Final Report

Hydrogeological Investigation

1012 Yonge Street, Barrie, Ontario

Prepared for Crown (Barrie) Developments Inc.
by IBI Group
February 19, 2021

Document Control Page

CLIENT:	Crown (Barrie) Developments Inc.
PROJECT NAME:	
REPORT TITLE:	Hydrogeological Investigation
IBI REFERENCE:	2018-0390-003
VERSION:	3.0
DIGITAL MASTER:	\\coleengineering.ca\prj\mrk\2018\2018-0390\400_Tchncl\70_Rprts\Hydrogeology\Reporting\Final PDF Report\20210202_1012 Yonge Street, Barrie_Hydrogeological Investigation_Final.docx
ORIGINATOR:	Aron Zhao Bradley Trinh
REVIEWER:	Aron Zhao
AUTHORIZATION:	Hassan Ktaech
CIRCULATION LIST:	
HISTORY:	1.0 – First Submission 2.0 – Revised Underground Design 3.0 – Revised Shallower Design

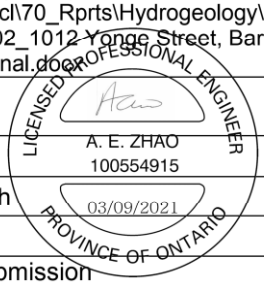


Table of Contents

Table of Contents (continued)

Table of Contents (continued)

List of Tables

List of Figures

Table of Contents (continued)

List of Appendices

1 INTRODUCTION

1.1 Project Background

IBI Group Inc. (IBI) (then known as IBI Engineering Group Ltd.) was retained by Crown (Barrie) Developments Inc. (the "Client") to undertake a hydrogeological investigation in support of the proposed residential development for the property at 1012 Yonge Street, Barrie, Ontario (the "Site"). The Site is located in a largely rural agricultural area on Yonge Street, approximately 230 m north of Lockhart Road. While immediately adjacent properties are undeveloped, the Site is bounded by residential subdivisions further to the north and the south. The location of the Site is shown on **Figure 1**.

Based on the most recent Site Plans, the proposed development will consist of 1,029 residential units, comprised of 3 storey townhouses and 3 storey and 6 storey condo blocks) with underground parking, extending to approximately 4.5 meters below ground. The site plan is shown in **Appendix A**.

1.2 Objectives of the Hydrogeological Investigation

The objectives of this hydrogeological investigation are:

- Characterize the existing geological and hydrogeological setting;
- Identify groundwater-related regulations applicable to the Site development;
- Assess the potential impacts to the natural environment and other groundwater users as a result of the development, and
- Evaluate the potential need for dewatering during construction and the need for a Permit to Take Water ("PTTW") or an Environmental Activity and Sector Registry ("EASR").

2 CHARACTERIZATION OF THE EXISTING GEOLOGICAL AND HYDROGEOLOGICAL SETTING

A conceptual understanding of the geological and hydrogeological system was developed through a review of existing reports and available geological information. This included:

- The Barrie Creeks, Lovers Creek, and Hewitts Creek Subwatershed Plan, Lake Simcoe Region Conservation Authority ("LSRCA") (2012);
- On-line mapping by York Peel Durham Toronto ("YPDT") Oak Ridges Moraine Groundwater ("ORM") Program;
- Geological and hydrogeological Information from Ontario Geological Survey ("OGS"), including:
    - Bedrock Geology, and
    - Quaternary Geology.
- Geological and hydrogeological Information from Ontario Ministry of Natural Resources and Forestry ("MNRF"), including:
    - The Natural Heritage Information Centre ("NHIC").

- Ministry of the Environment, Conservation and Parks ("MECP") Well Records.

3 APPLICABLE REGULATION AND AGENCIES

Environmental regulations and policies that may be relevant for this hydrogeological investigation are briefly discussed below.

Official Plan of the County of Simcoe

The consolidated Official Plan of the County of Simcoe was adopted in November 2008 and as approved by the Ontario Municipal Board as of December 29, 2016, is an overall planning document that guides economic, environmental and community building decisions to manage growth in the County of Simcoe.

According to the *Official Plan of the County of Simcoe*, the City of Barrie is administered separate from the remainder of the County, and planning decisions within the City of Barrie are not subject to provisions from the *Official Plan of the County of Simcoe*.

City of Barrie Official Plan

The current *City of Barrie Official Plan* was consolidated in 2018 and provides guidance for implementing by-laws and guidelines for more detailed planning and the means for controlling growth so that the City of Barrie's capacity to provide a healthy community environment is not exceeded.

The Site is also designated partially as residential area and partially as mixed-use nodes and corridors under the Hewitt's Secondary Plan.

The City of Barrie may require a Wellhead Protection Area Risk Assessment Report, Source Water Information Form or Threats and Issues Assessment – Water Quality Study for development falling within a Vulnerable Area, per Schedule G of the City of Barrie Official Plan. Based on available mapping, the Site does not fall within a Vulnerable Area.

No additional hydrogeological requirements arising from the municipal official plan or secondary plan apply to the Site.

O. Reg. 179/06 – Lake Simcoe Region Conservation Authority (LSRCA)

Under Section 28 of the *Conservation Authorities Act*, the local conservation authorities are mandated to protect the health and integrity of the regional greenspace system and to maintain or improve the hydrological and ecological functions performed by valley and stream corridors. The LSRCA enforces this Act through O.Reg. 179/06: Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses.

The Site does not lie within any of the LSRCA regulated areas and there are no natural surface water features traversing the Site. Therefore, no application under O.Reg. 179/06 is required for this project.

The Clean Water Act (2006)

The MECP mandates the protection of existing and future sources of drinking water under the *Clean Water Act*, 2006 ("CWA"). Initiatives undertaken under the *CWA* include the delineation of Wellhead Protection Areas ("WHPAs"), Significant Groundwater Recharge Areas ("SGRAs") and areas of Highly Vulnerable Aquifer ("HVA") as well as the assessment of drinking water quality and quantity threats within Source Protection Regions. Source Protection Plans are developed under the *CWA,* which include the restriction and prohibition of certain types of activities and land uses within WHPAs.

The Site lies within the Lakes Simcoe & Couchiching/Black River Source Protection Area and based on regional-scale source protection mapping and the City of Barrie Official Plan, the Site is not located within a WHPA. However, source mapping shows that the Site is located with a HVA with vulnerability score of 6 and a SGRA.

Under the CWA and Lake Simcoe Protection Plan (2009), an application for major development within a significant groundwater recharge area shall be accompanied by an environmental 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. A water balance analysis is completed under the scope of the Functional Servicing Report, provided under separate cover.

Permit to Taker Water - Ministry of the Environment, Conservation and Parks

For construction dewatering, water takings of more than 50,000 L/day but less than 400,000 L/day may be registered on the EASR, while water takings of more than 400,000 L/day require a PTTW issued by the MECP. If it is identified that an EASR or PTTW is required for the Site, then an updated hydrogeological report, largely based on the information in this report, would need to be submitted in support of the application. The updated report would include assessment of any potential impacts associated with the construction dewatering and establish a monitoring plan and set of mitigation measures to address the potential impacts.

4 REGIONAL GEOLOGICAL AND HYDROGEOLOGICAL UNDERSTANDING

4.1 Topography and Physiography

The Site lies within the Hewitt's Creek Subwatershed which is under the jurisdiction of the LSRCA. The Hewitt's Creek Subwatershed has a surface area of 17.5 km^2 and approximately 40% of the area lies in the southern portion of the City of Barrie, where the Site is located. Over half of the Hewitt's Creek subwatershed is occupied by agriculture, while natural heritage features and urban land both occupy approximately 20% of the surface area, each.

There are no natural watercourses traversing the Site. The regional topography slopes northerly toward Kempenfelt Bay, which ultimately drains into Lake Simcoe. A regional topographic map is presented as **Figure 2**.

The ground surface topography at the Site is generally flat and ranges in elevation from approximately 270 m above sea level ("masl") to 275 masl.

The Site is located within the Peterborough Drumlin Field physiographic region. The Peterborough Drumlin Field physiographic region is characterized by drumlinized till plains and is one of the largest drumlin fields in southern Ontario. The drumlins are composed of well sorted and stratified sand and gravel, particularly to the north of the Site, close to Kempenfelt Bay. A physiography map of the Site and surrounding area is shown on **Figure 3**.

4.2 Regional Geology and Hydrogeology

The understanding of the geological and hydrogeological conditions was based on scientific work conducted by the OGS, the YPDT ORM Groundwater Program and information available from the LSRCA.

Groundwater within the Hewitt's Creek Subwatershed generally flows north, towards Kempenfelt Bay. Data from LSRCA indicates that groundwater discharge is a significant contributor to flow in the subwatershed and that groundwater levels and flows in Hewitt's Creek rise quickly in response to precipitation events, before normalizing again.

Based on available MECP well records and the Bedrock Topography and Overburden Thickness Mapping, Southern Ontario (OGS, 2006) and the YPDT ORM Groundwater Program, overburden thickness in the vicinity of the Site is interpreted to be approximately 120 m to 180 m. Mapping from the OGS indicates that the surficial geology across the Site is composed of ice-contact stratified deposits of sand and gravel, with minor silt, clay and till, surrounded by neighboring properties underlain by stone-poor, sandy silt to silty sand-textured till on Paleozoic limestone. The surficial geology of the Site area is illustrated on **Figure 4.**

A regional north to south and west to east geological cross-section developed by the YPDT ORM Groundwater Program along Hewitt's Creek Subwatershed and traversing the Site is provided on **Figures 5a and 5b**, respectively. Based on a review of the regional cross sections, the following units overlie the bedrock (with oldest layers at the bottom, and recent layers near the surface) include:

- Halton Till;
- Oak Ridges Moraine;
- Newmarket Till;
- Thorncliffe Formation;
- Sunnybrook Aquitard;
- Scarborough Formation; and
- Bedrock.

Halton Till - The Halton Till is a regionally extensive clay till deposited approximately 13,000 years ago during the Wisconsin glaciation. During the same time, late stage ice in the Lake Ontario Basin deposited the Tills that generally consist of a sandy silt to clayey silt material interbedded with silt, clay, sand and gravel. It is understood that the Halton Till acts as an aquitard of regional extent.

Oak Ridges Moraine ("ORM") - The ORM is an extensive stratified sediment complex, approximately 160 km long and 5 km to 20 km wide, located to the south of the Site. The deposits consist mainly of sand and gravel. The ORM is a major groundwater recharge area. The sediments in this area are around 100 m thick beneath the crest of the moraine but thins out rapidly towards its margins. The unit is water bearing and occurs at the Site at elevations between 240 masl and 270 masl and thicknesses generally between 0 m and 20 m.

The ORM is a regionally significant recharge area. It is known to be unconfined near the crest of the moraine, while it is confined by the till units both to the north and south of the highland. This unit serves as the main source of water for creeks as nearly 90% of the recharge via the ORM sediments discharges to the stream networks flowing north and south from the regional topographic divide. The ORM forms a regional aquifer and is commonly used for water supply.

Newmarket Till – The Newmarket Till is regionally extensive and is typically a massive, frequently over-consolidated, stony and dense silty sand diamicton deposited approximately 18,000 to 20,000 years B.P., when the Laurentide ice sheet was at its maximum extent. It acts as a regional aquitard separating the ORM Aquifer from the underlying Thorncliffe Formation aquifer. The thickness of Newmarket Till typically varies between 20 m to 50 m but locally can exceed 60 m in thickness.

Thorncliffe Formation – The Thorncliffe Formation was deposited approximately 45,000 years B.P. and is made up of glaciofluvial and lacustrine deposits containing sand, silt, and clay. The Thorncliffe Formation shows a considerable variation in grain size and thickness regionally, and locally can vary between 10 m to 30 m in thickness. It acts as an aquifer of regional extent. Based on YPDT ORM mapping, the Thorncliffe Formation is less than 1 m thick across the Site.

Sunnybrook Drift – The Sunnybrook Drift is a clast-poor silt to silty clay unit and is a regionally extensive aquitard. The thickness of the Sunnybrook Drift is generally less than 10 m to 20 m, although locally it can reach a thickness of 30 m.

Scarborough Formation – The Scarborough Formation marks the beginning of the Wisconsin glaciation, approximately 100,000 years B.P. It is composed of graduated materials that vary from fine silts and clays to sand in a deltaic sequence. The Scarborough Formation acts as an aquifer of regional extent.

Bedrock – The bedrock geology was formed in the Middle Ordovician period and consists the Lindsay Formation of the Simcoe Group. This formation is characterized thickly bedded dolomitic limestones. The bedrock topography in the vicinity of the Site is approximately 125 masl. A map of the bedrock geology is presented as **Figure 6.**

5 LOCAL GEOLOGY AND HYDROGEOLOGY

The current understanding of the local geological and hydrogeological environment at the Site is based on the geotechnical investigation conducted by Soil Engineers Ltd. and the hydrogeological investigation conducted by IBI.

5.1 Geotechnical Investigation

As part of the geotechnical investigation by Soil Engineers Ltd. in March 2020 (Soil Engineers, 2020), seven (7) boreholes were drilled to a maximum depth of approximately 9.3 m below ground surface (“mbgs”). The boreholes were identified as BH1 to BH7.

Based on the borehole logs, the primary composition of the overburden material at the Site consists of a sandy silt till underlain by fine to medium native sand. The Site, in investigated locations, is generally covered by a layer of topsoil with approximate thickness of 0.3 to 0.45 m. The topsoil was underlain by a sandy silt till in boreholes BH1, BH2, BH3, BH4 and BH6. This sandy silt till was underlain, in these boreholes, by native sand deposits to the maximum explored depths of approximately 9.3 mbgs in this investigation. The topsoil was directly underlain by the native sand material in boreholes BH5 and BH7.

The corresponding borehole logs are included in **Appendix B**.

5.2 Monitoring Network

As part of the hydrogeological investigation, four (4) boreholes were completed as 50.8 mm monitoring wells to approximate depths of between 6.1 mbgs and 7.6 mbgs (BH1, BH2, BH4 and BH5). The monitoring wells were used to measure groundwater levels, collect samples for groundwater quality analyses and estimate hydraulic conductivity of the screened units. A map illustrating the location of the boreholes and monitoring wells is provided as **Figure 7**. Monitoring well details are summarized in **Table 5-1.**

Table 5-1 Monitoring Well Details

MW ID	Coordinates		Ground Elevation (masl)	Well Depth (mbgs)	Top of Riser above Grade (m)	Well Diameter (mm)	Screen Length (m)	Screened Geological Unit
	Easting	Northing						
BH1	609427	4910420	271.67	7.58	0.84	50	3.0	Fine to Medium Sand
BH2	609454	4910488	271.14	6.10	0.86	50	3.0	Medium Sand
BH4	609549	4910507	271.00	7.61	0.64	50	3.0	Fine to Medium Sand
BH5	609617	4910469	268.72	6.05	0.81	50	3.0	Fine to Medium Sand

5.2.1 Groundwater Levels

Each monitoring well was developed prior to the first water level measurement by removing a minimum of three (3) well volumes of water to clear any silt or drilling debris from the sand pack and well casing. Four (4) monitoring events were conducted on March 24, 2020, April 22, 2020, May 25, 2020 and January 21, 2021 to assess groundwater levels at the Site. Also, ground surface elevations at the monitoring well locations were surveyed by IBI using a GPS receiver.

The groundwater table was identified to range between 263.75 masl and 264.33 masl. The highest observed groundwater level (264.33 masl) was measured at BH1 and the lowest observed water level (263.93 masl) was measured at BH4.

Based on the conceptual understanding of the local hydrogeology, the monitoring wells are considered to be screened within the unconfined overburden and the water levels recorded from the monitoring wells are interpreted to be representative of the shallow groundwater table.

The monitoring data is presented in **Table 5-2**.

Table 5-2 Water Level Measurements

Well ID	Depth to Bottom (mbgs)	24-March-2020		22-April-2020		25-May-2020		21-January-2021	
		Depth to Water (mbgs)	Equivalent masl	Depth to Water (mbgs)	Equivalent masl	Depth to Water (mbgs)	Equivalent masl	Depth to Water (mbgs)	Equivalent masl
BH1	7.58	Dry	Dry	7.34	264.33	7.41	264.26	Dry	Dry
BH2	6.10	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
BH4	7.61	7.07	263.93	6.74	264.26	6.77	264.23	7.11	263.89
BH5	6.05	4.73	263.99	4.61	264.11	4.70	264.02	4.97	263.75

5.2.2 Groundwater Flow

At a regional scale, groundwater flows towards the northwest and northeast following the topography and towards Lake Simcoe. Groundwater levels measured on April 22, 2020 were used to interpret the shallow groundwater flow pattern for the Site. The shallow groundwater mimics the surface topography and flows in an easterly to southeasterly direction. An interpreted shallow groundwater flow pattern is presented on **Figure 7**.

5.2.3 Hydraulic Conductivity

Single-well hydraulic tests were conducted by IBI on March 24, 2020 in two (2) on-site monitoring wells. These tests were carried out to estimate the in-situ hydraulic conductivity (K) of the screened overburden materials at the Site. Prior to hydraulic testing, all wells were developed by purging several well volumes to ensure debris within the screen was dislodged and representative groundwater from the formation adjacent to the screen is flowing freely to the well.

