203 W	1971/04 2514	6	FR 0071	12/62/10/1:30	DO	0071 3	5707925 ()	PRDG 0017 BRWN SAND CLAY 0071 YLLW FSND 0074
INNISFIL TOWNSHIP CON 13 005	17 602969 4912263 W	1973/06 4608	30	FR 0015	8//3/0:30	DO		5710466 ()	LOAM SAND 0002 GREY CLAY 0020
INNISFIL TOWNSHIP CON 13 005	17 602630 4912141 W	1966/09 2514	6	FR 0050	2/44/7/1:30	DO		5701522 ()	PRDG 0010 GRVL 0013 MSND GRVL BLDR 0050 GRVL 0051
INNISFIL TOWNSHIP CON 13 005	17 602625 4912145 W	1962/05 3414	7	FR 0122	92/118/7/4:0	DO	0122 4	5701708 ()	PRDG 0094 BRWN FSND 0120 MSND 0126
INNISFIL TOWNSHIP CON 13 005	17 602935 4912250 W	1967/05 4608	30	FR 0009	9//2/:	DO		5701523 ()	LOAM MSND 0003 GREY CLAY STNS 0018
INNISFIL TOWNSHIP CON 13 005	17 602716 4912175 W	1961/03 1614	4	FR 0049	12/28/4/2:0	DO		5701518 ()	LOAM 0002 CLAY MSND 0033 CLAY HPAN 0045 GRVL 0049
INNISFIL TOWNSHIP CON 14	17 602716 4912281 W	2019/08 7360	2	UT 0010		MO	0010 5	7353349 (Z311900) A272414	SAND WBRG 0015
INNISFIL TOWNSHIP CON 14 004	17 602504 4912193 W	1971/08 1830	30	FR 0012	12/14/1/1:0	DO		5708187 ()	LOAM MSND 0002 BRWN MSND 0018 GREY CLAY 0022

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
INNISFIL TOWNSHIP CON 14 005	17 602714 4912273 W	1982/09 3135	5	FR 0090	32/82/7/2:30	DO	0091 3	5718493 ()	PRDG 0018 CLAY 0076 CLAY SAND GRVL 0090 SAND 0091
INNISFIL TOWNSHIP CON 14 005	17 602655 4912272 W	1963/03 2514	6	FR 0055	1/30/7/3:0	DO		5701710 ()	GRVL 0001 MSND 0017 BLUE CLAY 0048 MSND GRVL 0054 GRVL 0055
INNISFIL TOWNSHIP CON 14 005	17 602969 4912453 W	1967/07 2514	6	FR 0063	34/66/2/3:0	DO	0064 3	5701717 ()	FILL 0004 MUCK 0005 MSND GRVL CLAY 0014 BLUE CLAY 0027 BLUE CLAY FSND 0049 GREY FSND 0067 SILT 0068
INNISFIL TOWNSHIP CON 14 005	17 602820 4912320 W	1966/10 4715	4	FR 0036	9/20/3/2:0	DO	0035 3	5701715 ()	CLAY MSND GRVL 0036 FSND GRVL 0038
INNISFIL TOWNSHIP CON 14 005	17 602788 4912298 W	1965/10 4715	4	FR 0037	3/4/15/0:30	DO	0038 4	5701713 ()	PRDG 0013 CLAY MSND GRVL 0037 MSND GRVL 0042
INNISFIL TOWNSHIP CON 14 005	17 602589 4912213 W	1963/04 4102	30	FR 0006	6//4/:	DO		5701711 ()	BRWN CLAY 0004 GRVL 0012 BLUE CLAY 0020
INNISFIL TOWNSHIP CON 14 005	17 602977 4912368 W	1958/09 2514	6	FR 0047	/30/10/2:0	DO		5701695 ()	LOAM 0001 MSND 0021 BLUE CLAY 0029 BRWN CLAY 0042 MSND GRVL 0047

Appendix B

Borehole Logs

RECORD OF BOREHOLE No. 1

Project Number: **2103057**
Project Client: **DataTamer Inc.**
Project Name: **157 Ardagh Road**
Project Location: **Barrie, Ontario**
Drilling Location: **See Figure 2**

Drilling Method: **Hollow Stem Augers**
Drilling Machine: **Track Mount**
Logged By: **AJ**
Reviewed By: **AW**
Northing: **4912235**
Easting: **602880**
Date Started: **Sep. 9/21**
Date Completed: **Sep. 9/21**