During each single-well hydraulic tests a slug of known volume was added to the well and the falling-head and rising head recovery was measured either manually or using a data logger until a minimum of 80% recovery was achieved. Hydraulic conductivity estimates were obtained using the Hvorslev method (1951). Estimated K values are presented in **Table 5-3**. The corresponding analysis are presented in **Appendix C**.

Table 5-3 Estimated Hydraulic Conductivity

Well ID	Well Diameter (m)	Screen Length (m)	Screen Unit	K (m/s)
BH4	0.05	3.05	Fine to Medium Sand	6.5×10^{-6}
BH5	0.05	3.05	Fine to Medium Sand	1.1×10^{-4}
	Geometric Mean			2.6×10^{-5}

The estimated in-situ K values range from 6.5×10^{-6} m/s to 1.1×10^{-4} m/s. Overall, the estimated horizontal hydraulic conductivities are within the published range for the types of materials within which the monitoring wells were screened (Freeze and Cherry 1979).

5.2.4 Groundwater Quality

A groundwater sample was collected from monitoring well BH4 using a low-flow peristaltic pump on March 16, 2020. Prior to collecting the sample, the monitoring well was purged by pumping three (3) well volumes or pumping the well dry three (3) times. The purging process removes stagnant water from the well, thereby ensuring the groundwater samples are representative of the groundwater in the formation adjacent to the screen.

The collected groundwater samples were sent to ALS Environmental Ltd. in Mississauga for laboratory analysis of general inorganics and metals to characterize the baseline groundwater quality at the Site. Laboratory groundwater test results were compared to the applicable Table 2 Full Depth Generic Site Condition Standards in a Potable Groundwater Condition. The groundwater samples showed no exceedances.

Additional groundwater samples were collected from monitoring well BH4 using a low-flow peristaltic pump on January 20, 2021. Prior to collecting the sample, the monitoring well was purged by pumping three (3) well volumes or pumping the well dry three (3) times.

The collected groundwater samples were sent to Caduceon Environmental Laboratories in Barrie for laboratory analysis of water quality parameters and compared to City of Barrie sewer by-law criteria.

A review of the analytical results indicated copper exceedances of concentrations at 0.017 mg/L, above the City of Barrie storm sewer by-law criteria of 0.01 mg/L. The remaining tested parameters meets the City of Barrie storm sewer by-law criteria. All tested parameters met the City of Barrie sanitary/combined sewer by-law criteria.

A summary of the analytical results and laboratory certificate of analysis are provided in **Appendix D**.

6 ASSESSMENT OF DEWATERING REQUIREMENTS

Dewatering rates were estimated based on IBI's interpretation of the hydrogeological conditions at the Site. Estimates are based on water levels observed during monitoring events. This section does not provide a design for dewatering operations, but provides an estimate of the expected dewatering rates to obtain the desired drawdown. The most effective dewatering measures for the prevalent ground conditions and the design of the dewatering operations are the sole responsibility of the dewatering contractor on-site.

Based on a review of the geotechnical investigation report (Soil Engineers, 2020) and input from the Client, it is understood that the maximum depth of excavation for construction of the underground parking is approximately 4.5 m and the lowest excavation elevation is 264.74 masl. Based on water level measurements taken at the Site, the highest shallow groundwater table was identified to be 264.33 in April 22, 2020. Since the excavation bottom is anticipated to be above the seasonal high groundwater table, significant construction dewatering is not required for the Site. However, to maintain a safe and dry work area, temporary dewatering calculations have been completed to support the lowering of the water table to a depth of 1 m below the proposed excavation.

6.1 Required Drawdown

Dewatering to facilitate the construction of the underground parking will require drawing down the water table (in the sandy overburden) to approximately 1 m below the excavation depth (1 m has been added to the estimated dewatering depths in consideration of safe working conditions). Based on water level measurements taken at the Site, the shallow groundwater table was identified to range from 263.75 masl to 264.33 masl. The highest groundwater level in the monitoring wells was used to estimate the required drawdown for a conservative estimate. The geomean K value of 2.6 x 10^{-5} m/ was also assumed in assessing dewatering requirements. Dewatering requirements are summarized in **Table 6-1.**

Table 6-1 Dewatering Estimates Summary

Proposed Structure	Estimated Maximum Depth of Excavation (mbgs)	Highest Observed Water Level		Maximum Required Drawdown to 1 m below base of excavation (m)
		Equivalent (masl)	Well ID	
Underground Parking	4.5	264.33	BH1	1.6

6.2 Zone of Influence

An estimate of the Zone of Influence ("ZOI") for dewatering trenches in unconfined aquifers can be calculated using the following equation (Bear, 1979):

$$R_0 = 2.45\sqrt{\frac{HK}{S_y}}t$$

where,

R_0	=	Zone of Influence (m), beyond which there is negligible drawdown
H	=	Distance from initial static water level to bottom of saturated aquifer (m)
S_y	=	Specific yield of the aquifer formation (assumed to be 0.25 based on Johnson (1967))
t	=	Time, in seconds, required to draw the static groundwater level to the desired level (assumed to be equivalent to 14 days)
K	=	Hydraulic Conductivity (m/s)

A summary of the ZOI estimations for the dewatering calculations is presented in **Table 6-2**.

Table 6-2 Zone of Influence Calculations Summary

Proposed Structure	H (m)	S_y	K (m/s)	t (s)	Zone of Influence, R_0 (m)
Underground Parking	2.8	0.25	2.6×10^{-5}	1209600	46.3

6.3 Construction Dewatering Rate Calculations

Dewatering rate calculations were conducted based on the proposed construction methodology. Dewatering for a linear excavation (open trenches) was simulated as flow to both sides of a line of well points, plus that to the ends of the line that is simulated as two (2) half-wells. The dewatering equation was obtained from *Construction Dewatering and Groundwater Control: New Methods and Applications - Third Edition*. New York, New York: John Wiley & Sons (Powers *et al*., 2007). For the purposes of this analysis, the analytical assessment assumes steady state flow into an open excavation. Additionally, the equations of radial flow have the following assumptions:

- Ideal aquifer conditions (homogeneous, isotropic, uniform thickness and has infinite areal extent);
- Fully penetrating pumping well;
- Only lateral flow to the pumping well; and,
- Constant pumping rate with the flow to the pumping well reaching steady state.

The following equation was used for open trenches and is based on unconfined aquifer conditions (Powers *et al*., 2007):

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

where,

Q	=	Anticipated groundwater flow r into the trench (m^3/day)

K = Hydraulic Conductivity (m/day).

H = Distance from the static water level to the bottom of the saturated aquifer (m)

h = Depth of water in the well while pumping (m)

R_0 = Distance from a point of greatest drawdown to a point where there is zero drawdown radius of influence) (m)

r_s = Distance to the wellpoints from the centre of the trench, assumed to be half of the trench width (m)

x = Trench length (m)

L = Distance from a line source to the trench, assumed to be equivalent to R_0 (m)

A summary of the dewatering rates is presented in **Table 6-3**. The details of the dewatering calculations are presented in **Appendix E.**

The Trench equation was modified for the dewatering scenario. The footprint of the proposed underground parking was conceptually divided into two (2) equal dewatering trench sections, each with a width of 2 m and length of 310 m. The total dewatering volume required for the proposed underground parking was estimated by totaling the calculated dewatering volumes from two (2) imaginary dewatering trench sections.

Table 6-3 Construction Dewatering Rate Calculations Summary

Proposed Structure	H (m)	h (m)	K (m/s)	x (m)	r_s (m)	Zone of Influence R_0 (m)	Pumping Rate (m^3/day)	Pumping Rate (L/s)
Underground parking	2.8	1.3	2.6×10^{-5}	310	1.0	46.3	109.8	1.27
Dewatering of the entire proposed underground parking							219.5	2.54
Total Estimated Dewatering Rate (with a factor of safety of 2)							439.0	5.08

To account for uncertainties and natural variability in the range of hydraulic conductivity as well as incident precipitation contribution, the calculated pumping rates were multiplied by a factor of safety of two, resulting in an overall pumping rate of 439.0 m^3/day (439,000 L/day). Incorporating the factor of safety in the dewatering calculations provides flexibility to the dewatering contractor in meeting project schedules and helps to account for the initial pumping period under transient conditions when dewatering volumes are expected to be higher.

Since the anticipated dewatering rate is greater than 400,000 L/day, the MECP will require a PTTW application to permit the construction water takings.

The design of the overall dewatering system is the responsibility of the dewatering contractor.

6.4 Long-Term Dewatering Calculations

It has been assumed that a perimeter weeping tile system surrounding the foundations will be sufficient as a passive permanent dewatering system. As these weeping tiles would be situated, partially, in saturated ground (foundations), long-term dewatering will be required on site. However, this system is expected to only be required for a short period of time during springtime each year.

6.4.1 Seepage Rate Calculations

Seepage rate calculations were completed based on modeling the foundation weeping tiles surrounding the buildings, as an open excavation. The calculations for estimating seepage from an open face in an unconfined aquifer were completed using the Dupuit equation. This equation provides a flow per unit width of open face based on the drawdown required. For the purposes of analysis, the following assumptions are made:

- The hydraulic gradient is equal to the slope of the water table;
- For small water-table gradients, the streamlines are horizontal and equipotential lines are vertical;
- Ideal aquifer conditions (homogeneous, isotropic, uniform thickness and has infinite areal extent); and
- Only lateral flow to the face.

A summary of the seepage calculation parameters is shown in **Table 6-4**:

Table 6-4 Long-Term Dewatering Parameters

Proposed Structure	Maximum Depth (mbgs)	Foundation Perimeter (m)	Highest Observed Water Level (masl)	Max Required Drawdown (m)	Local Soil Type
Perimeter Weeping Tiles	4.5	960	264.33	0.6	Sand

The following equation was used for the seepage faces at the outside perimeter of the foundation and footings is based on unconfined aquifer conditions:

$$q' = \left[\frac{K(H^2 - h^2)}{2L} \right]$$

Where:

q’ = Flow per unit width (m^2/day)

K = Hydraulic Conductivity (m/day)

H = Head at the origin (static water level) (m)

h = Head at the lowest point of drawdown (m)

L = Distance from a point of greatest drawdown to a point where there is zero drawdown radius of influence) (m)

Since the Dupuit equation provides a unit length flow, this is multiplied by the perimeter length of the foundation footings to obtain a flow rate. A summary of the calculated seepage rate is presented in **Table 6-5**:

Table 6-5 Long-Term Dewatering Rate Summary

Proposed Structure	H (m)	K (m/s)	ZOI, L (m)	Unit Flow (m^2/day)	Perimeter Length (m)	Pumping Rate (m^3/day)
Underground Parking	4.6	2.6×10^{-5}	46.3	0.07	960	69.9
Safety Factor of 2						**139.9**

A safety factor of 2 was applied to the above seepage calculations to account for variation in hydraulic conductivity in geological materials and seasonal variation.

Flow monitoring of the seepage rates during construction is recommended to better inform long-term dewatering requirements of the proposed structure. It is possible that the need for a perpetual PTTW (>50,000 L/day) can be avoided.

The seepage calculations are included in **Appendix E.**

7 WATER BALANCE

A water balance analysis is completed to compare pre-development and post-development recharge conditions to evaluate predicted changes in recharge and runoff volumes due to the proposed development.

It is understood that the pre- and post-development Site water balance understanding, and accompanying stormwater management design, is being completed under the scope of the Functional Servicing Report (FSR), provided under separate cover.

8 POTENTIAL RECEPTORS

8.1 Local Groundwater Users

A MECP well records search conducted around the Site identified 17 wells within 500 m of the Site. Based on the MECP well records, the majority of wells were classified as water supply. The search results are summarized in **Table 8-1**. The locations of nearby MECP well records are illustrated on **Figure 8**.

Table 8-1 Summary of Private Well Uses within 500 m of the Site

Well Use	Number of Wells
Test Hole	1
Abandoned/Unknown	1
Water Supply	15
Total	**17**

A search of permitted water takers within 500 m of the Site was conducted in March 2020 through the MECP digital data request process. No permitted water takers were identified within 500 m of the Site.

8.2 Private Water Well Survey

None of the identified domestic wells are located within the estimated ZOI and the temporary dewatering drawdowns are minimal.

As the area of influence is anticipated to be small, a private well survey is not required.

8.3 Environmental Features

A search of the NHIC returned no significant environmental features within the Site's boundary (MNRF, 2015). The natural features located within a 1 km buffer of the Site are illustrated on **Figure 9**.

Coldwater fish species, including mottled sculpin and brook trout have been found in Hewitt's Creek (LSRCA, 2012). As discussed previously, groundwater discharge supports baseflow contributing to the cold-water habitat. At its nearest point, Hewitt's Creek is located approximately 670 m east of the Site.

A small portion of a provincially significant wetland is located approximately 370 m southwest of the Site. However, the required drawdown of 1.6 m for the proposed development is anticipated to have negligible impact as it is not located within the ZOI and therefore expected to not interfere with any key environmental features.

9 POTENTIAL IMPACTS AND PROPOSED MITIGATION

Potential impacts associated with the proposed development can manifest in the short term as a result of construction-related activities, or in the long term if changes that occur during the Site development alter the natural form or function of the hydrologic system. The key receptors typically include:

- The groundwater system;
- Natural features (streams and wetlands); and
- Other groundwater users.

9.1 Identification and Mitigation of Potential Short-Term Impacts

9.1.1 Potential Short-Term Impacts to the Groundwater System

Dewatering can result in a decline in the groundwater level in the shallow unconfined aquifer. Although the required drawdown is small, the calculated dewatering flows are significant, due to the sand overburden aquifer. A PTTW is required to permit the construction dewatering takings.

9.1.2 Potential Short-Term Impacts to Natural Features

The lowering of the shallow groundwater level due to construction dewatering could potentially reduce the groundwater input into nearby groundwater dependent features. No groundwater dependent natural ecosystem features have been identified surrounding the Site; therefore, impacts are not expected.

Dewatering discharge directed to nearby watercourses could potentially alter the physical, chemical and thermal regime of the receiving streams. As no nearby watercourses are located on-site, short-term impacts to natural features are not expected.

9.1.3 Potential Short-Term Impacts to Other Groundwater Users

Dewatering may result in a reduction in the available groundwater supply for any private wells around the Site. As the zone of influence is localized, the on-site dewatering activities can potentially result in an impact to nearby groundwater users (i.e. dry wells) within its radius.

9.1.4 Mitigation of Short-Term Impacts

The zone of influence due to dewatering (conservative approach) is expected to be localized and limited. However, the estimated dewatering is expected to be greater than 400,000 L/day and a PTTW application will be required to permit the construction dewatering.

If construction dewatering is expected to be discharged to the municipal infrastructure, compliance with the City of Barrie Sewer Use By-Law will be required. The groundwater generally meets the City of Barrie sanitary/combined sewer parameter criteria and may therefore be discharged into the sanitary/combined network but additional management/treatment will be required (i.e. sedimentation tanks) prior to discharge to storm infrastructure.

9.2 Identification and Mitigation of Potential Long-Term Impacts

9.2.1 Potential Long-Term Impacts to the Groundwater System

No permanent dewatering system is required at the Site and no structures are within the ZOI, except the existing buildings on Site. As dewatering requirements are only in the short-term, significant settlement impacts are not anticipated.

9.2.2 Potential Long-Term Impacts to Natural Areas

Potential long-term impacts to natural features are usually related to surface water features and woodland features. There are no surface water features or wetlands on or in close proximity to the Site. Therefore, long-term impacts to natural features are not expected.

9.2.3 Potential Long-Term Impacts to Other Groundwater Users

Given that the proposed development will be serviced with municipal water, significant long-term impacts to other groundwater users are not anticipated. The local water balance will be maintained as described in the Functional Servicing Report, provided under separate cover.

9.2.4 Mitigation of Long-Term Impacts

Recharge to the aquifer system should be maintained post-development to ensure no unacceptable long-term impacts to the groundwater system. Through the implementation of low-impact development (“LID”) measures, potential development impacts to the water balance may be minimized and infiltration may be maintained in the post-development scenario. As outlined in the Functional Servicing Report, an annual infiltration deficit of 4,580.5 m^3 is expected in the post-development scenario. A Roof Water Collector system and Underground Infiltration Chambers are proposed to provide the required infiltration to compensate the deficit.

As outlined in the MOE SWMP Design Manual, there are a number of mitigation techniques that can be used to increase the potential for post-development infiltration. Techniques to maximize the water availability in pervious areas such as designing grades to direct roof runoff towards lawns, side and rear yard swales, and other open space areas throughout the development can help to increase the infiltration.