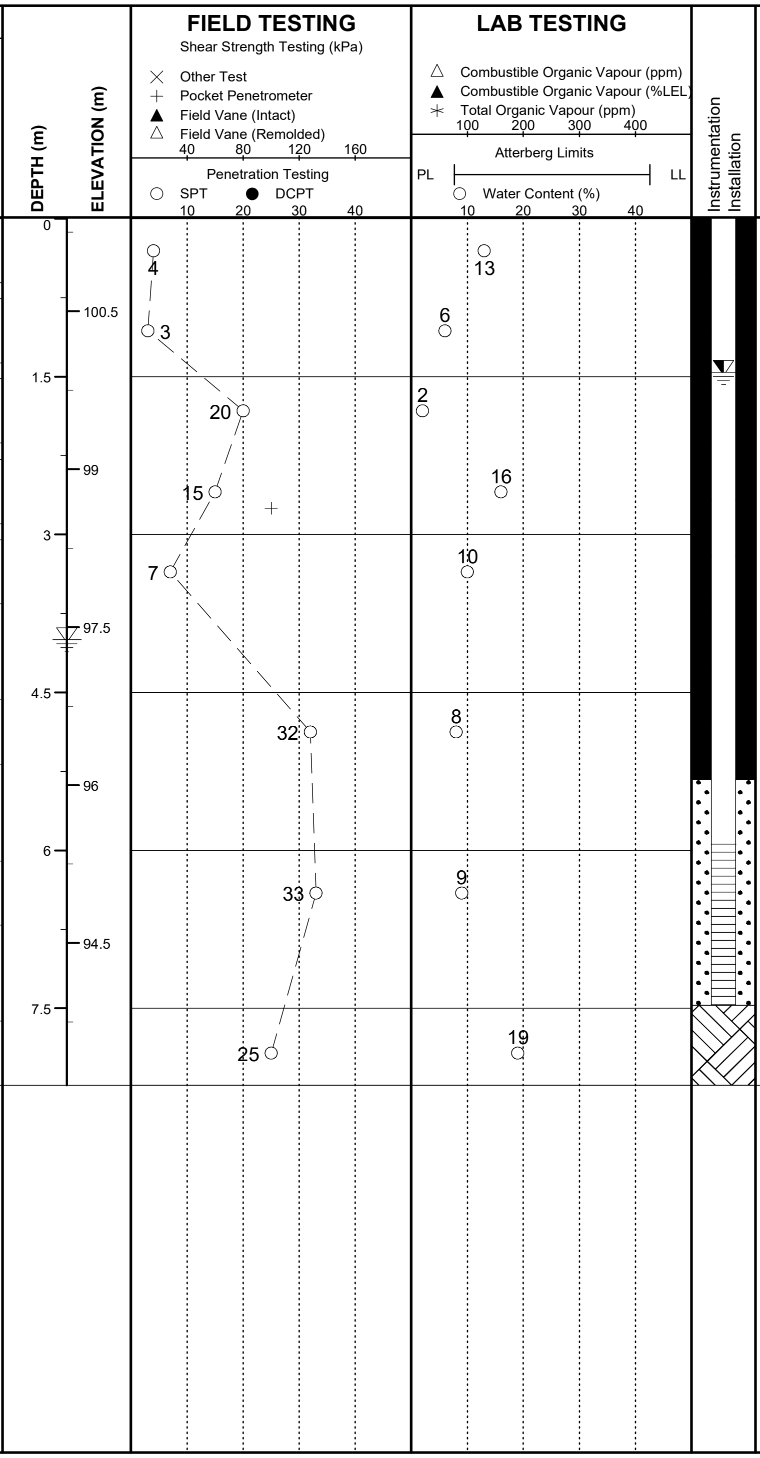
LITHOLOGY PROFILE

Local **101.38m**

Depth (m)	Elevation (m)	DESCRIPTION
0.1	101.3	Topsoil = 100mm
1.5	99.9	FILL: Sand, Trace Gravel, Very Loose to Loose, Brown, Moist
2.6	98.8	FILL: Sand and Gravel, Compact, Brown, Moist
7.6	93.8	SILTY SAND to SILT & SAND GLACIAL TILL, Some Clay, Trace Gravel, Very Stiff, Brown, Moist --- Firm --- --- Trace Clay, Dense ---
8.2	93.2	SAND, Trace to Some Gravel, Trace Silt, Compact, Grey, Wet
		End of Borehole @ 8.2m

SOIL SAMPLING

Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)	GR	SA	SI	CL
SS	1	25	4	13				
SS	2	33	3	6				
SS	3	38	20	2				
SS	4A 4B	83	15	16				
SS	5	88	7	10				
SS	6	75	32	8				
SS	7	96	33	9	3	59	28	10
SS	8	96	25	19				



COMMENTS & GRAIN SIZE DISTRIBUTION (%)

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647 Welham Road, Unit 14
Barrie, Ontario L4N 0B8
T : (705) 719-7994
www.geiconsultants.com

Groundwater depth encountered on completion of drilling: **4.0m**

Cave depth after auger removal: **Open**

Groundwater depth observed on **Oct. 19/21** at a depth of: **1.46m**

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

Scale: **1 :75**

Page: **1 of 1**

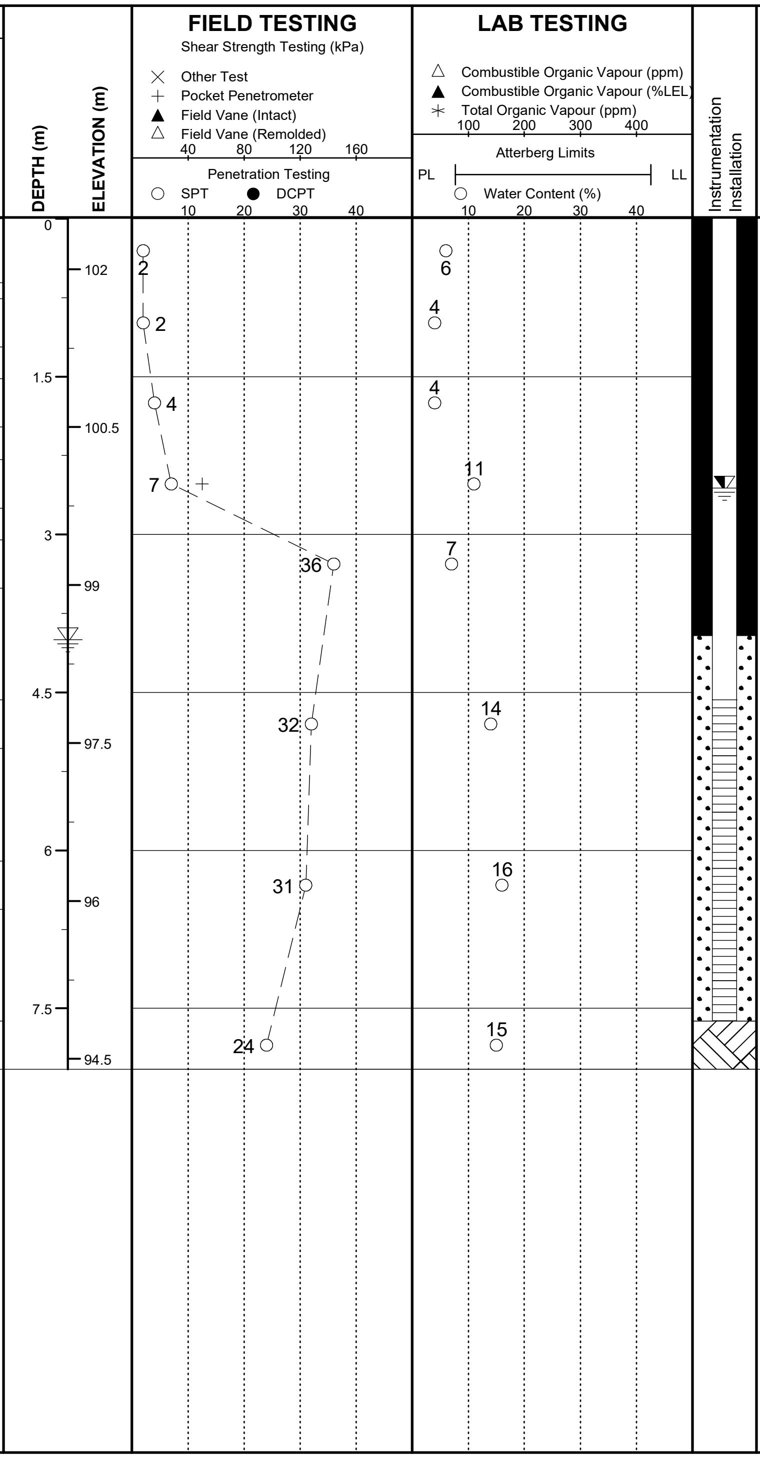
RECORD OF BOREHOLE No. 2

Project Number: **2103057**
Project Client: **DataTamer Inc.**
Project Name: **157 Ardagh Road**
Project Location: **Barrie, Ontario**
Drilling Location: **See Figure 2**

Drilling Method: **Hollow Stem Augers**
Drilling Machine: **Track Mount**
Logged By: **BH**
Reviewed By: **AW**
Northing: **4912224**
Easting: **602894**
Date Started: **Sep. 13/21**
Date Completed: **Sep. 13/21**

LITHOLOGY PROFILE / SOIL SAMPLING / COMMENTS & GRAIN SIZE DISTRIBUTION (%)

DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	GR	SA	SI	CL
Local **102.48m**								
0.1 102.4								
Topsoil = 50mm								
FILL: Silty Sand, Trace Gravel, Trace Organics, Very Loose, Brown, Moist	SS	1	100	2				
0.8 101.7								
FILL: Sand, Trace Gravel, Trace Organics, Trace Silt, Very Loose, Brown, Moist	SS	2	100	2				
--- Some Gravel, Very Loose ---	SS	3	100	4				
2.3 100.2								
SILTY SAND GLACIAL TILL, Some Clay, Trace Gravel, Firm, Brown, Moist	SS	4	100	7	1	38	41	20
--- Trace Clay, Dense, Grey ---	SS	5	100	36				
4.6 97.9								
SAND, Trace to Some Gravel, Trace Silt, Dense, Grey, Wet	SS	6	100	32				
	SS	7	100	31				
--- Compact ---	SS	8	100	24				
8.1 94.4								
End of Borehole @ 8.1m								



GEI CONSULTANTS

647 Welham Road, Unit 14
Barrie, Ontario L4N 0B8
T : (705) 719-7994
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Groundwater depth encountered on completion of drilling: **4.0m**

Cave depth after auger removal: **Open**

Groundwater depth observed on **Oct. 19/21** at a depth of: **2.56m**

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

Scale: **1 :75**

Page: **1 of 1**

RECORD OF BOREHOLE No. 3

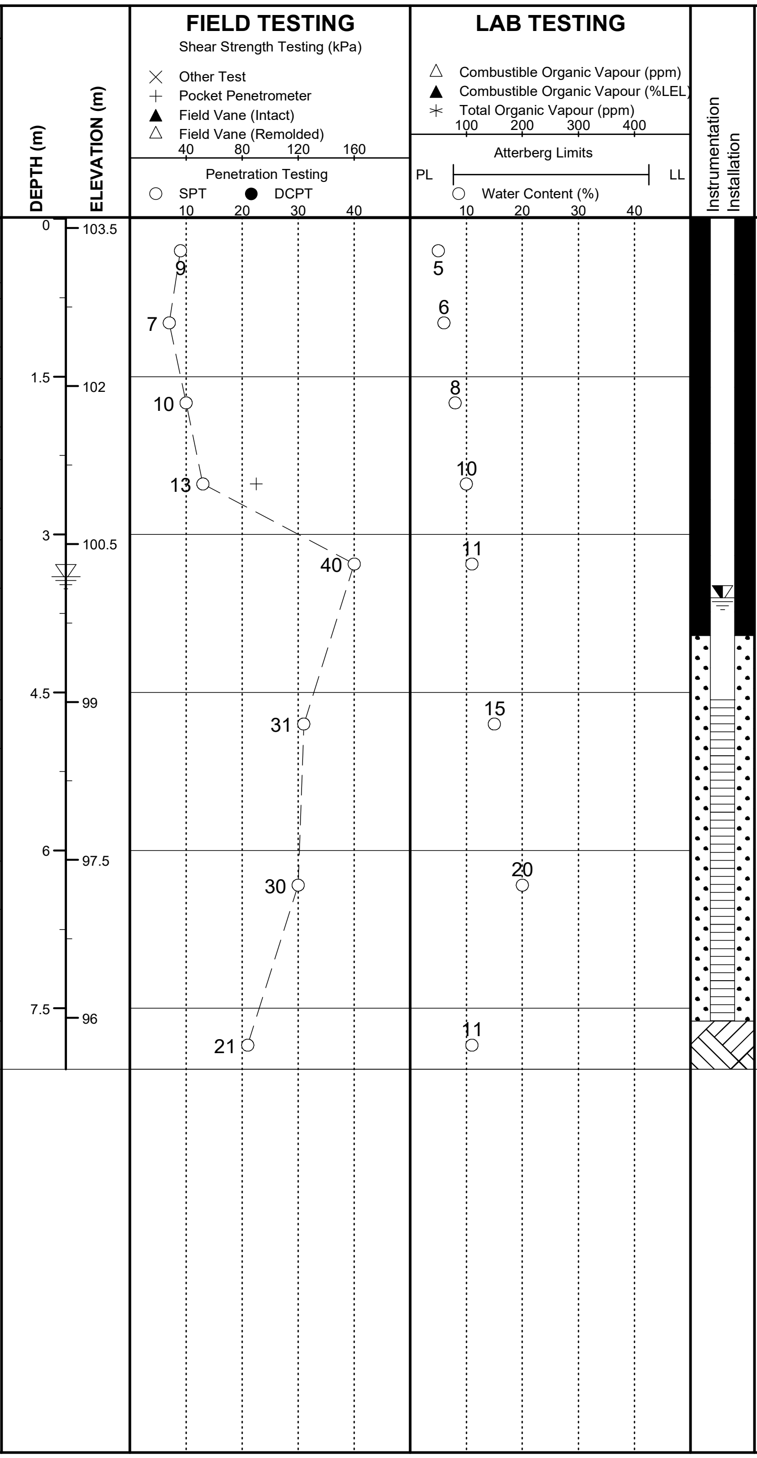
Project Number: **2103057**
Project Client: **DataTamer Inc.**
Project Name: **157 Ardagh Road**
Project Location: **Barrie, Ontario**
Drilling Location: **See Figure 2**

Drilling Method: **Hollow Stem Augers**
Drilling Machine: **Track Mount**
Logged By: **BH**
Northing: **4912202**
Date Started: **Sep. 13/21**
Reviewed By: **AW**
Easting: **602900**
Date Completed: **Sep. 13/21**

LITHOLOGY PROFILE / SOIL SAMPLING

Local **103.59m**

Depth (m)	Elevation (m)	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value	Water Content (%)	GR	SA	SI	CL
0.1	103.5	Topsoil = 50mm									
		FILL: Sand, Trace Silt, Loose, Brown, Moist	SS	1	100	9	5				
			SS	2	100	7	6				
2.3	101.3		SS	3	100	10	8				
3.1	100.5	SILTY SAND to SILT & SAND GLACIAL TILL, Some Clay, Trace Gravel, Stiff, Brown, Moist	SS	4	100	13	10				
		SAND, Trace to Some Gravel, Trace Silt, Dense, Grey, Moist to Wet	SS	5	100	40	11				
		--- Wet ---	SS	6	100	31	15				
			SS	7	100	30	20				
8.1	95.5	--- Compact ---	SS	8	100	21	11	7	88	(5)	
		End of Borehole @ 8.1m									



COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GEI CONSULTANTS

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Barrie, Ontario L4N 0B8
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Groundwater depth encountered on completion of drilling: **3.4m**