10 SUMMARY

A summary of the hydrogeological investigation is provided below:

- The Site is located within the Hewitt’s Creek Subwatershed. It is not located within any LSRCA regulated area;
- The Site is within the Peterborough Drumlin Plain physiographic region, characterized by a physiography of drumlinized till plains, composed of well sorted and stratified sand and

gravel. The Site is generally flat and represents a local topographic high point, with the local topography falling off to both the east and west of the Site;

- The surficial geology across the Site is composed of ice-contact stratified deposits of sand and gravel, with minor silt, clay and till. Bedrock was not encountered as part of this investigation but is expected to lie approximately 125 mbgs;
- Groundwater levels at the monitoring wells on-site were measured March 24, 2020, April 22, 2020, May 25, 2020, and January 20, 2021. Water level ranged between 263.75 masl and 264.33 masl;
- Single-well falling-head and rising-head tests were conducted in on-site monitoring wells to determine the in-situ hydraulic conductivity of the screened overburden materials. The in-situ K values were determined to range from 1.1×10^{-4} m/s to 6.5×10^{-6} m/s;
- Groundwater quality samples collected on March 16, 2020 met all criteria for Table 2 Full Depth Generic Site Condition Standards;
- Groundwater quality samples collected on January 20, 2021 indicated an exceedance of copper at concentrations of 0.017 mg/L, above the City of Barrie storm sewer by-law criteria of 0.01 mg/L. The remaining tested parameters met the City of Barrie storm sewer by-law criteria. All tested parameters met the City of Barrie sanitary/combined sewer by-law criteria;
- MECP water well search results indicate 17 well records within 500 m radius of the Site. The majority of the wells in the area were drilled as domestic wells. No active groundwater taking with a PTTW was identified within a 500 m radius of the Site;
- Based on observed groundwater levels during this investigation and the Client's current design inputs (underground parking, assumed at 4.5 mbgs, base at approximately 264.74 masl), the excavation will not intersect the water table. However, when accounting for a safety factor of 1 m below the excavation bottom to maintain a safe and dry working environment, the construction dewatering is anticipated to be 439.0 m^3/day (439,000 L/day);
- A passive perimeter weeping tile system has been assumed for the building to manage a calculated seepage rate of 139.9 m^3/day. It is expected this system will only be required seasonally, during springtime of each year; and
- Various best management practices could be incorporated into the proposed development, including promoting infiltration through LID practices to mitigate recharge reductions. A water balance analysis will be required to identify how groundwater resources will be maintained in the post-construction scenario. A water balance analysis has been completed and included in the Functional Servicing Report, provided under separate cover.

11 RECOMMENDATIONS

The following recommendations are made:

- As construction dewatering rates are estimated to exceed 400,000 L/day, a Category 3 PTTW will be required to permit construction dewatering;
- A perpetual (long-term) PTTW is required for the building, as permanent seepage rates are calculated to exceed 50,000 L/day during times of high groundwater (spring). It is recommended that flow monitoring is completed during construction to confirm long-term seepage requirements;
- There is less than 0.5 m separation between the basement slab and the seasonally high groundwater table. As such, the groundwater table should be taken into consideration by the geotechnical and structural engineers during detailed design of the proposed buildings; and
- It is recommended that excavation works to support the proposed construction and building addition be completed during summer to late summer months, at which time the

groundwater levels are at its lowest and temporary dewatering requirements can be minimized or avoided entirely. This can help to control real-life construction efforts and costs.

12 REFERENCES

Bear, J. (1979). Hydraulics of Groundwater, McGraw-Hill, New York, New York.

Chapman, L.J. and Putnam, D.F. (1984). The Physiography of Southern Ontario, 3rd ed. Ontario Geological Survey. Toronto: Ontario Ministry of Natural Resources.

City of Barrie (2014). The City of Barrie Official Plan, Office Consolidation.

Freeze, A. & Cherry, J. (1979). Groundwater. New Jersey: Prentice-Hall Inc.

Hvorslev, M. J. (1951) Time Lag and Soil Permeability in Groundwater Observations. Vicksburg, Miss: U.S. Army Corps. Engrs. Waterway Exp. Sta. Bull. 36

LSRCA (2015). Approved South Georgian Bay Lake Simcoe Source Protection Plan, Lake Simcoe Region Conservation Authority, Nottawasauga Valley Conservation Authority, and Severn Sound Environmental Association.

LSRCA (2012). Barrie Creeks, Lovers Creek, and Hewitt's Creek Subwatershed Plan.

Ministry of Energy, Northern Development and Mines. 2018. OGSEarth.

Ministry of the Environment, Conservation and Parks. 2020. Permit to Take Water Database.

Ministry of the Environment, Conservation and Parks. 2020. Water Well Information System.

Ministry of Natural Resources and Forestry, Natural Heritage Information Centre database – Make a Heritage Map. Accessed March 2020, Queen's Printer for Ontario, 2020.

Oak Ridges Moraine Groundwater Program - Partner Agency Data Portal, 2020. Accessed March, 2020 (https://oakridgeswater.ca/). (Previously referred to as York Peel Durham Toronto - Conservation Authorities Moraine Coalition (YPDT-CAMC) Groundwater Program.)

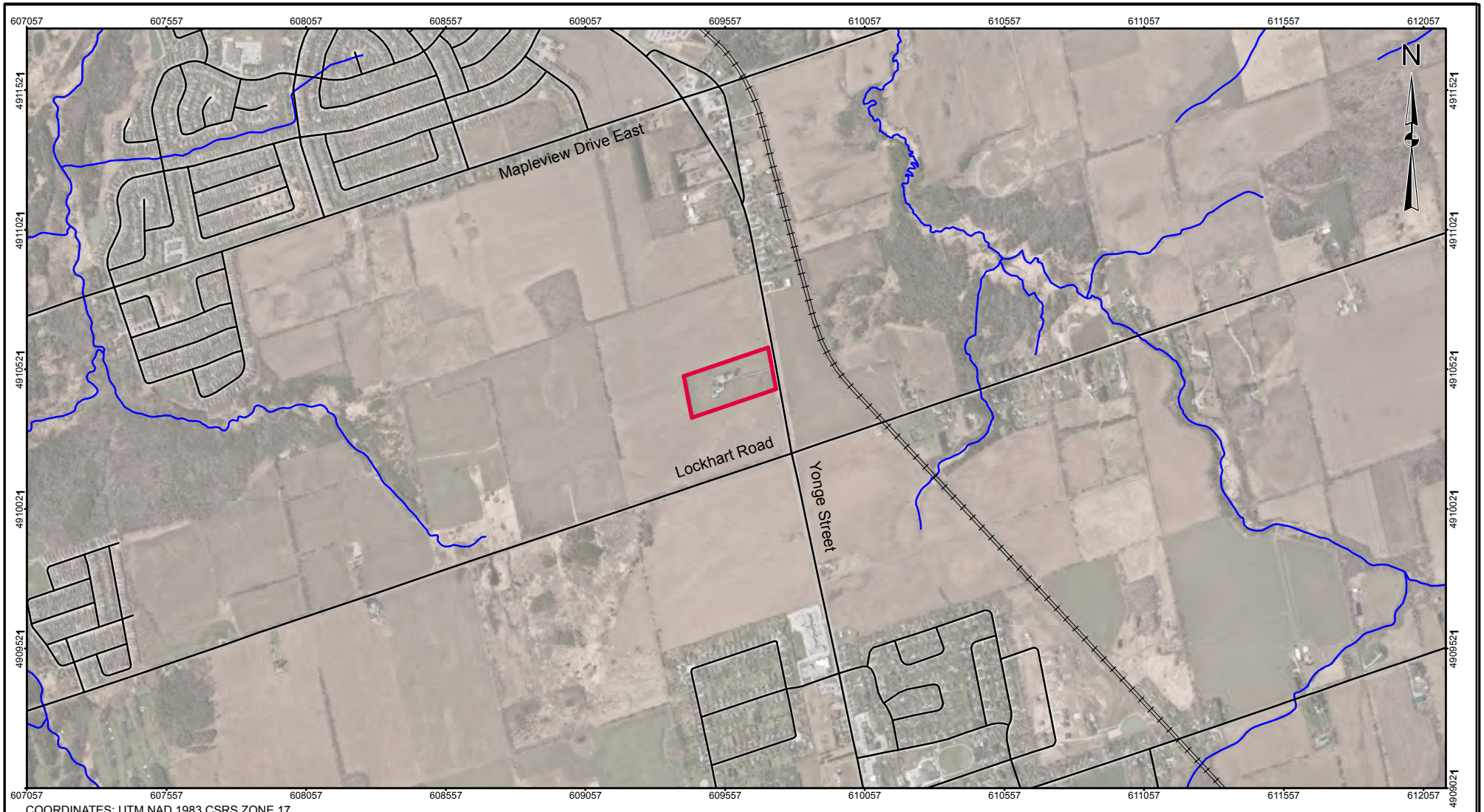
Ontario Ministry of the Environment and Climate Change. Source Protection Information Atlas Accessed February 2020. Queen's Printer for Ontario. 2020.

Ontario Ministry of the Environment and Climate Change. 2003. Stormwater Management Planning and Design Manual.

Powers, P., J., Crown, A. B., Schmall, P. C., and Kaeck, W. E., 2013. Construction Dewatering and Groundwater Control, New Methods and Application, New York, New York: John Wiley & Sons.

Soil Engineers Ltd. (2020), Proposed Residential Development, 1012 Yonge Street, City of Barrie.

FIGURES

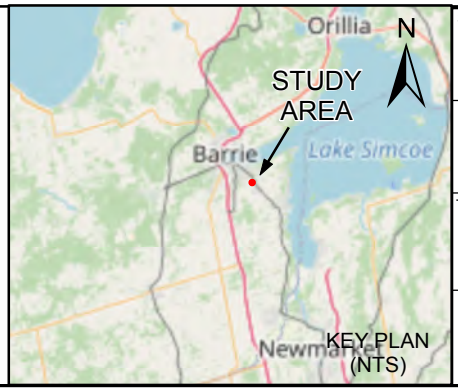


COORDINATES: UTM NAD 1983 CSRS ZONE 17.

LEGEND

- Site Boundary
- Road
- Railway
- Watercourse

REFERENCE



SCALE 1:20,000

340 0 340 680 Meters

PROJECT

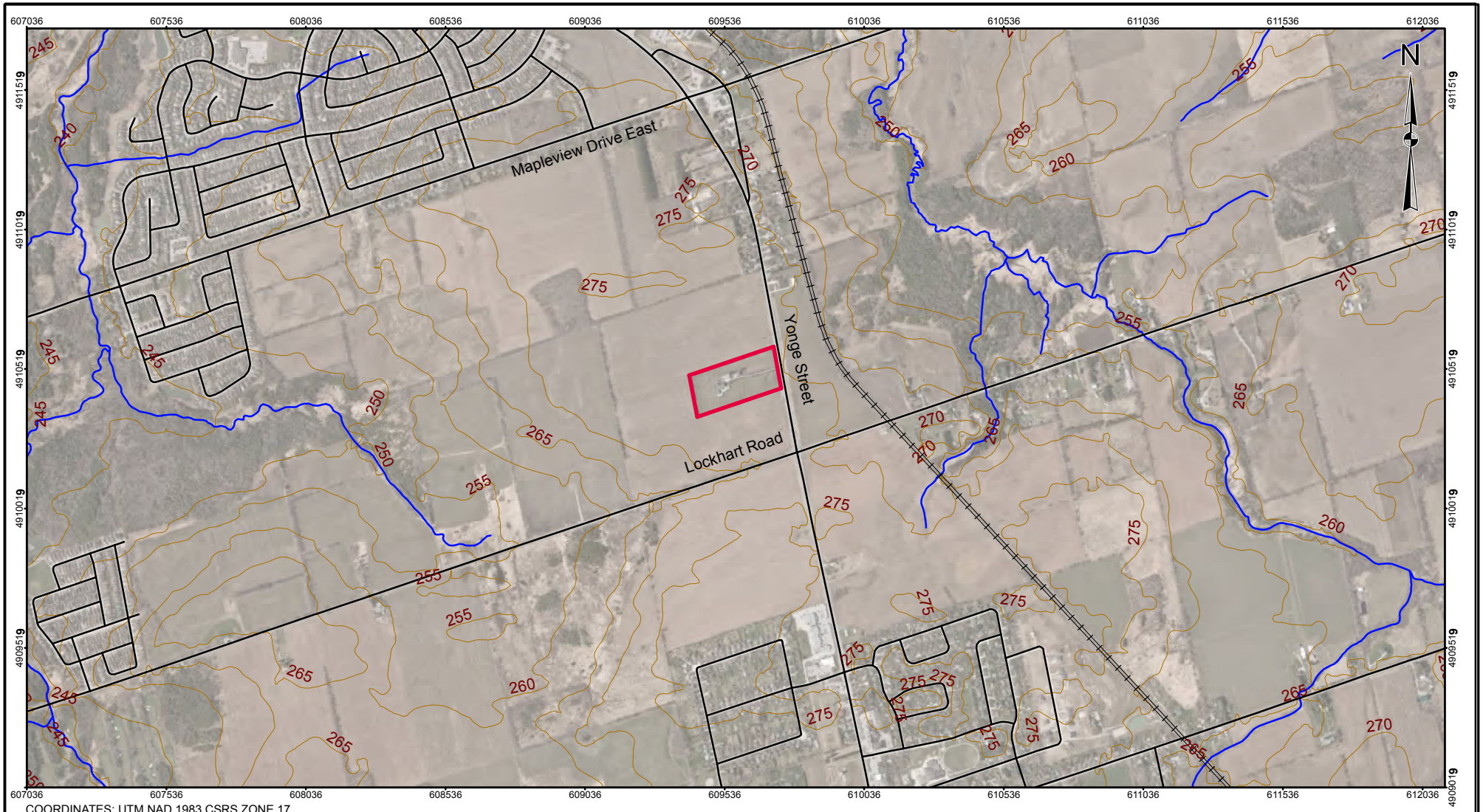
Hydrogeological Investigation
1012 Yonge Street, Barrie, Ontario

TITLE

SITE LOCATION

IBI

DATE: 02/26//2020			PROJECT: 2018-0390
GIS	A.Z.	02/26//2020	REV. 0.0
DESIGN	A.H.	02/26//2020	FIGURE 1
CHECK	A.H.	02/26//2020	

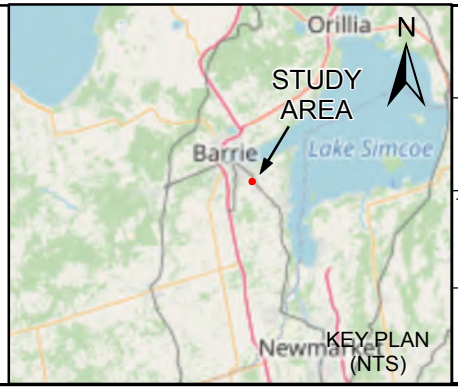


COORDINATES: UTM NAD 1983 CSRS ZONE 17.

LEGEND

- Site Boundary
- Elevation Contour (masl)
- Road
- Railway
- Watercourse

REFERENCE



KEY PLAN (NTS)

SCALE 1:20,000

330 0 330 660 Meters

PROJECT

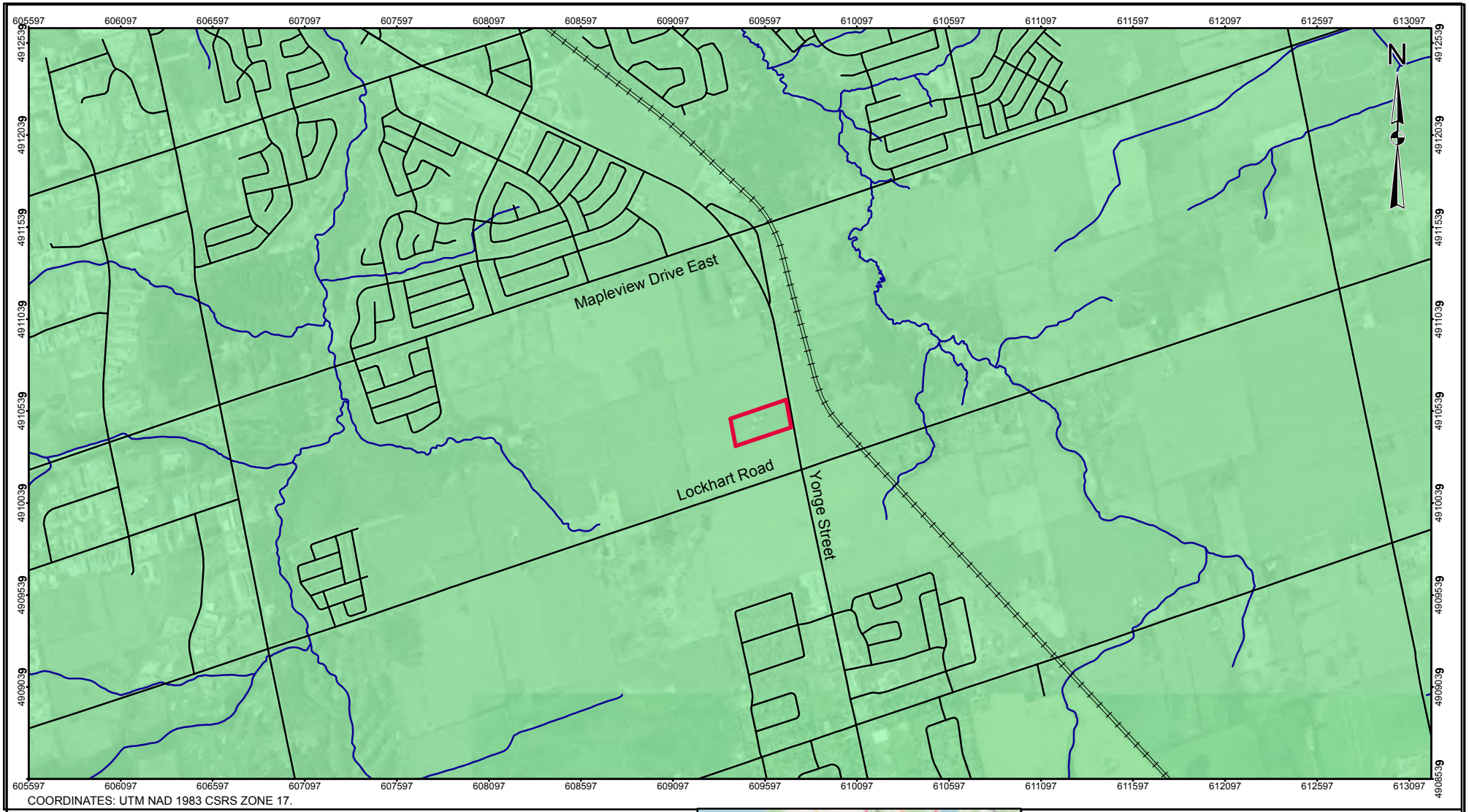
Hydrogeological Investigation
1012 Yonge Street, Barrie, Ontario

TITLE

REGIONAL TOPOGRAPHY

IBI

DATE: 02/26//2020			PROJECT: 2018-0390
GIS	A.Z.	02/26//2020	REV. 0.0
DESIGN	A.H.	02/26//2020	FIGURE 2
CHECK	A.H.	02/26//2020	



COORDINATES: UTM NAD 1983 CSRS ZONE 17.