Cave depth after auger removal: **Open**

Groundwater depth observed on **Oct. 19/21** at a depth of: **3.60m**

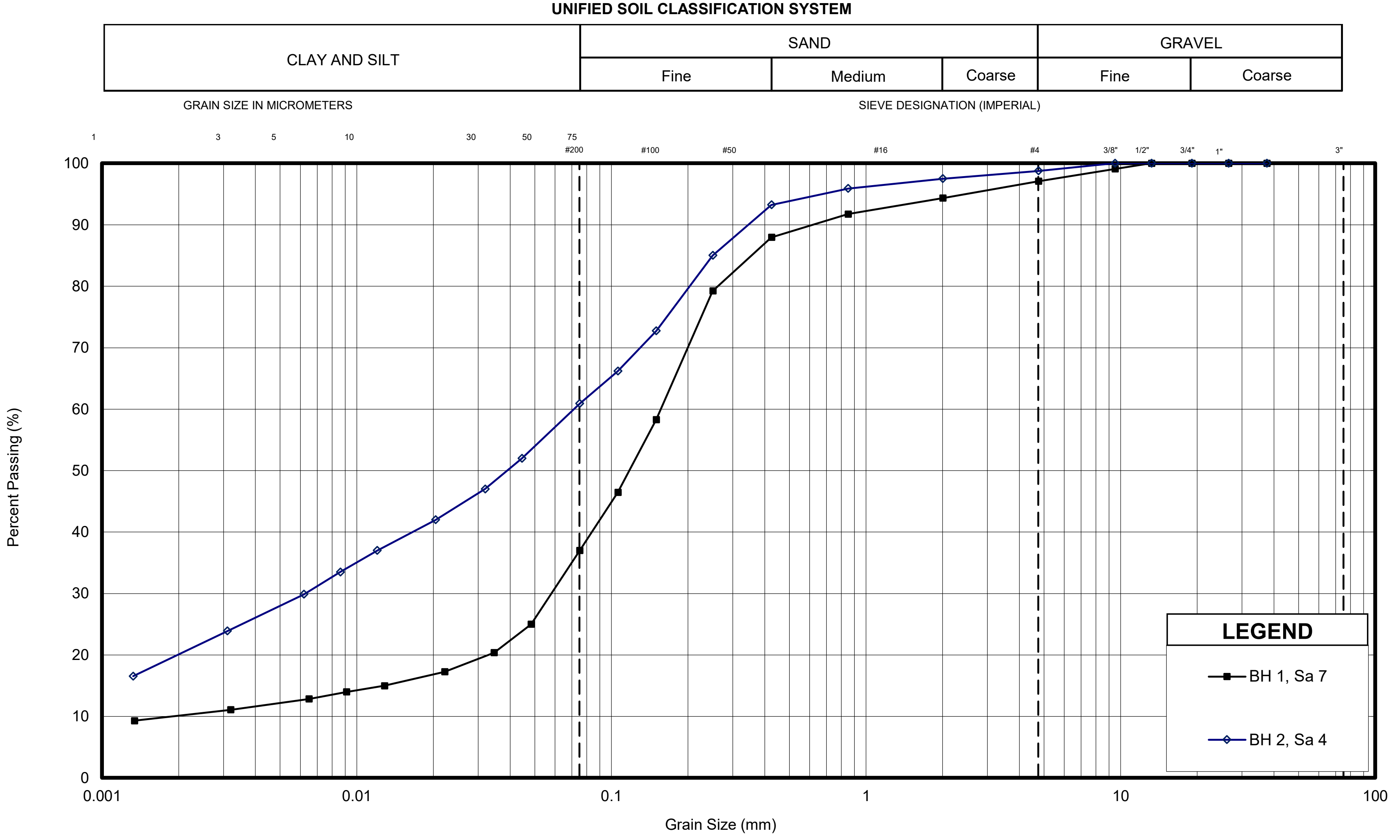
Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and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

Scale: **1 :75**

Page: **1 of 1**

Appendix C

Geotechnical Laboratory Results



Sample	Description	Gr.	Sa.	Si.	Cl.	D_{10}	D_{30}	D_{60}	C_u	C_c
BH 1, Sa 7	SILTY SAND GLACIAL TILL, Trace Clay, Trace Gravel	3	59	28	10	0.002	0.058	0.16	82.9	11.6
BH 2, Sa 4	SILT & SAND GLACIAL TILL, Some Clay, Trace Gravel	1	38	41	20	-	0.006	0.072	-	-

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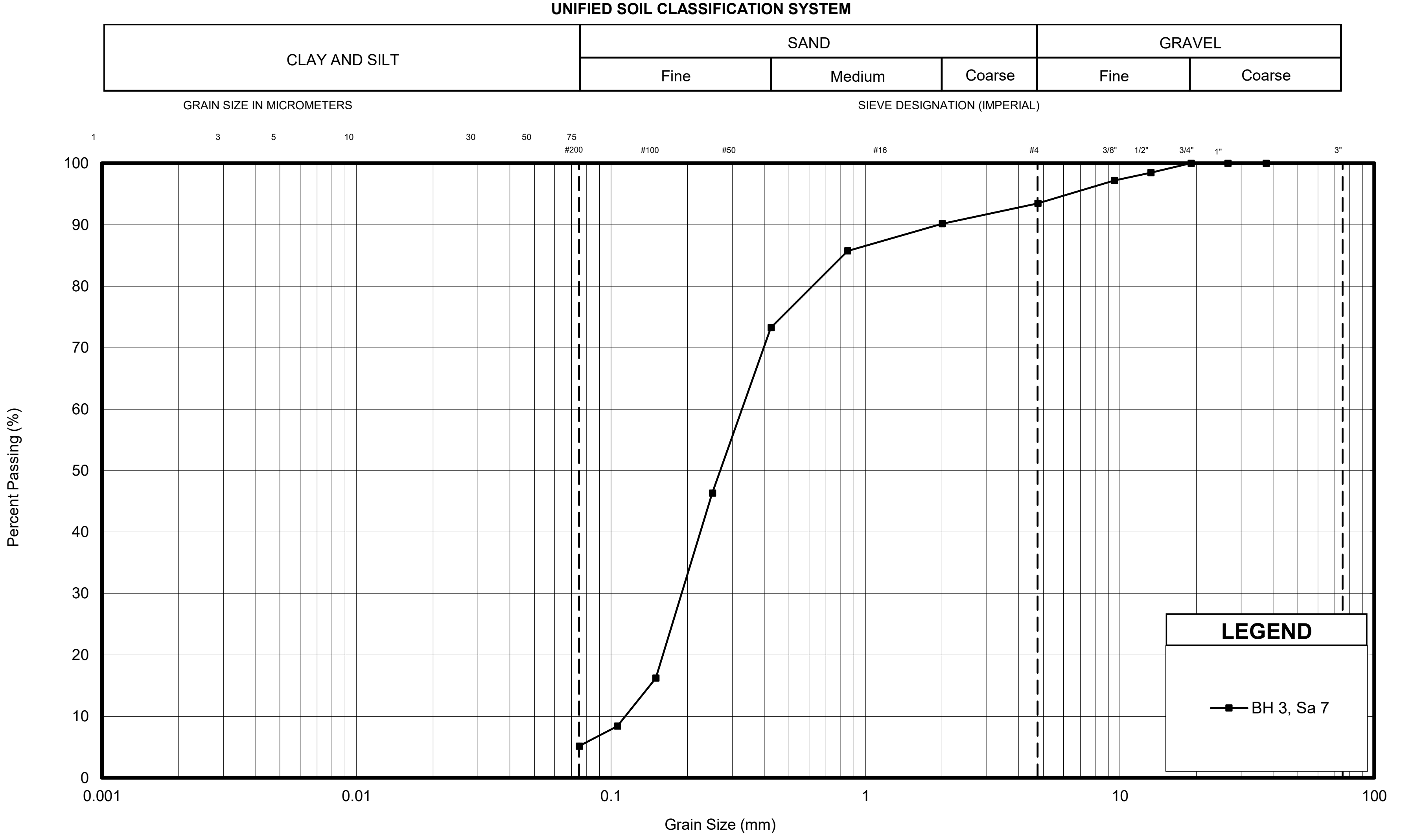
GRAIN SIZE DISTRIBUTION