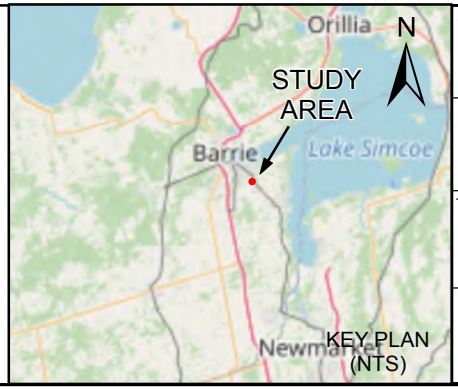
LEGEND

- Site Boundary
- Road
- Railway
- Watercourse

Physiographic Region

31, Peterborough Drumlin Field

REFERENCE



SCALE 1:30,000

500 0 500 1,000 Meters

PROJECT

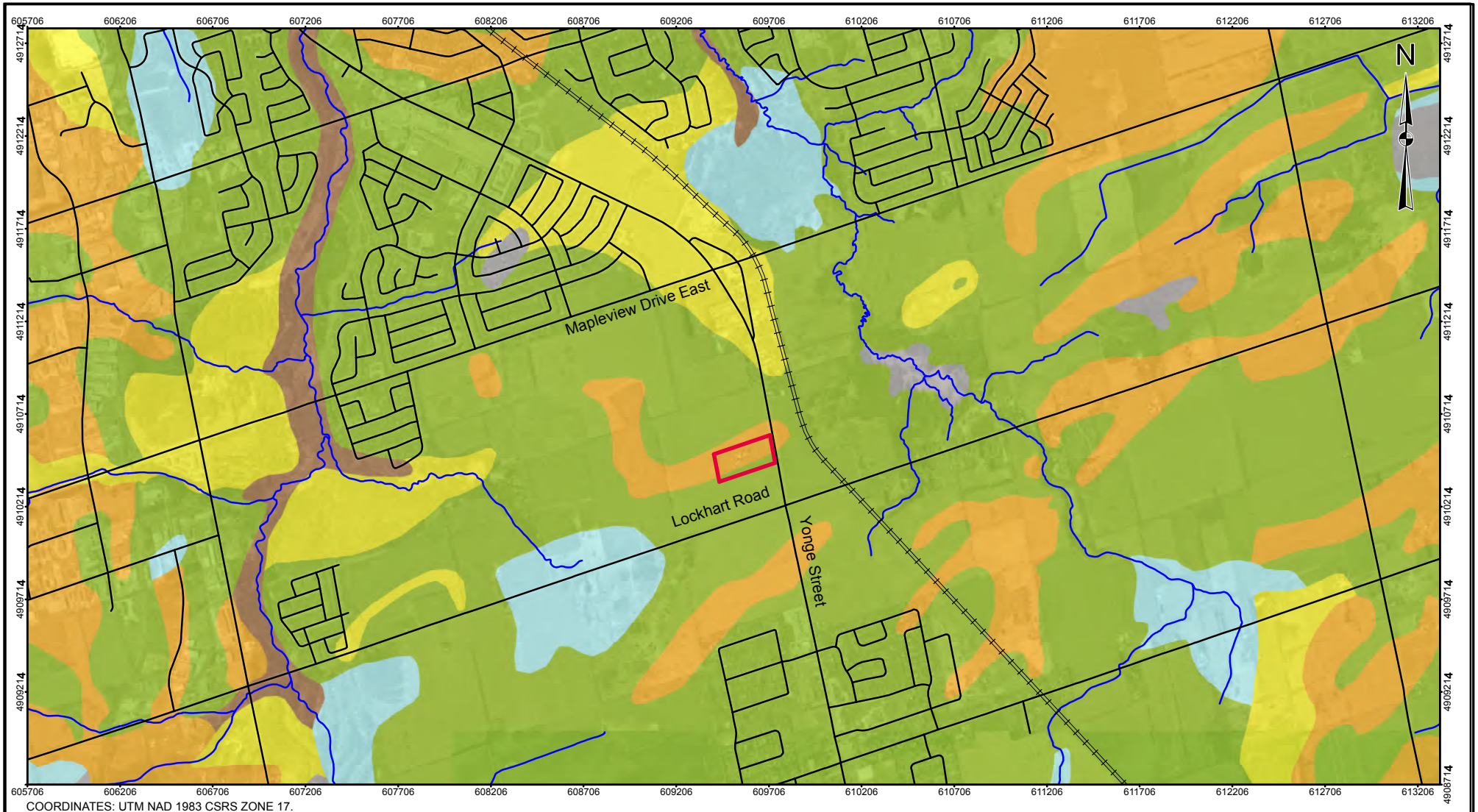
Hydrogeological Investigation
1012 Yonge Street, Barrie, Ontario

TITLE

PHYSIOGRAPHY

IBI

DATE: 02/26//2020			PROJECT: 2018-0390
GIS	A.Z.	02/26//2020	REV. 0.0
DESIGN	A.H.	02/26//2020	**FIGURE 3**
CHECK	A.H.	02/26//2020	

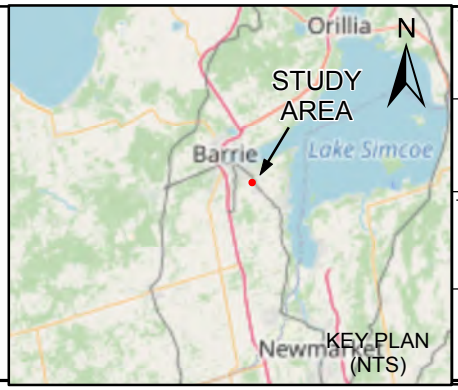


COORDINATES: UTM NAD 1983 CSRS ZONE 17.

LEGEND

- Site Boundary
- Road
- Railway
- Watercourse
- 5b: Stone-poor, carbonate-derived silty to sandy till
- 6: Ice-contact stratified deposits
- 8a: Massive-well laminated
- 9b: Littoral-foreshore deposits
- 9c: Foreshore-basinal deposits
- 19: Modern alluvial deposits
- 20: Organic deposits

REFERENCE



SCALE 1:30,000

500 0 500 1,000 Meters

PROJECT

Hydrogeological Investigation
1012 Yonge Street, Barrie, Ontario

TITLE

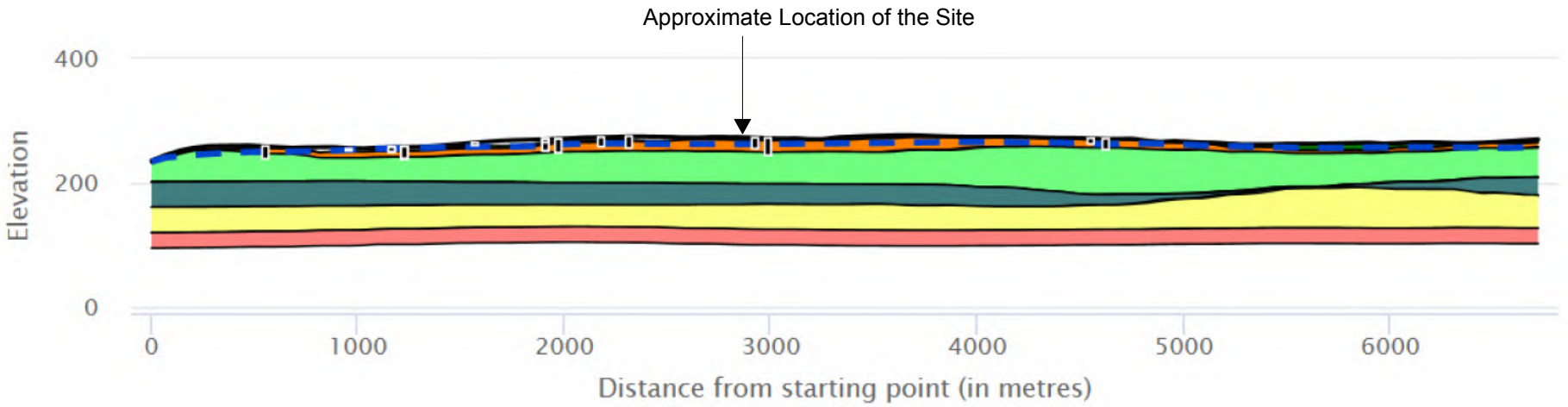
SURFICIAL GEOLOGY

IBI

DATE: 02/26//2020			PROJECT: 2018-0390
GIS	A.Z.	02/26//2020	REV. 0.0
DESIGN	A.H.	02/26//2020	**FIGURE 4**
CHECK	A.H.	02/26//2020	

North

South



REFERENCE

Produced by Cole Engineering under licence from the Oak Ridges Moraine Groundwater Program. Accessed 2020.

SCALE AS SHOWN

PROJECT

Hydrogeological Investigation
1012 Yonge Street, Barrie, Ontario

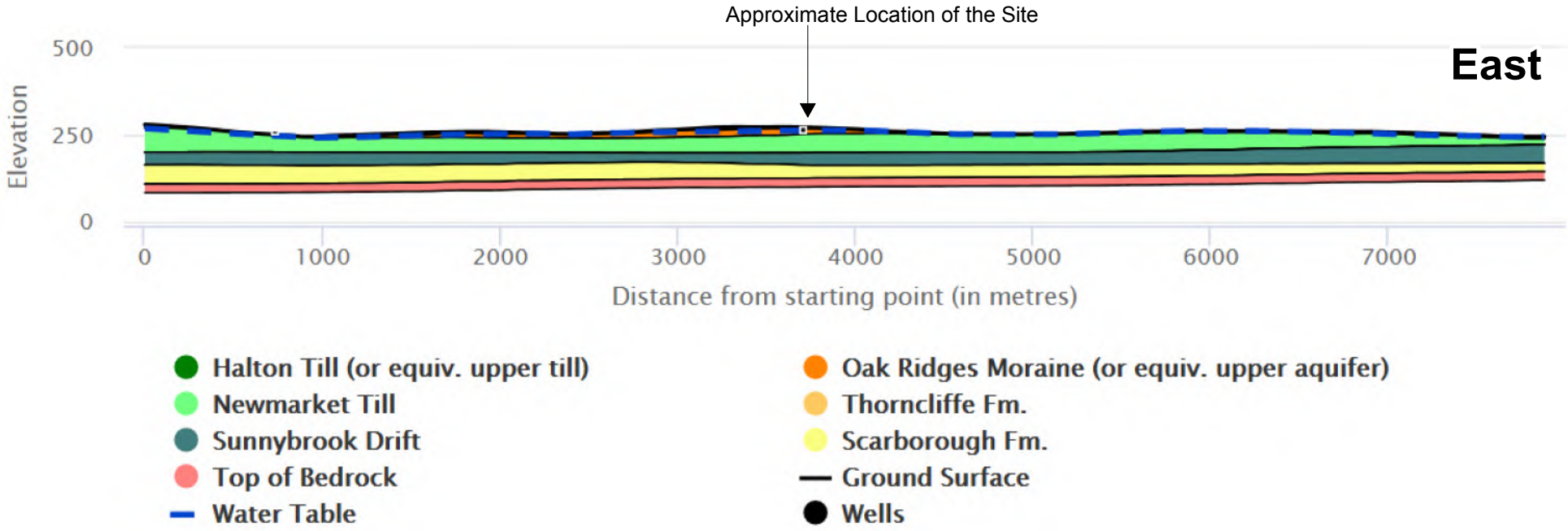
TITLE

N-S GEOLOGICAL CROSS-SECTION

IBI

DATE: 02/26//2020			PROJECT: 2018-0390
GIS	A.Z.	02/26//2020	REV. 0.0
DESIGN	A.H.	02/26//2020	**FIGURE 5a**
CHECK	A.H.	02/26//2020	

West



REFERENCE

Produced by Cole Engineering under licence from the Oak Ridges Moraine Groundwater Program. Accessed 2020.

SCALE AS SHOWN

PROJECT

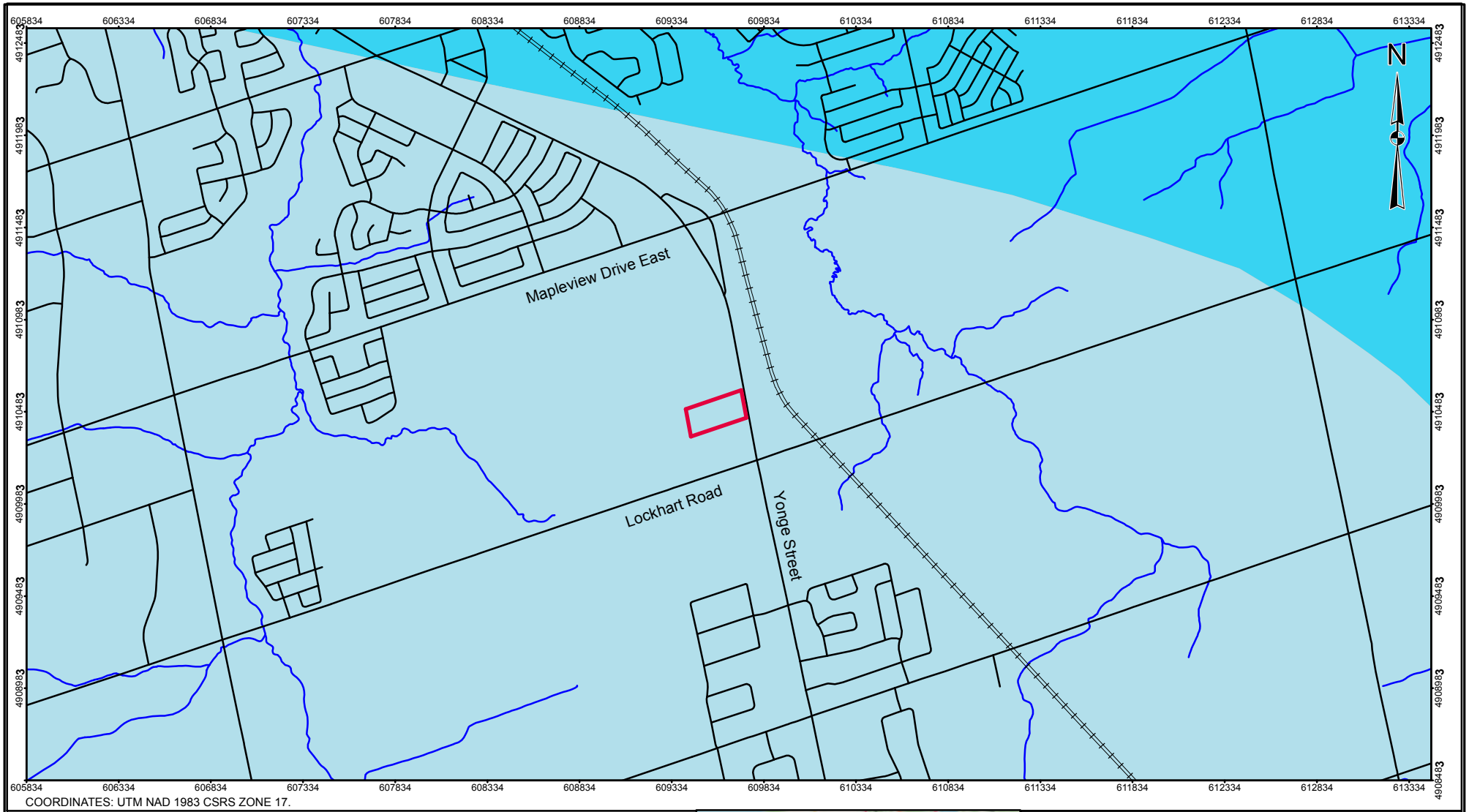
Hydrogeological Investigation
1012 Yonge Street, Barrie, Ontario

TITLE

W-E GEOLOGICAL CROSS-SECTION

IBI

DATE: 02/26//2020			PROJECT: 2018-0390
GIS	A.Z.	02/26//2020	REV. 0.0
DESIGN	A.H.	02/26//2020	**FIGURE 5b**
CHECK	A.H.	02/26//2020	



COORDINATES: UTM NAD 1983 CSRS ZONE 17.

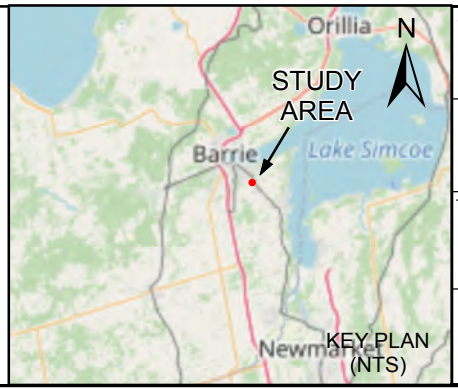
LEGEND

- Site Boundary
- Road
- Railway
- Watercourse

Bedrock Geology

- 11: Lindsay
- 10: Verulam

REFERENCE



SCALE 1:30,000

500 0 500 1,000 Meters

PROJECT

Hydrogeological Investigation
1012 Yonge Street, Barrie, Ontario

TITLE

BEDROCK GEOLOGY

IBI

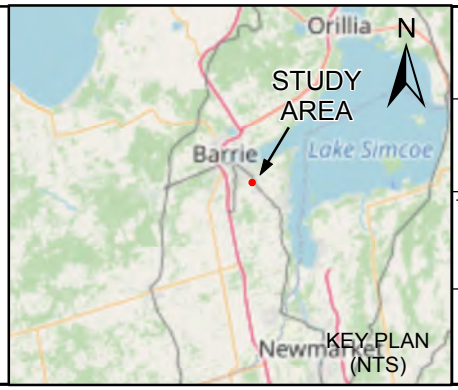
DATE: 02/26//2020			PROJECT: 2018-0390
GIS	A.Z.	02/26//2020	REV. 0.0
DESIGN	A.H.	02/26//2020	FIGURE 6
CHECK	A.H.	02/26//2020	

COORDINATES: UTM NAD 1983 CSRS ZONE 17.

LEGEND

- Site Boundary
- Monitoring Well
- Groundwater Contour
- 263.93 Groundwater Elevation (masl)
- Interpreted Groundwater Flow Direction

REFERENCE



SCALE 1:2,000

30 0 30 60 Meters

PROJECT

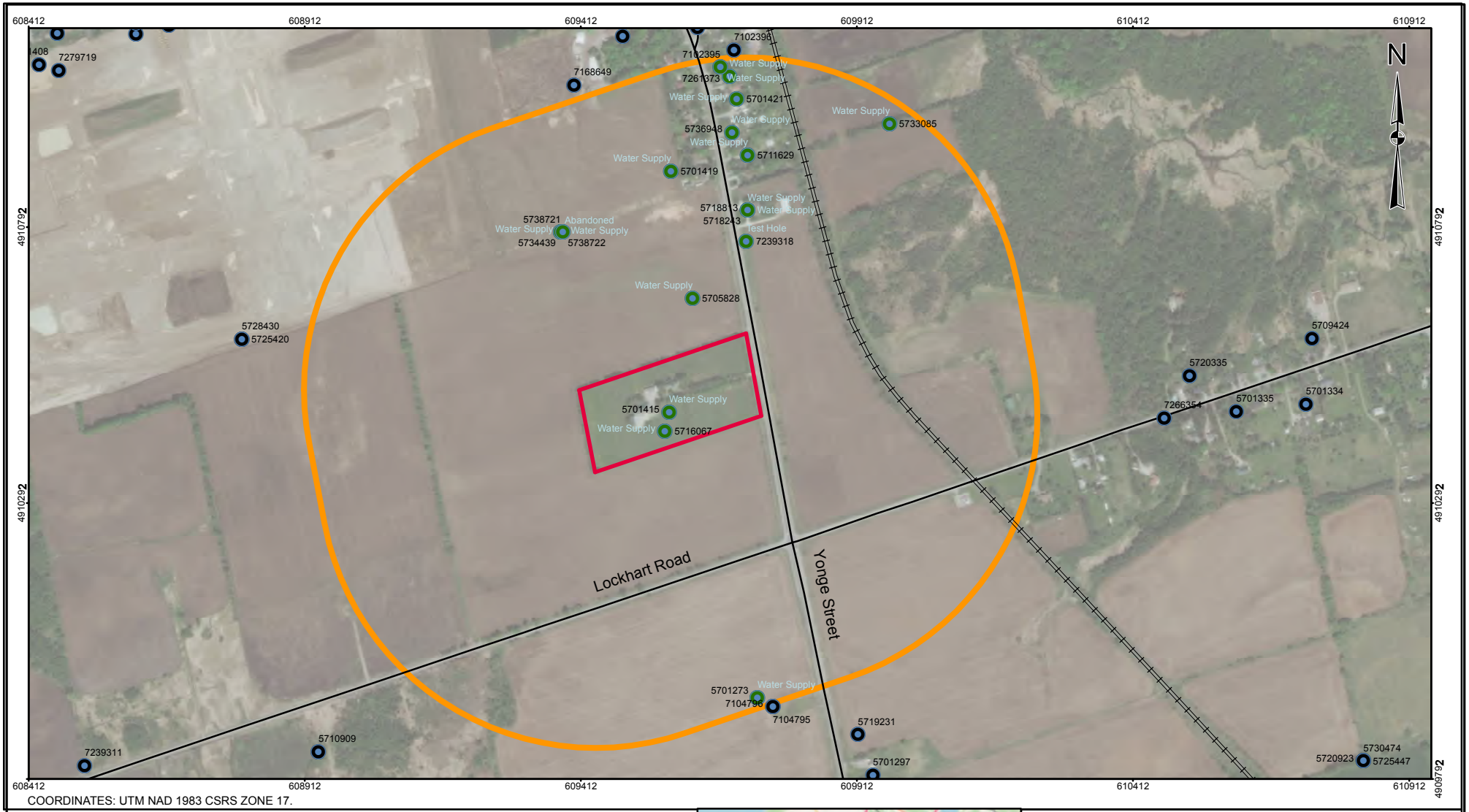
Hydrogeological Investigation
1012 Yonge Street, Barrie, Ontario

TITLE

INTERPRETED SHALLOW GROUNDWATER FLOW PATTERN

IBI

DATE: 04/06//2020			PROJECT: 2018-0390
GIS	A.Z.	04/06//2020	REV. 0.0
DESIGN	A.H.	04/06//2020	FIGURE 7
CHECK	A.H.	04/06//2020	

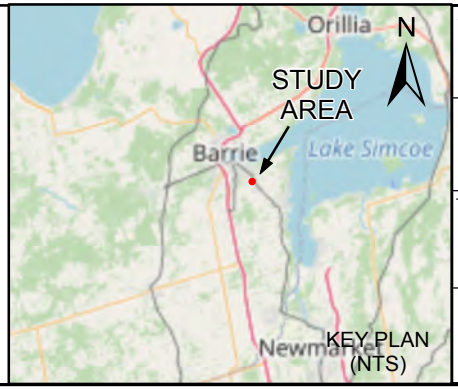


COORDINATES: UTM NAD 1983 CSRS ZONE 17.

LEGEND

- Site Boundary
- 500 m buffer
- Road
- Railway
- MECP Well Record
- MECP Well Record within 500 m

REFERENCE



SCALE 1:10,000

160 0 160 320 Meters

PROJECT

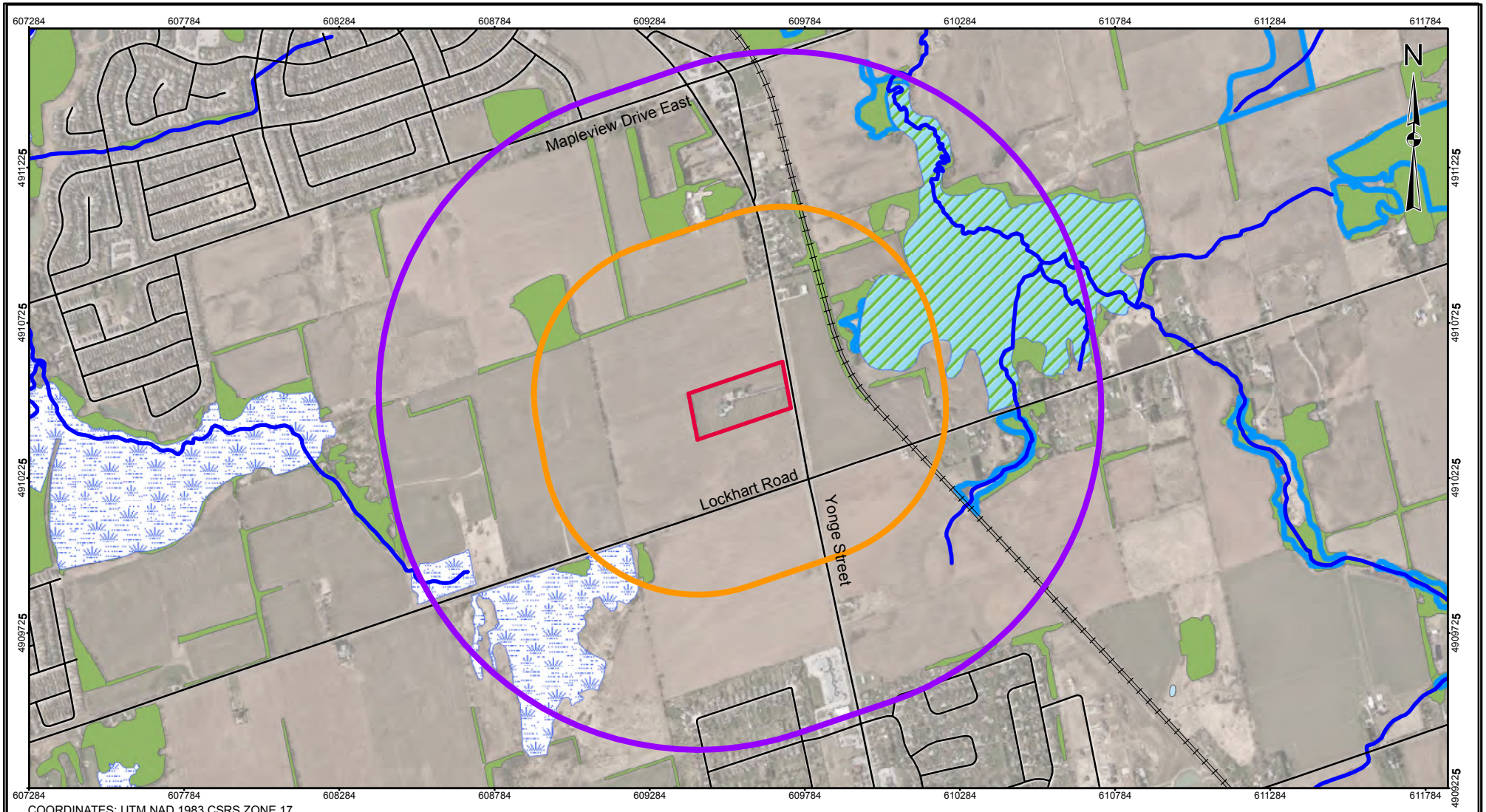
Hydrogeological Investigation
1012 Yonge Street, Barrie, Ontario

TITLE

MECP WELL MAP

IBI

DATE: 02/26//2020			PROJECT: 2018-0390
GIS	A.Z.	02/26//2020	REV. 0.0
DESIGN	A.H.	02/26//2020	FIGURE 8
CHECK	A.H.	02/26//2020	

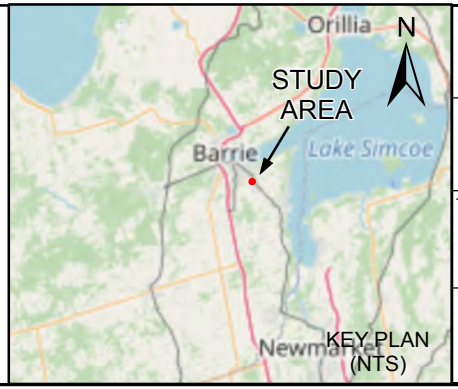


COORDINATES: UTM NAD 1983 CSRS ZONE 17.

LEGEND

- Site Boundary
- 1000 m buffer
- 500 m buffer
- Railway
- Road
- Watercourses
- Waterbodies
- Non Provincially Significant Wetland
- Provincially Significant Wetland
- Unevaluated Wetland
- Wooded Area

REFERENCE



SCALE 1:18,000

300 0 300 600 Meters

PROJECT

Hydrogeological Investigation
1012 Yonge Street, Barrie, Ontario

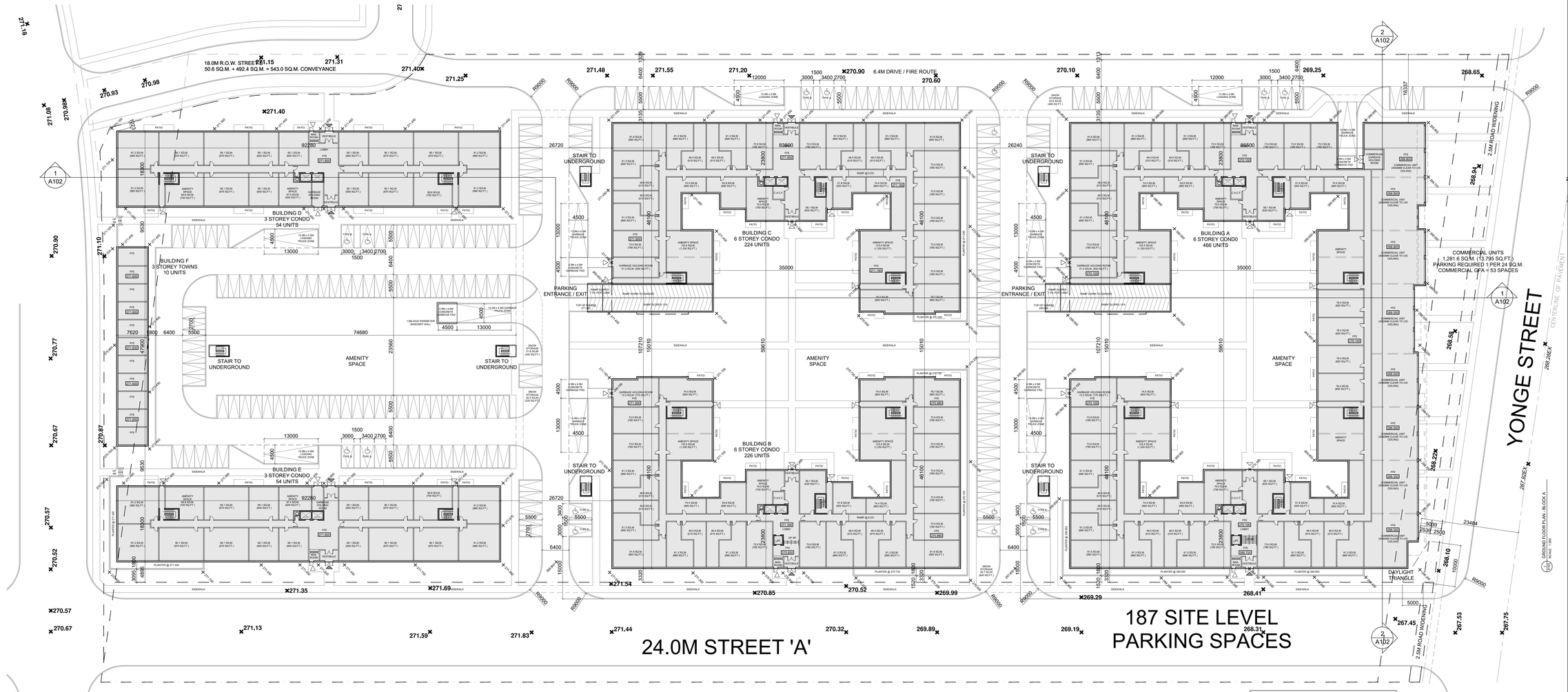
TITLE

KEY ENVIRONMENTAL FEATURES

IBI

DATE: 02/26//2020			PROJECT: 2018-0390
GIS	A.Z.	02/26//2020	REV. 0.0
DESIGN	A.H.	02/26//2020	FIGURE 9
CHECK	A.H.	02/26//2020	