SILTY SAND to SAND & SILT GLACIAL TILL

APP. No.	B1
REF. No.	2103057
DATE	November 2021



Sample	Description	Gr.	Sa.	Si.	Cl.	D_{10}	D_{30}	D_{60}	C_u	C_c
BH 3, Sa 7	SAND, Trace Gravel, Trace Fines	7	88	5		0.11	0.19	0.327	2.9	1.0

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GRAIN SIZE DISTRIBUTION

SAND

APP. No.	B2
REF. No.	2103057
DATE	November 2021

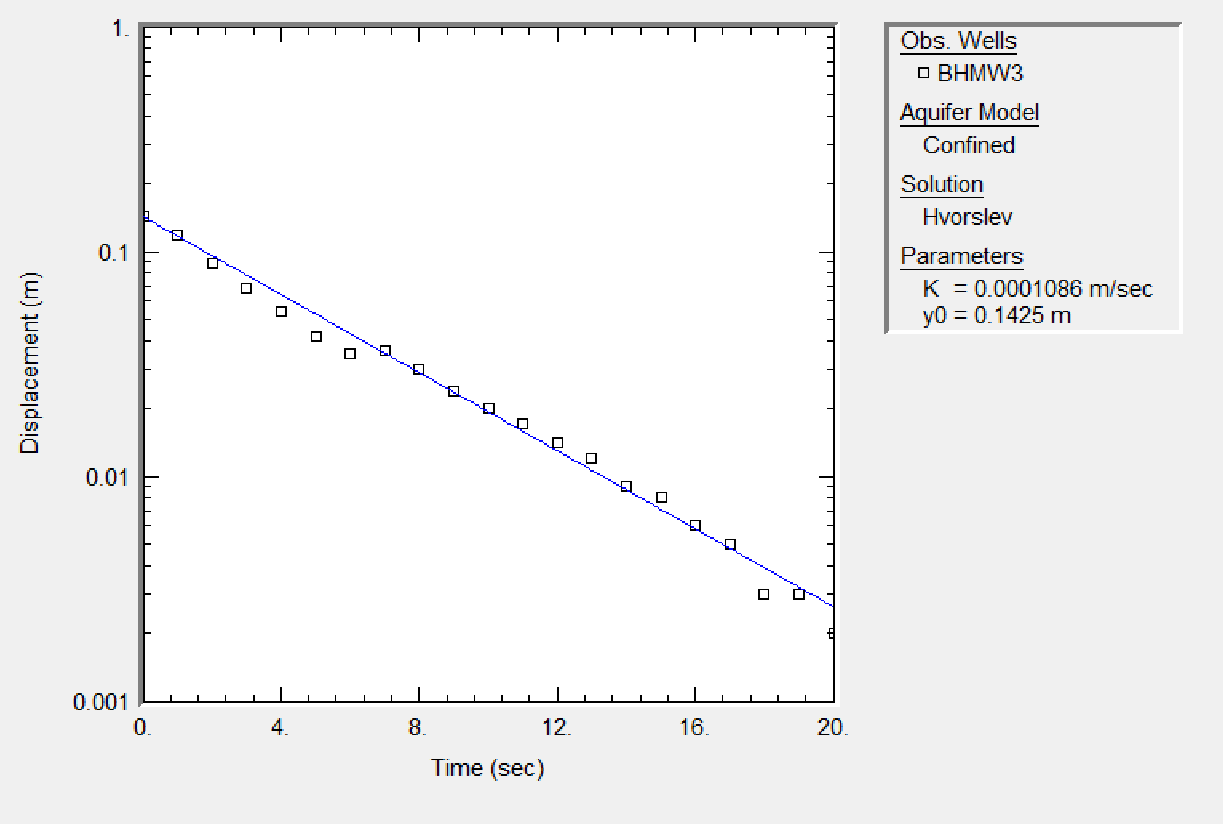
Appendix D

Rising Head Test Results

Estimation of K by Slug Test, based on Hvorslev equation

Date:	May 11, 2021
Conducted by:	S.Griffith

Well Number:	BH/MW3	
Well Screen Bottom:	7.50	mbgs
Top of Pipe:	0.69	mags
Well Casing Diameter:	5.08	cm
Well Elevation:	100.00	masl
Static Water Level:	3.59	mbgs
$K = r^2\ln(L/R)/(2LTo) =$	**$1.09\text{x}10^{-4}$**	m/s



Appendix E

Groundwater Chemistry Certificates of Analysis

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B21-36675 (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: 08-Nov-21

DATE REPORTED: 16-Nov-21

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:

P.O. NUMBER: 2103057

WATERWORKS NO.

Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
Cyanide	1	Kingston	US	11-Nov-21	A-CN-001 (k)	SM 4500CN
Conductivity	1	Holly Lane	JGC	15-Nov-21	A-COND-02 (o)	SM 2510B
Anions	1	Holly Lane	pcu	09-Nov-21	A-IC-01 (o)	SM4110C
pH	1	Holly Lane	JGC	15-Nov-21	A-PH-01 (o)	SM 4500H
Chromium (VI)	2	Holly Lane	LMG	12-Nov-21	D-CRVI-01 (o)	MOE E3056
Mercury	2	Holly Lane	PBK	12-Nov-21	D-HG-02 (o)	SM 3112 B
Metals - ICP-OES	2	Holly Lane	NHG	11-Nov-21	D-ICP-01 (o)	SM 3120
Metals - ICP-MS	2	Holly Lane	TPR	11-Nov-21	D-ICPMS-01 (o)	EPA 200.8

µg/g = micrograms per gram (parts per million) and is equal to mg/Kg
F1 C6-C10 hydrocarbons in µg/g, (F1-btex if requested)
F2 C10-C16 hydrocarbons in µg/g, (F2-napth if requested)
F3 C16-C34 hydrocarbons in µg/g, (F3-pah if requested)
F4 C34-C50 hydrocarbons in µg/g
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
Any deviations from the method are noted and reported for any particular sample.
nC6 and nC10 response factor is within 30% of response factor for toluene:
nC10,nC16 and nC34 response factors within 10% of each other:
C50 response factors within 70% of nC10+nC16+nC34 average:
Linearity is within 15%:
All results expressed on a dry weight basis.
Unless otherwise noted all chromatograms returned to baseline by the retention time of nC50.

Unless otherwise noted all extraction, analysis, QC requirements and limits for holding time were met.
If analyzed for F4 and F4G they are not to be summed but the greater of the two numbers are to be used in application to the CWS PHC
QC will be made available upon request.

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

CBurke

Christine Burke
Lab Manager

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

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Attention: Alicia Kimberley

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

DATE RECEIVED: 08-Nov-21
DATE REPORTED: 16-Nov-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2103057
WATERWORKS NO.