Appendix A – Site Plan



1,029 RESIDENTIAL UNITS (10 TOWNHOUSE UNITS AND 1,019 CONDO UNITS)

80,906.5 SQ.M. (870,875 SQ.FT.) OF RESIDENTIAL GFA

1,281.6 SQ.M. (13,795 SQ.FT.) OF COMMERCIAL GFA

1 A100 SITE PLAN
SCALE: 1:400

BARRIER FREE PARKING STALLS TO BE SIGNED (Rb-93) AND MARKED IN ACCORDANCE WITH ONTARION TRAFFIC MANUAL BOOK 5 - REGULATORY SIGNS

	TYPE	AREA	UNITS
PARKING	UNDERGROUND GARAGE	35,283.5 SQ.M. (379,790 SQ.FT.)	1,033 SPACES
	SITE LEVEL PARKING		187 SPACES
	TOTAL PARKING (53 COMMERCIAL SPACES REQUIRED)		1,220 SPACES
	PARKING RATIO OF 1.13 SPACES PER UNIT		
	COMMERCIAL SPACE (OFF YONGE) (REQUIRES 53 PARKING SPACES)	1,281.6 SQ.M. (13,795 SQ.FT.)	N/A
BLOCK A (MIXED-USE) 6 STOREY CONDO	GROUND (RESIDENTIAL)	4,657.0 SQ.M. (50,125 SQ.FT.)	46 UNITS
	GROUND (COMMERCIAL)	1,281.6 SQ.M. (13,795 SQ.FT.)	
	TYPICAL (2ND TO 6TH)	6,116.3 SQ.M. (65,835 SQ.FT.)	83 UNITS
	TOTAL (GROUND TO 6TH)	36,520.1 SQ.M. (393,100 SQ.FT.)	461 UNITS
BLOCK B 6 STOREY CONDO	GROUND	2,884.1 SQ.M. (31,045 SQ.FT.)	31 UNITS
	TYPICAL (2ND TO 6TH)	2,884.1 SQ.M. (31,045 SQ.FT.)	39 UNITS
	TOTAL	17,304.6 SQ.M. (186,265 SQ.FT.)	226 UNITS
BLOCK C 6 STOREY CONDO	GROUND	2,715.7 SQ.M. (29,230 SQ.FT.)	29 UNITS
	TYPICAL (2ND TO 6TH)	2,884.1 SQ.M. (31,045 SQ.FT.)	39 UNITS
	TOTAL	17,136.2 SQ.M. (184,455 SQ.FT.)	224 UNITS
BLOCK D 3 STOREY CONDO	GROUND	1,688.7 SQ.M. (18,175 SQ.FT.)	16 UNITS
	TYPICAL (2ND TO 3RD)	1,688.7 SQ.M. (18,175 SQ.FT.)	19 UNITS
	TOTAL	5,066.1 SQ.M. (54,530 SQ.FT.)	54 UNITS
BLOCK E 3 STOREY CONDO	GROUND	1,688.7 SQ.M. (18,175 SQ.FT.)	16 UNITS
	TYPICAL (2ND TO 3RD)	1,688.7 SQ.M. (18,175 SQ.FT.)	19 UNITS
	TOTAL	5,066.1 SQ.M. (54,530 SQ.FT.)	54 UNITS
BLOCK F 3 STOREY TOWNS	GROUND	365.0 SQ.M. (3,930 SQ.FT.)	
	TYPICAL (2ND TO 3RD)	365.0 SQ.M. (3,930 SQ.FT.)	
	TOTAL	1,095.0 SQ.M. (11,785 SQ.FT.)	10 UNITS
TOTAL	RESIDENTIAL GFA	80,906.5 SQ.M. (870,875 SQ.FT.)	1,029 UNITS
	COMMERCIAL GFA	1,281.6 SQ.M. (13,795 SQ.FT.)	
	TOTAL GFA	82,188.1 SQ.M. (884,670 SQ.FT.)	

2 A100 BUILDING AND PROJECT STATISTCS
SCALE: 1:400

SITE STATISTICS:

SITE AREA	39,606.3 SQ.M. (426,320 SQ.FT.)
BUILDING COVERAGE	15,626.9 SQ.M. (168,205 SQ.FT.) OR 39.46%
FSI	2.08 (INCLUDING COMMERCIAL)
	2.04 (EXCLUDING COMMERCIAL)
UNDERGROUND GARAGE	35,283.5 SQ.M. (379,790 SQ.FT.)

SELLABLE AREA STATISTICS:		AREA (GFA)	SERVICE AREA	SELLABLE AREA (TSA)
BLOCK A (MIXED-USE) 6 STOREY CONDO	GROUND (RESIDENTIAL)	4,657.0 SQ.M.	1,668.4 SQ.M.	2,988.6 SQ.M.
	TYPICAL (2ND TO 6TH)	6,116.3 SQ.M.	532.3 SQ.M.	5,584.0 SQ.M.
	TOTAL (GROUND TO 6TH)	35,238.5 SQ.M.	4,329.9 SQ.M.	30,908.6 SQ.M. (87.7%)
'DOES NOT INCLUDE 1,281.6 SQ.M. (13,795 SQ.FT.) OF GROUND FLOOR COMMERCIAL				
BLOCK B 6 STOREY CONDO	GROUND	2,884.1 SQ.M.	829.5 SQ.M.	2,054.6 SQ.M.
	TYPICAL (2ND TO 6TH)	2,884.1 SQ.M.	245.6 SQ.M.	2,638.5 SQ.M.
	TOTAL	17,304.6 SQ.M.	2,057.5 SQ.M.	15,247.1 SQ.M. (88.1%)
BLOCK C 6 STOREY CONDO	GROUND	2,715.7 SQ.M.	808.1 SQ.M.	1,907.6 SQ.M.
	TYPICAL (2ND TO 6TH)	2,884.1 SQ.M.	245.6 SQ.M.	2,638.5 SQ.M.
	TOTAL	17,136.2 SQ.M.	2,036.1 SQ.M.	15,100.1 SQ.M. (88.1%)
BLOCK D 3 STOREY CONDO	GROUND	1,688.7 SQ.M.	405.9 SQ.M.	1,282.8 SQ.M.
	TYPICAL (2ND TO 3RD)	1,688.7 SQ.M.	159.9 SQ.M.	1,528.8 SQ.M.
	TOTAL	5,066.1 SQ.M.	725.7 SQ.M.	4,340.4 SQ.M. (85.7%)
BLOCK E 3 STOREY CONDO	GROUND	1,688.7 SQ.M.	405.9 SQ.M.	1,282.8 SQ.M.
	TYPICAL (2ND TO 3RD)	1,688.7 SQ.M.	159.9 SQ.M.	1,528.8 SQ.M.
	TOTAL	5,066.1 SQ.M.	725.7 SQ.M.	4,340.4 SQ.M. (85.7%)
BLOCK F 3 STOREY TOWNS	GROUND	365.0 SQ.M.	0 SQ.M.	365.0 SQ.M.
	TYPICAL (2ND TO 3RD)	365.0 SQ.M.	0 SQ.M.	730.0 SQ.M.
	TOTAL	1,095.0 SQ.M.	0 SQ.M.	1,095.0 SQ.M. (100%)
PROJECT TOTAL		80,906.5 SQ.M.	9,874.9 SQ.M.	71,031.6 SQ.M. (87.8%)

THESE DRAWINGS ARE NOT TO BE SCALED:
ALL DIMENSIONS MUST BE VERIFIED BY CONTRACTOR PRIOR TO COMMENCEMENT OF ANY WORK. ANY DISCREPANCIES MUST BE REPORTED DIRECTLY TO SRN ARCHITECTS INC.

NO:	DATE:	ISSUED FOR:
1	23/04/20	CLIENT REVIEW
2	02/05/20	CLIENT REVIEW
3	09/05/20	CLIENT REVIEW
4	23/05/20	CLIENT REVIEW
5	22/11/20	CLIENT REVIEW
6	14/12/20	CLIENT REVIEW
7	19/01/21	CLIENT REVIEW
8	26/02/21	CLIENT REVIEW

ADDITIONAL NOTES:

PRELIMINARY, NOT FOR CONSTRUCTION
ALL AREAS CALCULATIONS ARE PRELIMINARY

NO:	DATE:	REVISION COMMENT:

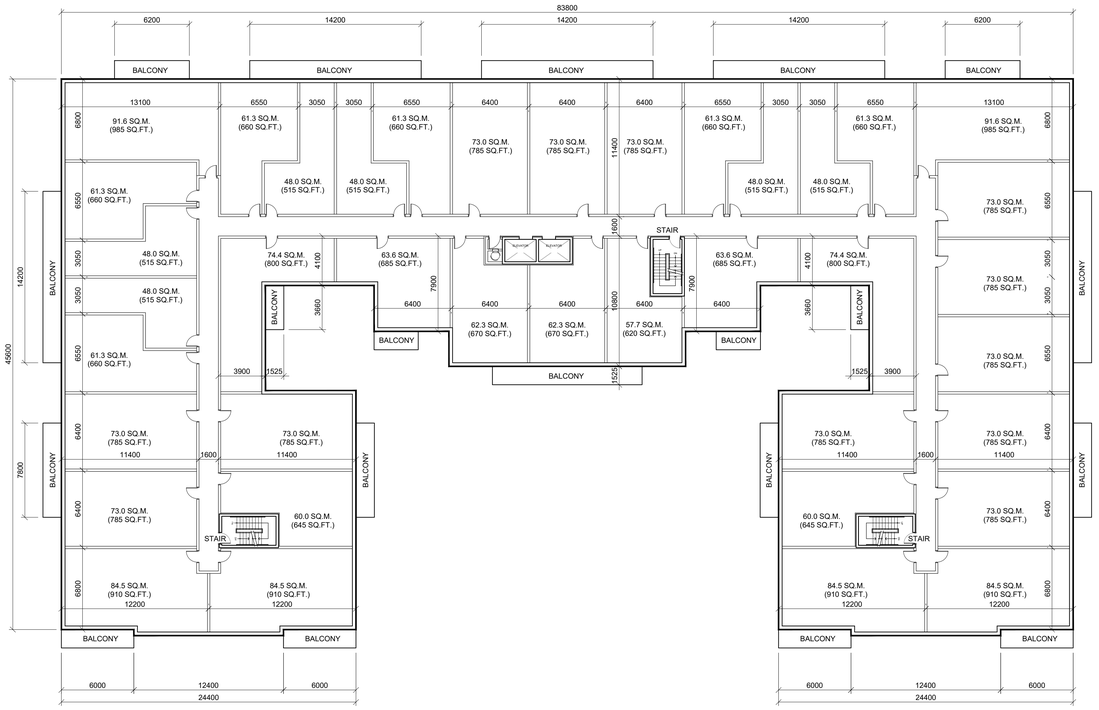
SRN ARCHITECTS
8395 JANE STREET, SUITE 203
VAUGHAN, ONTARIO. L4K 5Y2
PHONE: 905.417.5515 FAX: 905.417.5517

CLIENT:

PROJECT:
BARRIE MIXED-USE
1012 YONGE STREET
BARRIE, ONTARIO.

DRAWING TITTLE:
SITE PLAN,
STATS AND OBC MATRIX

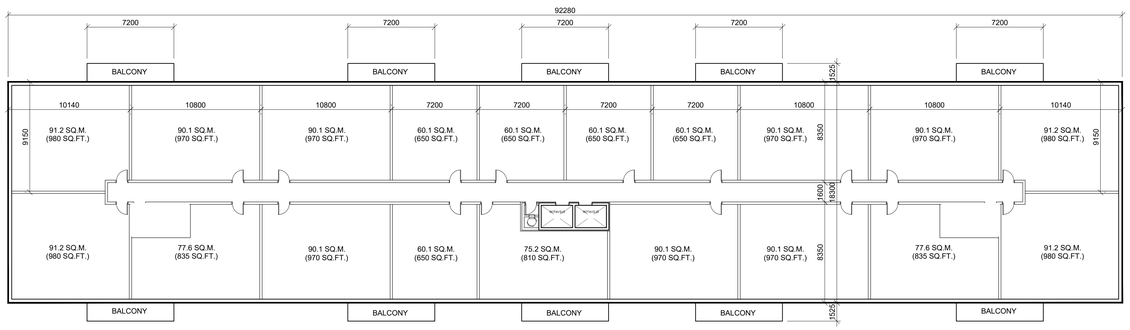
DATE: 14/12/20 | SCALE: 1:400
DRAWN BY: G.P.R. | CHECKED BY: G.P.R.
PROJECT NUMBER: S19013 | DRAWING NUMBER: A100



2 / A101 TYPICAL FLOOR PLATE - BLOCK B & C

SCALE: 1:200

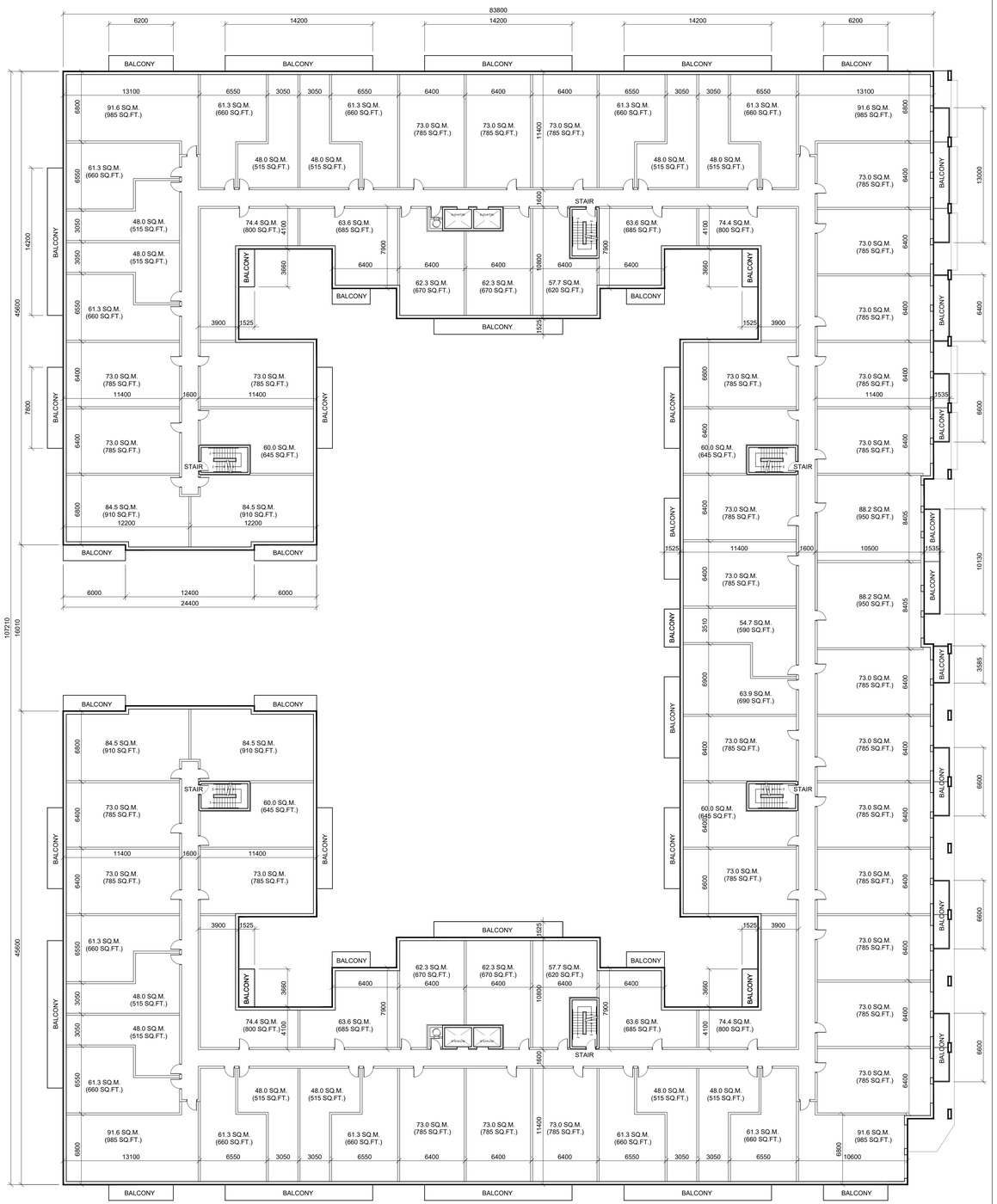
2,884.1 SQ.M. (31,045 SQ.FT.)
39 UNITS



3 / A101 TYPICAL FLOOR PLATE - BLOCK D & E

SCALE: 1:200

1,688.7 SQ.M. (18,175 SQ.FT.)
19 UNITS



1 / A101 TYPICAL FLOOR PLATE - BLOCK A

SCALE: 1:200

6,116.3 SQ.M. (65,835 SQ.FT.)
83 UNITS

THESE DRAWINGS ARE NOT TO BE SCALED:
ALL DIMENSIONS MUST BE VERIFIED BY CONTRACTOR PRIOR TO COMMENCEMENT OF ANY WORK. ANY DISCREPANCIES MUST BE REPORTED DIRECTLY TO SRN ARCHITECTS INC.

NO:	DATE:	ISSUED FOR:
1	23/04/20	CLIENT REVIEW
2	02/05/20	CLIENT REVIEW
3	09/05/20	CLIENT REVIEW
4	23/05/20	CLIENT REVIEW
5	22/11/20	CLIENT REVIEW
6	14/12/20	CLIENT REVIEW
7	19/01/21	CLIENT REVIEW
8	26/02/21	CLIENT REVIEW

ADDITIONAL NOTES:

PRELIMINARY, NOT FOR CONSTRUCTION
ALL AREAS CALCULATIONS ARE PRELIMINARY

NO:	DATE:	REVISION COMMENT:

SRN ARCHITECTS
8395 JANE STREET, SUITE 203
VAUGHAN, ONTARIO. L4K 5Y2
PHONE: 905.417.5515 FAX: 905.417.5517

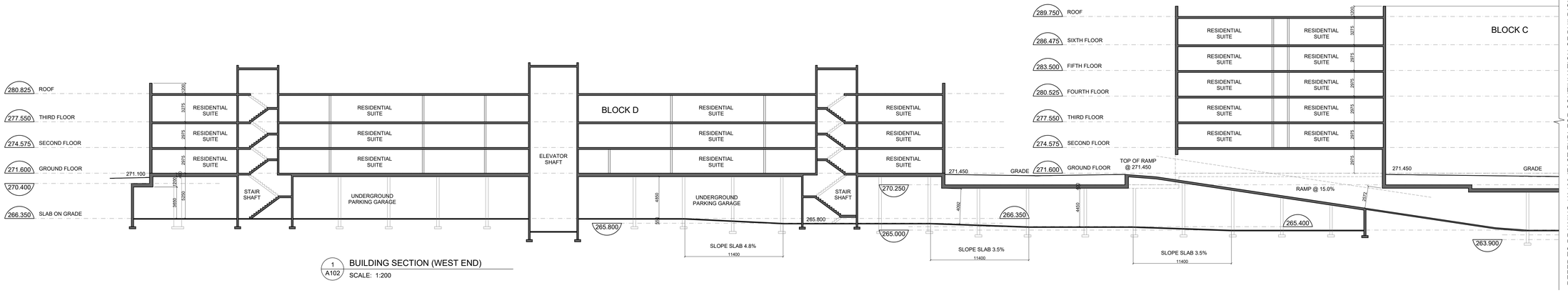
CLIENT:

PROJECT:
BARRIE MIXED-USE

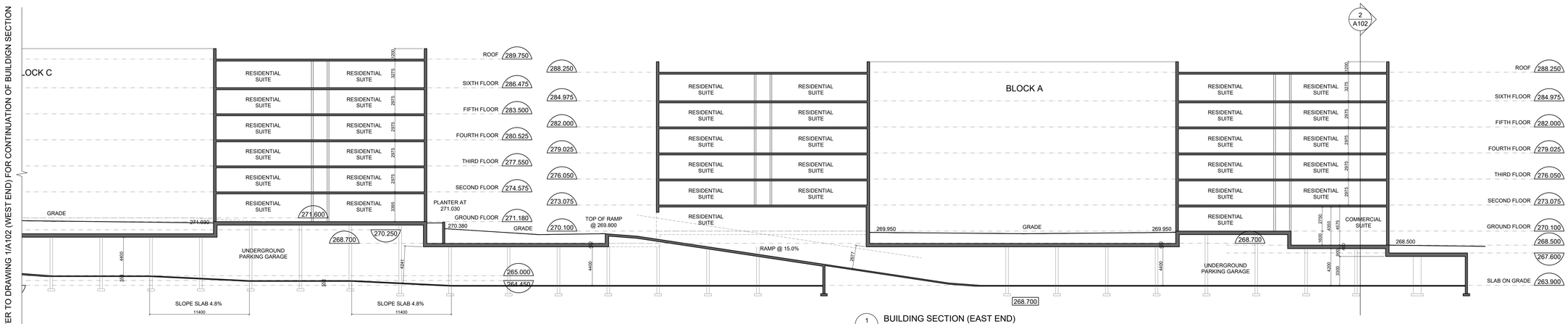
1012 YONGE STREET
BARRIE, ONTARIO.

DRAWING TITTLE:
TYPICAL FLOOR PLATES
CONDO BUILDINGS

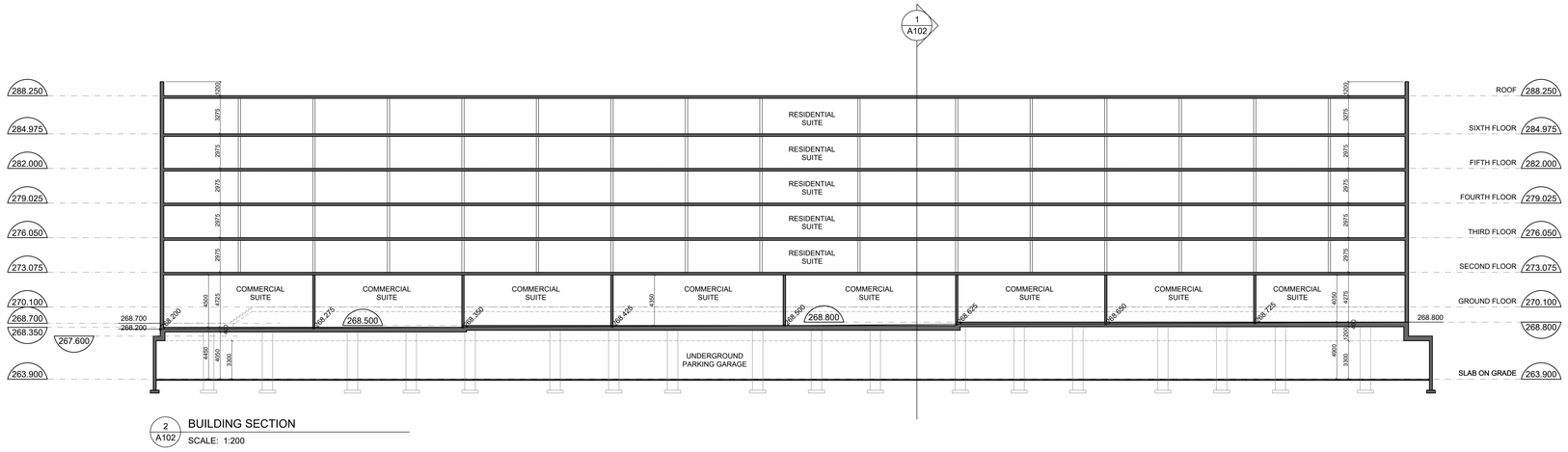
DATE: 22/11/20	SCALE: 1:200
DRAWN BY: G.P.R.	CHECKED BY: G.P.R.
PROJECT NUMBER: S19013	DRAWING NUMBER: A101



1 A102 BUILDING SECTION (WEST END)
SCALE: 1:200



1 A102 BUILDING SECTION (EAST END)
SCALE: 1:200



2 A102 BUILDING SECTION
SCALE: 1:200

THESE DRAWINGS ARE NOT TO BE SCALED:
ALL DIMENSIONS MUST BE VERIFIED BY CONTRACTOR PRIOR TO COMMENCEMENT OF ANY WORK. ANY DISCREPANCIES MUST BE REPORTED DIRECTLY TO SRN ARCHITECTS INC.

NO:	DATE:	ISSUED FOR:
1	23/04/20	CLIENT REVIEW
2	02/05/20	CLIENT REVIEW
3	09/05/20	CLIENT REVIEW
4	23/05/20	CLIENT REVIEW
5	22/11/20	CLIENT REVIEW
6	14/12/20	CLIENT REVIEW
7	19/01/21	CLIENT REVIEW
8	26/02/21	CLIENT REVIEW

ADDITIONAL NOTES:

PRELIMINARY, NOT FOR CONSTRUCTION
ALL AREAS CALCULATIONS ARE PRELIMINARY

NO:	DATE:	REVISION COMMENT:

SRN ARCHITECTS
8395 JANE STREET, SUITE 203
VAUGHAN, ONTARIO. L4K 5Y2
PHONE: 905.417.5515 FAX: 905.417.5517

CLIENT:

PROJECT:
BARRIE MIXED-USE
1012 YONGE STREET
BARRIE, ONTARIO.

DRAWING TITTLE:
SITE SECTIONS

DATE: 06/02/21	SCALE: 1:400
DRAWN BY: G.P.R.	CHECKED BY: G.P.R.
PROJECT NUMBER: S19013	DRAWING NUMBER: A102

1 A103 FRONT (YONGE STREE) ELEVATION - BLOCK A

SCALE: 1:150

THESE DRAWINGS ARE NOT TO BE SCALED:
ALL DIMENSIONS MUST BE VERFIED BY CONTRACTOR PRIOR TO COMMENCEMENT OF ANY WORK. ANY DISCREPANCIES MUST BE REPORTED DIRECTLY TO SRN ARCHITECTS INC.

NO:	DATE:	ISSUED FOR:
1	23/04/20	CLIENT REVIEW
2	02/05/20	CLIENT REVIEW
3	09/05/20	CLIENT REVIEW
4	23/05/20	CLIENT REVIEW
5	22/11/20	CLIENT REVIEW
6	14/12/20	CLIENT REVIEW
7	19/01/21	CLIENT REVIEW
8	26/02/21	CLIENT REVIEW

ADDITIONAL NOTES:

PRELIMINARY, NOT FOR CONSTRUCTION
ALL AREAS CALCULATIONS ARE PRELIMINARY

NO:	DATE:	REVISION COMMENT:

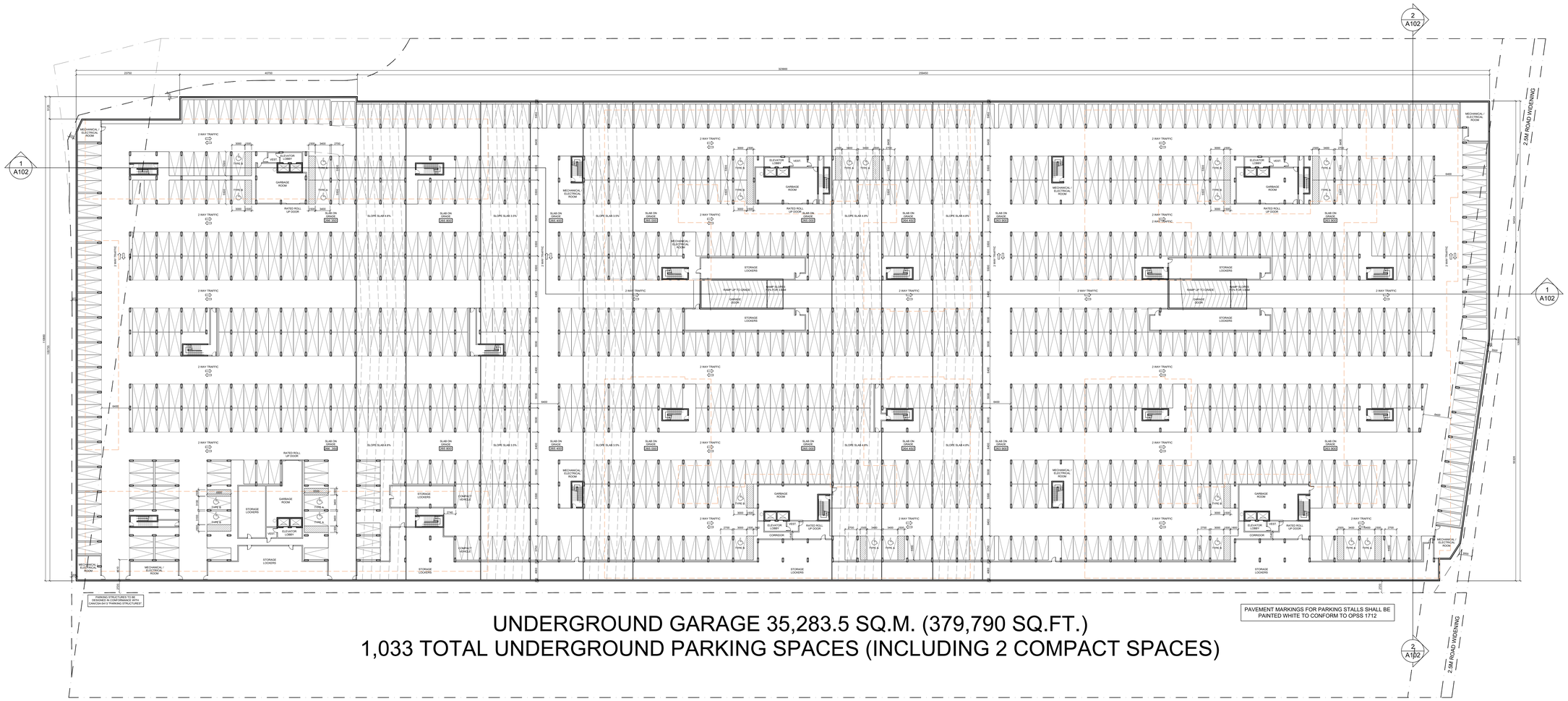
SRN ARCHITECTS
8395 JANE STREET, SUITE 203
VAUGHAN, ONTARIO. L4K 5Y2
PHONE: 905.417.5515 FAX: 905.417.5517

CLIENT:

PROJECT:
BARRIE MIXED-USE
1012 YONGE STREET
BARRIE, ONTARIO.

DRAWING TITTLE:
FRONT (YONGE STREET) ELEVATION

DATE: 15/12/20	SCALE: 1:150
DRAWN BY: G.P.R.	CHECKED BY: G.P.R.
PROJECT NUMBER: S19013	DRAWING NUMBER: A103



UNDERGROUND GARAGE 35,283.5 SQ.M. (379,790 SQ.FT.)
1,033 TOTAL UNDERGROUND PARKING SPACES (INCLUDING 2 COMPACT SPACES)

1 P100 PARKING GARAGE PLAN
SCALE 1:400

THESE DRAWINGS ARE NOT TO BE SCALED:
ALL DIMENSIONS MUST BE VERIFIED BY CONTRACTOR PRIOR TO COMMENCEMENT OF ANY WORK. ANY DISCREPANCIES MUST BE REPORTED DIRECTLY TO SRN ARCHITECTS INC.

NO:	DATE:	ISSUED FOR:
1	23/04/20	CLIENT REVIEW
2	02/05/20	CLIENT REVIEW
3	09/05/20	CLIENT REVIEW
4	23/05/20	CLIENT REVIEW
5	22/11/20	CLIENT REVIEW
6	14/12/20	CLIENT REVIEW
7	19/01/21	CLIENT REVIEW
8	26/02/21	CLIENT REVIEW

ADDITIONAL NOTES:

PRELIMINARY, NOT FOR CONSTRUCTION
ALL AREAS CALCULATIONS ARE PRELIMINARY

NO:	DATE:	REVISION COMMENT:

SRN ARCHITECTS
8395 JANE STREET, SUITE 203
VAUGHAN, ONTARIO. L4K 5Y2
PHONE: 905.417.5515 FAX: 905.417.5517

CLIENT:

PROJECT:
BARRIE MIXED-USE
1012 YONGE STREET
BARRIE, ONTARIO.

DRAWING TITTLE:
UNDERGROUND GARAGE PLAN, STATS AND OBC MATRIX

DATE: 15/12/20	SCALE: 1:400
DRAWN BY: G.P.R.	CHECKED BY: G.P.R.
PROJECT NUMBER: S19013	DRAWING NUMBER: P100

File:H:\Acad SRN Projects\S19013 Crown Communities 1012 Yonge St Barrie\ACAD Drawings\01 DESIGN\S19013 Site Plan February 26 2021.dwg Plotted: Feb 26, 2021 By:greg/

Appendix B – Geotechnical Borehole Logs

JOB NO.:

LOG OF BOREHOLE NO.: 1

FIGURE NO.: **1**

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Hollow Stem Auger

PROJECT LOCATION: 1012 Yonge Street, City of Barrie

DRILLING DATE: March 12, 2020

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
271.0	Ground Surface							
0.3	**25 cm TOPSOIL**	1	DO	6	0		21	
	Brown, compact to very dense **SANDY SILT TILL** traces of clay and gravel occ. sand seams and layers, cobbles and boulders	2	DO	11	1		15	
		3	DO	50/15	2		7	
		4	DO	91/24	3		7	
267.6		5	DO	87/24			12	
3.4	Brown, very dense **SAND** fine to medium grained occ. silt seams and gravel	6	DO	50/12	4		4	
		7	DO	70/28	6		3	
		8	DO	50/10	7		17	
261.7		9	DO	50/12	9		16	
9.3	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 6.1 m completed with 3.1 m screen Sand backfill from 2.4 m to 6.1 m Bentonite seal from 0.0 m to 2.4 m Provided with a momument steel casing				10 11 12			W.L. @ El. of 271.0 m upon completion of drilling. Cave-in @ El. of 263.1 m upon completion of drilling.