	Client I.D.		MW3 - unfiltered	MW3 - filtered			**PWQO**	
	Sample I.D.		B21-36675-1	B21-36675-2			**Interim PWQO**	**PWQO**
	Date Collected		08-Nov-21	08-Nov-21				
Parameter	**Units**	**R.L.**						
pH @25°C	pH Units		7.98					8.5
Conductivity @25°C	mS/cm	0.001	0.785					
Cyanide (Free)	µg/L	5	< 5					5
Chloride	µg/L	500	95700					
Nitrite (N)	µg/L	100	< 100					
Nitrate (N)	µg/L	100	2700					
Sodium	µg/L	200	28800	39800				
Hardness (as CaCO3)	mg/L	1	410	342				
Antimony	µg/L	0.1	0.4	< 0.1			20	
Arsenic	µg/L	0.1	0.6	0.2			5	5
Beryllium	µg/L	2	< 2	< 2				11
Boron	µg/L	5	51	18			200	
Cadmium	µg/L	0.015	< 0.015	< 0.015			0.1	0.2
Chromium	µg/L	1	4	1				
Chromium (VI)	µg/L	1	< 1	< 1				1
Cobalt	µg/L	0.1	**3.2**	0.3			0.9	
Copper	µg/L	0.1	**5.7**	0.6			5	
Iron	µg/L	5	**4420**	7				300
Lead	µg/L	0.02	**2.27**	0.02			1	5
Mercury	µg/L	0.02	0.06	< 0.02				0.2
Molybdenum	µg/L	0.1	0.2	0.2			40	
Nickel	µg/L	0.2	4.8	0.8				25
Selenium	µg/L	1	< 1	< 1				100
Silver	µg/L	0.1	< 0.1	< 0.1				0.1

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

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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Attention: Alicia Kimberley

Caduceon Environmental Laboratories
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Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 08-Nov-21

DATE REPORTED: 16-Nov-21

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:

P.O. NUMBER: 2103057

WATERWORKS NO.

	Client I.D.		MW3 - unfiltered	MW3 - filtered			**PWQO**	
	Sample I.D.		B21-36675-1	B21-36675-2			**Interim PWQO**	**PWQO**
	Date Collected		08-Nov-21	08-Nov-21				
Parameter	**Units**	**R.L.**						
Thallium	µg/L	0.05	< 0.05	< 0.05			0.3	0.3
Tungsten	µg/L	10	< 10	< 10			30	
Uranium	µg/L	0.05	0.26	0.20			5	
Vanadium	µg/L	0.1	4.2	0.5			6	
Zinc	µg/L	5	**24**	< 5			20	30
Zirconium	µg/L	3	< 3	< 3			4	

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

CBurke

Christine Burke
Lab Manager

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DATE RECEIVED: 08-Nov-21
DATE REPORTED: 16-Nov-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2103057
WATERWORKS NO.

Summary of Exceedances

Interim PWQO

MW3 - unfiltered	Found Value	Limit
Zinc (µg/L)	24	20
Lead (µg/L)	2.27	1
Copper (µg/L)	5.7	5
Cobalt (µg/L)	3.2	0.9

Provincial Water Quality Objectives

MW3 - unfiltered	Found Value	Limit
Iron (µg/L)	4420	300

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

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Christine Burke
Lab Manager

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DATE RECEIVED: 08-Nov-21

DATE REPORTED: 16-Nov-21

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:

P.O. NUMBER: 2103057

WATERWORKS NO.

Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
PHC(F2-F4)	1	Kingston	KPR	10-Nov-21	C-PHC-W-001 (k)	MOE E3421
VOC's	1	Richmond Hill	FAL	09-Nov-21	C-VOC-02 (rh)	EPA 8260
PHC(F1)	1	Richmond Hill	FAL	09-Nov-21	C-VPHW-01 (rh)	MOE E3421

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

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

Christine Burke
Lab Manager

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Fax: 705-252-5746

DATE RECEIVED: 08-Nov-21

DATE REPORTED: 16-Nov-21

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:

P.O. NUMBER: 2103057

WATERWORKS NO.

	Client I.D.		MW3 - unfiltered				**O. Reg. 153 Tbl. 1 - GW (µg/L)**	
	Sample I.D.		B21-36675-1					
	Date Collected		08-Nov-21					
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

CBurke

Christine Burke
Lab Manager

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Tel: 705-252-5743
Fax: 705-252-5746

DATE RECEIVED: 08-Nov-21
DATE REPORTED: 16-Nov-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2103057
WATERWORKS NO.

	Client I.D.		MW3 - unfiltered				**O. Reg. 153 Tbl. 1 - GW (µg/L)**	
	Sample I.D.		B21-36675-1					
	Date Collected		08-Nov-21					
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					

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

CBurke

Christine Burke
Lab Manager

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

CADUCEON
ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B21-36675 (i)

Rev. 1

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: 08-Nov-21

DATE REPORTED: 16-Nov-21

SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:

P.O. NUMBER: 2103057

WATERWORKS NO.

	Client I.D.		MW3 - unfiltered				**O. Reg. 153** **Tbl. 1 - GW** **(µg/L)**	
	Sample I.D.		B21-36675-1					
	Date Collected		08-Nov-21					
Parameter	**Units**	**R.L.**						
Xylene, o-	µg/L	0.5	< 0.5					
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	

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

CBurke

Christine Burke
Lab Manager

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
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JOB/PROJECT NO.:
P.O. NUMBER: 2103057
WATERWORKS NO.

Summary of Exceedances

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

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Christine Burke
Lab Manager

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SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:

P.O. NUMBER: 2103057

WATERWORKS NO.

Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
SVOC	1	Kingston	sge	12-Nov-21	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

CBurke

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Lab Manager

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P.O. NUMBER: 2103057
WATERWORKS NO.

	Client I.D.		MW3 - unfiltered				**O. Reg. 153 Tbl. 1 - GW (µg/L)**	
	Sample I.D.		B21-36675-1					
	Date Collected		08-Nov-21					
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)fluoranthene	µg/L	0.05	< 0.05				0.1	
Benzo(b+k)fluoranthene	µg/L	0.1	< 0.1					
Benzo(g,h,i)perylene	µg/L	0.05	< 0.05				0.2	
Benzo(k)fluoranthene	µg/L	0.05	< 0.05				0.1	
Chrysene	µg/L	0.05	< 0.05				0.1	
Dibenzo(a,h)anthracene	µg/L	0.05	< 0.05				0.2	
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	
Methylnaphthalene 2-(1-)	µg/L	1	< 1				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	

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

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Christine Burke
Lab Manager

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P.O. NUMBER: 2103057
WATERWORKS NO.

Summary of Exceedances

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

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GENERAL SAMPLE SUBMISSION FORM

CADUCEON ENVIRONMENTAL LABORATORIES

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)
B21-36675

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
Contact: A.Kimberley
Tel: 705-795-9351
Fax:
Email: akimberley@geiconsultants.com
Additional Info (email, cell, etc):
Address: 647 Welham Road, Barrie
Quote #:
P.O. #:
Invoicing Address (if different):
Project Name/#: 2103057
Additional Info:

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

ANALYSES REQUESTED — Indicate Test For Each Sample By Using A Check Mark In The Box Provided

Lab No.	Sample Source and/or Sample Identification	S.P.L.	Sample Matrix *	Date Collected (yy-mm-dd)	Time Collected	PWQO metals	O.Reg.153 inorganics	nitrite/nitrate, ~~ammonia~~ CB	O.Reg.153 PHCs/VOCs		PAH as per client email CB						Suspected Highly Contaminated X	Field pH	Field Temp.	# Bottles/ Sample	Field Filtered Y/N
	MW3 - unfiltered		GW	21-11-08		x	x	x	x		X										Y
	MW3 - filtered		GW	21-11-08		x															Y

↳NH3 cancelled per client email CB

Gen chem, metals, ~~Hg~~ JE, chromium (filtered metals, chromium, Hg) → O
1L Amber, PHC 500mL amber, CN, nut → K

VOC vials, ~~PHC 500mL~~ JE → RH

SAMPLE SUBMISSION INFORMATION

	Sampled by:	Submitted by:
Print:	A. Kimberley	A. Kimberley
Sign:		
Date (yy-mm-dd)/Time:		

SHIPPING INFORMATION
Courier (Client account) ☐
Courier (Caduceon account) ☐
Drop Off ☑
Caduceon (Pick-up) ☐
Invoice
# of Pieces

REPORTING / INVOICING
Report by Fax ☐
Report by Email ☑
Invoice by Email ☑
Invoice by Mail ☐

SAMPLE RECEIVING INFORMATION (LABORATORY USE ONLY)
Received By (print): Jamie
Signature: JE
Date Received (yy-mm-dd): 21/11/08
Time Received: 13:15
Laboratory Prepared Bottles: ☑ Yes ☐ No
Sample Temperature °C: 16.5
Labeled by: JE

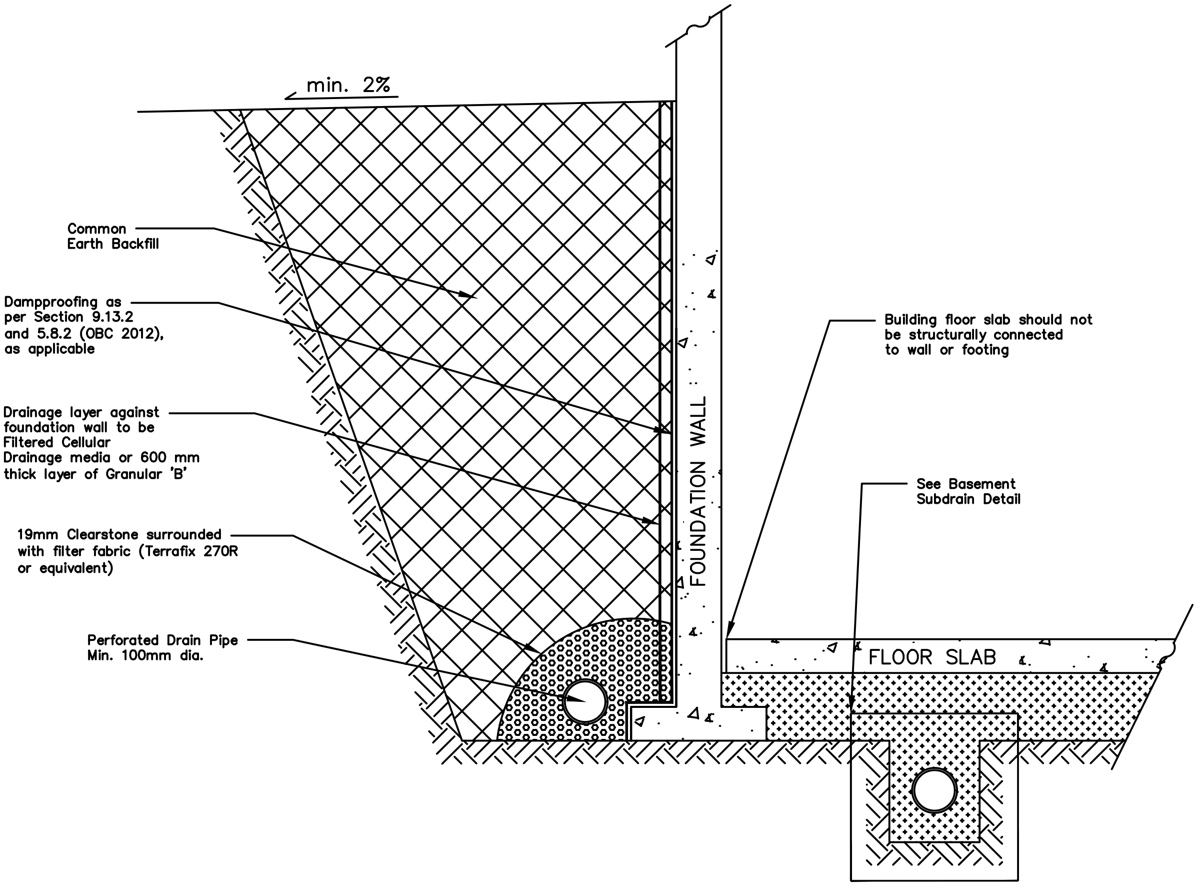
Comments:

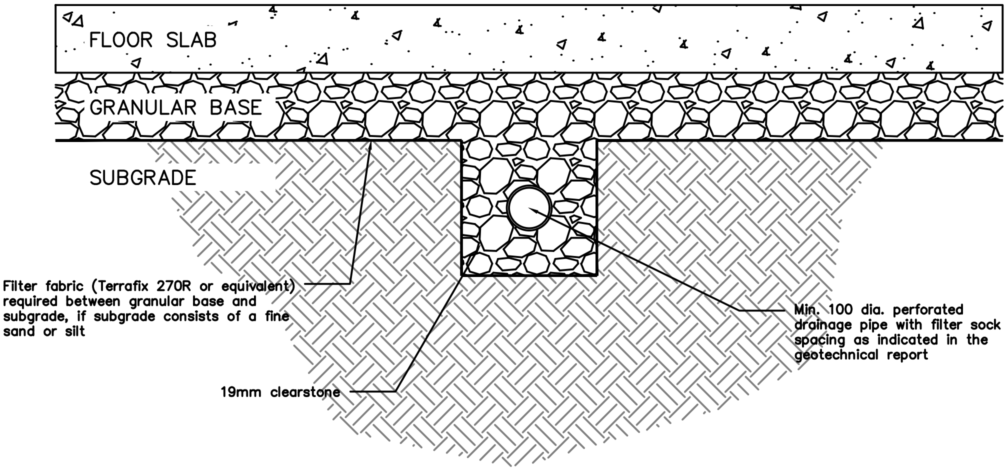
Page 1 of 1

COC May 2020 Revision No: 21

Appendix F

Basement Drainage Typical Details

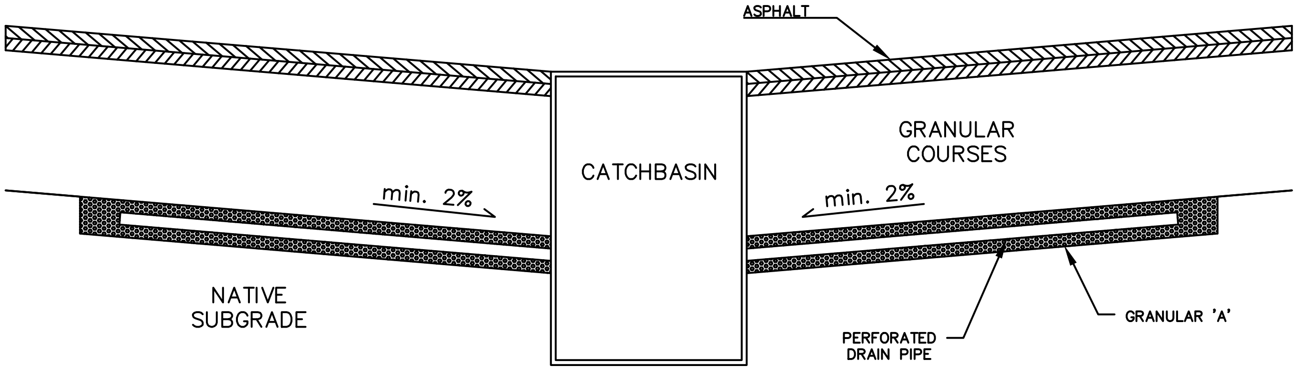


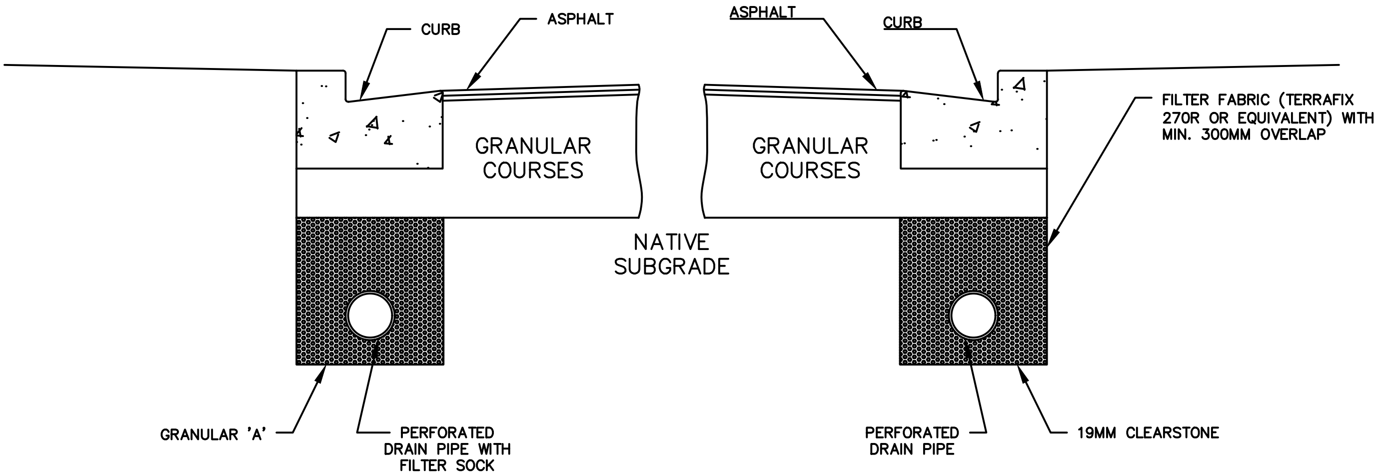


GEI Consultants

647 Welham Rd, Unit 14, Barrie, ON, L4N 0B7
P: (705) 719-7994

BASEMENT FOUNDATION WALL & SUBFLOOR DRAINAGE TYPICAL DETAIL

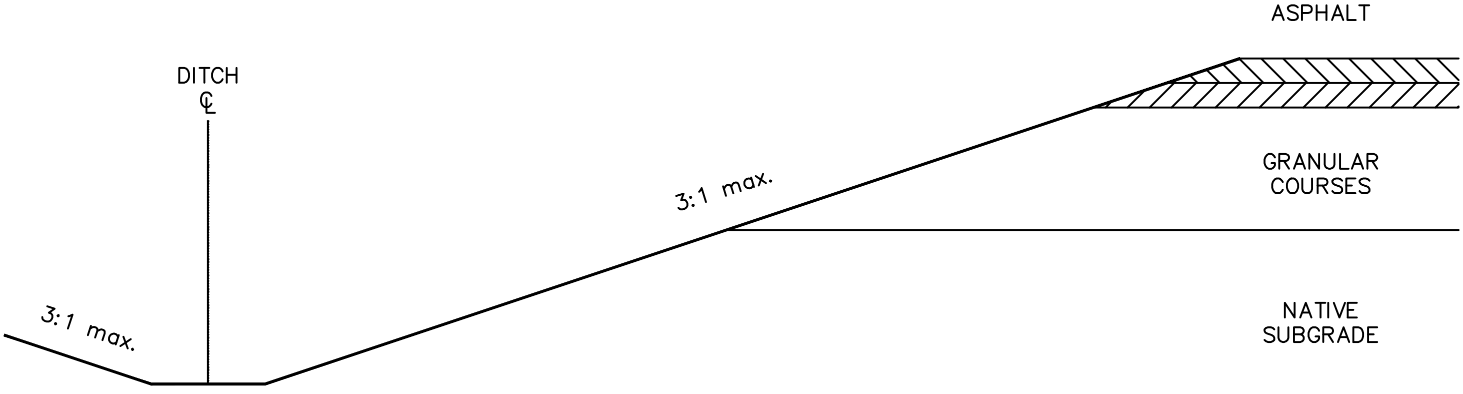




Unwrapped Trench

Wrapped Trench

Urban Cross Sections



Rural Cross Section

GEI Consultants

647 Welham Rd, Unit 14, Barrie, ON, L4N 0B7

PAVEMENT DRAINAGE ALTERNATIVES TYPICAL DETAILS

Appendix G

Preliminary Water Balance

File No. 2103057

Water Balance - 157 Ardagh Road

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 MOECC Infiltration Factor (mm)	57.8	43.3	40.7	23.6	5.2	0.0	0.0	0.0	0.0	0.0	42.3	51.5	264.3
	Potential Surface Water Runoff (mm)	24.8	18.5	17.4	10.1	2.2	0.0	0.0	0.0	0.0	0.0	18.1	22.1	113.3
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	985.0	70%	689.5	78.1	182.2	107%
	Impervious Area		30%	295.5	234.3	0.0	**Infiltration Decrease Pre to Post**
	TOTAL	-	100%	985.0	312.4	182.2	-71%
Proposed Land Use (Post-Development)	Pervious Area	985.0	20%	197.0	22.3	52.1	**Infiltration Required to Meet Pre-Development Conditions (m^3)**
	Impervious Area (Assumed based on proposed two semi-detached homes and parking)		80%	788.0	624.9	0.0	
	TOTAL	-	100%	985.0	647.2	52.1	130

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

Infiltration Criteria	**Site Description**	**Infiltration Factor**
Topography	Rolling Land - Average Slope 2.8 to 3.8 m/km	0.2
Soils	Open Sandy Loam	0.4
Cover	Cultivated Land	0.1
	Sum of Infiltration Factors	**0.7**