JOB NO.: 2002-S036

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Hollow Stem Auger

PROJECT LOCATION: 1012 Yonge Street, City of Barrie

DRILLING DATE: March 12, 2020

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
271.2	Ground Surface							
	30 cm TOPSOIL	1	DO	6	0		27	
0.3	Brown, compact to very dense **SANDY SILT TILL** traces of clay and gravel occ. sand seams and layers, cobbles and boulders	2	DO	19	1		9	
		3	DO	44	2		9	
268.8		4	DO	50/8			7	
2.4	Brown, very dense **SAND** medium grained occ. silt seams and gravel	5	DO	67	3		8	
		6	DO	50/12	4		5	
		7	DO	50/12	5		7	
		8	DO	50/10	6		17	
261.9		9	DO	50/12	7		20	
9.3	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 6.1 m completed with 3.1 m screen Sand backfill from 2.4 m to 6.1 m Bentonite seal from 0.0 m to 2.4 m Provided with a momument steel casing				8 9 10 11 12			

W.L. @ El. of 271.2 m upon completion of drilling.
Cave-in @ El. of 263.6 m upon completion of drilling.

JOB NO.: 2002-S036

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Hollow Stem Auger

PROJECT LOCATION: 1012 Yonge Street, City of Barrie

DRILLING DATE: March 12, 2020

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
270.2	Ground Surface							
	25 cm TOPSOIL				0			
0.3	Brown, loose to very dense **SANDY SILT TILL** traces of clay and gravel occ. sand seams and layers, cobbles and boulders	1	DO	8			16	
		2	DO	8	1		13	
		3	DO	20	2		11	
		4	DO	73/25			8	
267.4					3			
2.8	Brown, very dense **SAND** fine to medium grained occ. cobbles and boulders	5	DO	78/23			7	
		6	DO	50/8	4		3	
		7	DO	50/15	5			
		8	DO	50/15	6		10	
					7			
					8		15	
260.9		9	DO	50/15	9		18	
9.3	**END OF BOREHOLE**				10			
					11			
					12			

W.L. @ El. of 270.2 m upon completion of drilling.
Cave-in @ El. of 264.1 m upon completion of drilling.

Soil Engineers Ltd.

JOB NO.: 2002-S036

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Hollow Stem Auger

PROJECT LOCATION: 1012 Yonge Street, City of Barrie

DRILLING DATE: March 12, 2020

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
217.7	Ground Surface							
	33 cm TOPSOIL	1	DO	4	0		40	
0.3	Brown, loose to very dense **SANDY SILT TILL** traces of clay and gravel occ. sand seams and layers, cobbles and boulders	2	DO	9	1		11	
		3	DO	29	2		8	
		4	DO	67			7	
214.8					3			
2.9	Brown, very dense **SAND** fine to medium grained traces of silt and gravel occ. cobbles and boulders	5	DO	50/12			3	
		6	DO	50/10	4		4	
		7	DO	50/15	5		3	
		8	DO	50/10	6		12	
208.4		9	DO	50/15	7		15	
9.3	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 6.1 m completed with 3.1 m screen Sand backfill from 2.4 m to 6.1 m Bentonite seal from 0.0 m to 2.4 m Provided with a momument steel casing				8			
					9			
					10			
					11			
					12			

W.L @ El. of 264.6 m on March 24, 2020.

W.L. @ El. of 271.7 m upon completion of drilling.

Soil Engineers Ltd.

JOB NO.: 2002-S036

LOG OF BOREHOLE NO.: 5

FIGURE NO.: 5

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Hollow Stem Auger

PROJECT LOCATION: 1012 Yonge Street, City of Barrie

DRILLING DATE: March 17, 2020

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
268.8	Ground Surface							
	36 cm TOPSOIL	1	DO	2	0		15	
0.4	Brown, very dense **SAND** fine to medium grained a trace of silt occ. gravel	2	DO	24	1		17	
		3	DO	57	2		7	
		4	DO	72			5	
		5	DO	91/28	3		4	
		6	DO	50/15	4		14	
		7	DO	50/8	5		16	
		8	DO	50/15	6		12	
259.5		9	DO	50/15	7		18	
9.3	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 6.1 m completed with 3.1 m screen Sand backfill from 2.4 m to 6.1 m Bentonite seal from 0.0 m to 2.4 m Provided with a momument steel casing				8			
					9			
					10			
					11			
					12			

W.L. @ El. of 268.8 m upon completion of drilling.
Cave-in @ El. of 263.9 m upon completion of drilling.
W.L @ El. of 264.1 m on March 24, 2020.

Soil Engineers Ltd.

JOB NO.: 2002-S036

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 6

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Hollow Stem Auger

PROJECT LOCATION: 1012 Yonge Street, City of Barrie

DRILLING DATE: March 19, 2020

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
269.9	Ground Surface							
	36 cm TOPSOIL	1	DO	4	0		16	
0.4	Brown, loose to compact **SAND** fine grained a trace of silt	2	DO	15	1		4	
		3	DO	15	2		11	
267.8								
2.1	Brown, compact to very dense **SANDY SILT TILL** traces of clay and gravel occ. sand seams and layers, cobbles and boulders	4	DO	29	3		9	
266.5		5	DO	67			7	
3.4	Brown, very dense **SAND** fine grained occ. silt seams and gravel	6	DO	57	4		5	
		7	DO	50/12	6		8	
		8	DO	50/8	7		18	
260.6		9	DO	50/10	9		22	
9.3	**END OF BOREHOLE**				10			
					11			
					12			

W.L. @ El. of 269.9 m upon completion of drilling.
Cave-in @ El. of 263.2 m upon completion of drilling.

JOB NO.: 2002-S036

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 7

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Hollow Stem Auger

PROJECT LOCATION: 1012 Yonge Street, City of Barrie

DRILLING DATE: March 18, 2020

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
268.1	Ground Surface							
	45 cm TOPSOIL	1	DO	2	0		14	W.L. @ El. of 268.1 m upon completion of drilling. Cave-in @ El. of 263.8 m upon completion of drilling.
0.5	Brown, very dense **SAND** fine to medium grained traces of silt and gravel occ. cobbles and boulders	2	DO	6	1		14	
		3	DO	41	2		4	
		4	DO	45	3		2	
		5	DO	65	4		3	
		6	DO	50/12	5		12	
		7	DO	50/28	6		16	
		8	DO	50/8	7		18	
258.8		9	DO	50/12	8		18	
9.3	**END OF BOREHOLE**				9			
					10			
					11			
					12			

Soil Engineers Ltd.

Appendix C – Hydraulic Conductivity Analysis

1012 Yonge Street, Barrie, Ontario

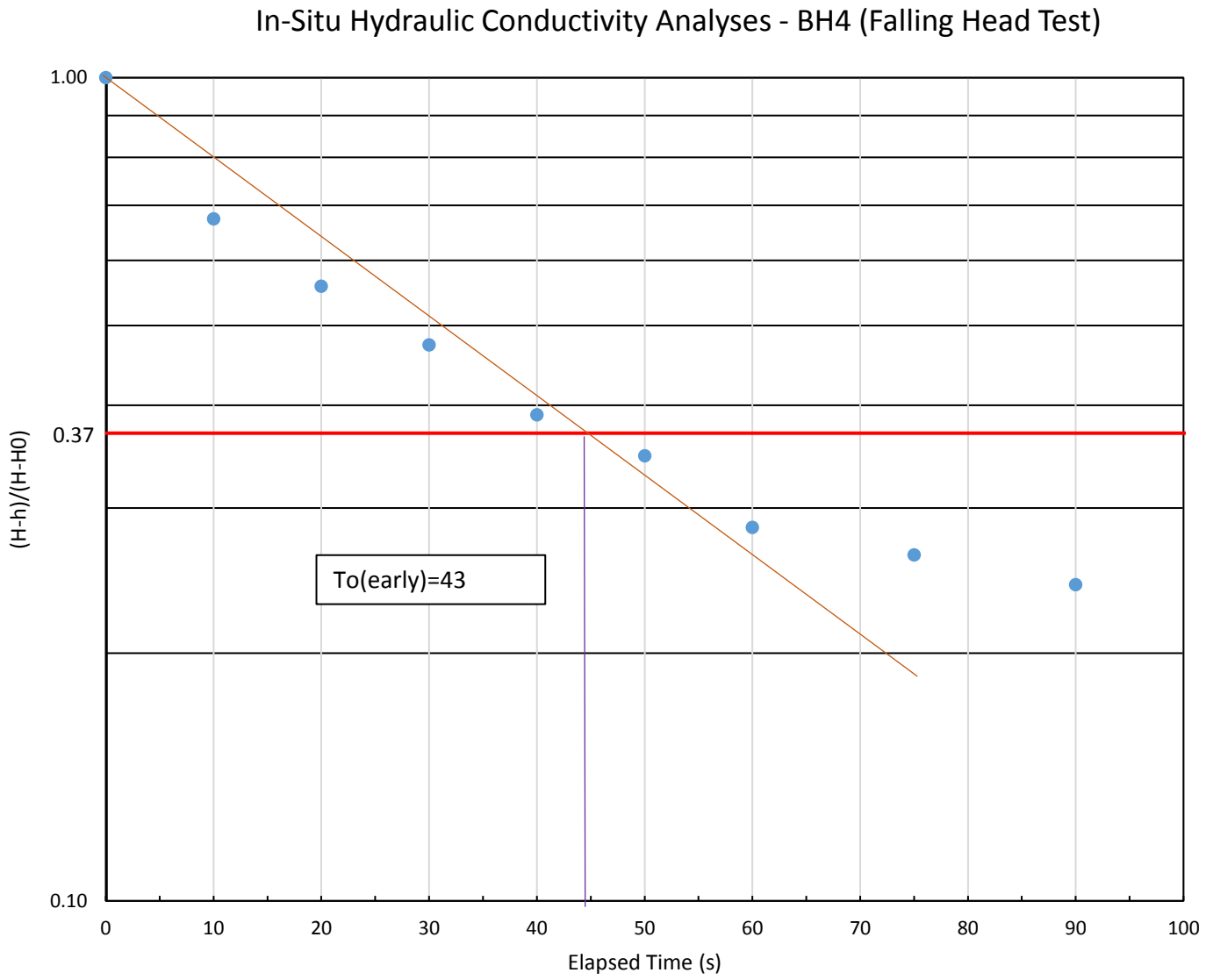
In-Situ Hydraulic Conductivity Analyses - BH4 (Falling Head Test)

Date: 24-Mar-20

Conducted By:	B.T.	
Well Depth:	8.25	mbtor
Screened Unit:	Sand	
Initial Water Level (logger reading):	7.705	mbtor
Available Drawdown (H):	0.55	m
Head at Time = 0 (Ho):	7.61	m
Screen Length (L):	3	m
Borehole Radius (R):	0.2032	m
Monitoring Well Radius (r):	0.025	m
Stick Up	0.64	m

To(early):	43	s
K(early):	6.52E-06	m/s
To(late):		s
K(late):		m/s
K(average):		m/s
Recovery:	84.2%	%

Elapsed Time (s)	Water Level (mtor)	H-h	H-Ho	(H-h)/(H-Ho)
0	7.61	-0.095	-0.095	1.000
10	7.641	-0.064	-0.095	0.674
20	7.652	-0.053	-0.095	0.558
30	7.66	-0.045	-0.095	0.474
40	7.668	-0.037	-0.095	0.389
50	7.672	-0.033	-0.095	0.347
60	7.678	-0.027	-0.095	0.284
75	7.68	-0.025	-0.095	0.263
90	7.682	-0.023	-0.095	0.242
105	7.685	-0.020	-0.095	0.211
120	7.686	-0.019	-0.095	0.200
150	7.69	-0.015	-0.095	0.158


In-Situ Hydraulic Conductivity Analyses - BH4 (Falling Head Test)
1.00
0.37
0.10
(H-h)/(H-H0)
To(early)=43
0
10
20
30
40
50
60
70
80
90
100
Elapsed Time (s)

1012 Yonge Street, Barrie, Ontario

In-Situ Hydraulic Conductivity Analyses - BH5 (Rising Head Test)

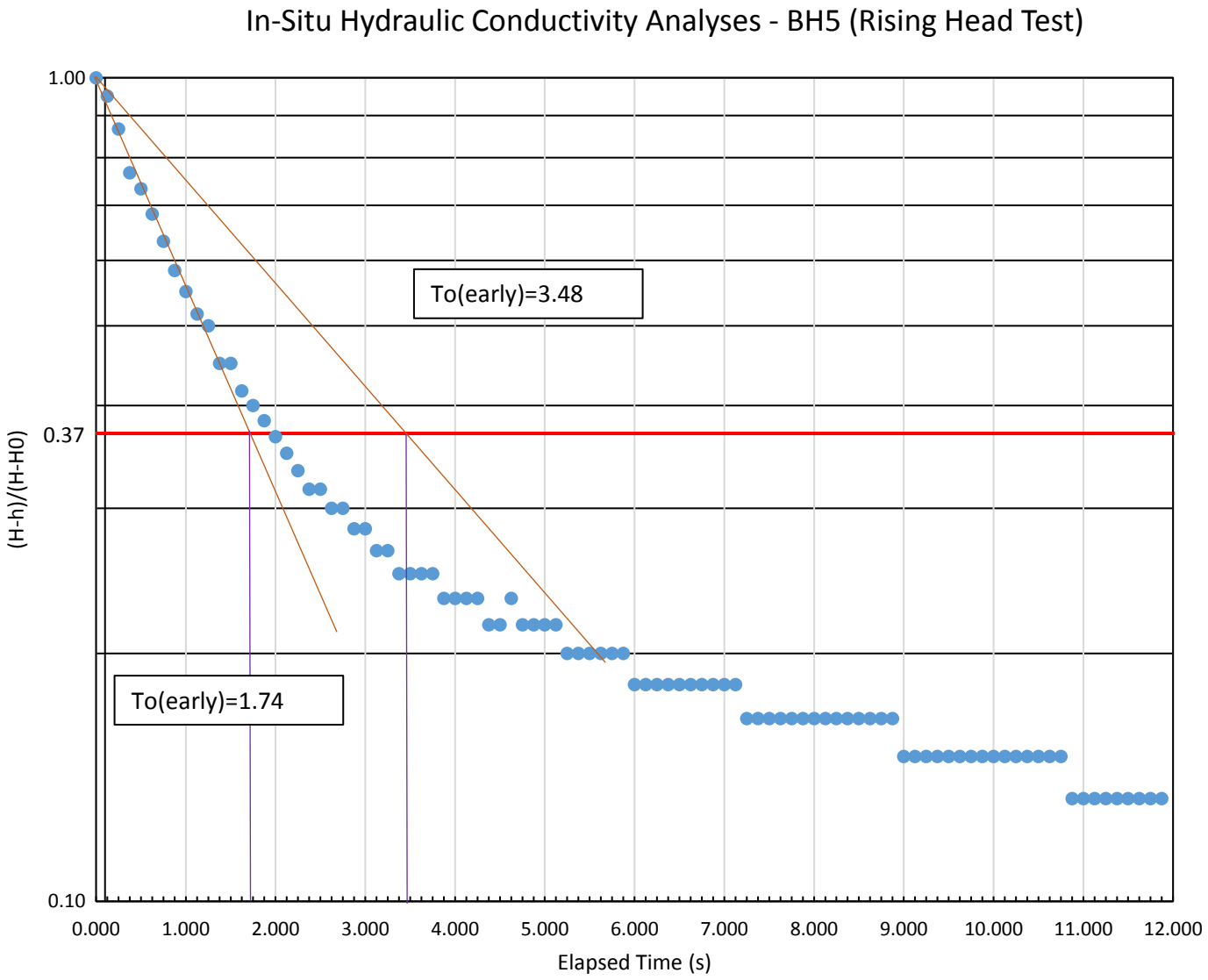
Date: 22-Apr-20

Conducted By:	B.T.	
Well Depth:	6.87	mbtor
Screened Unit:	Sand	
Initial Water Level (logger reading):	11.322	
Available Drawdown (H):		m
Head at Time = 0 (Ho):	11.14	m
Screen Length (L):	3	m
Borehole Radius (R):	0.2032	m
Monitoring Well Radius (r):	0.025	m
Stick Up	0.813	m

To(early):	1.74	s
K(early):	1.61E-04	m/s
To(late):	3.48	s
K(late):	8.06E-05	m/s
K(average)	1.1E-04	m/s
Recovery:	86.7%	%

Elapsed Time (s)	Logger Water Level (m)	H-h	H-Ho	(H-h)/(H-Ho)
0.000	11.14	-0.180	-0.180	1.000
0.125	11.15	-0.171	-0.180	0.950
0.250	11.17	-0.156	-0.180	0.867
0.375	11.18	-0.138	-0.180	0.767
0.500	11.19	-0.132	-0.180	0.733
0.625	11.20	-0.123	-0.180	0.683
0.750	11.21	-0.114	-0.180	0.633
0.875	11.22	-0.105	-0.180	0.583
1.000	11.22	-0.099	-0.180	0.550
1.125	11.23	-0.093	-0.180	0.517
1.250	11.23	-0.090	-0.180	0.500
1.375	11.24	-0.081	-0.180	0.450
1.500	11.24	-0.081	-0.180	0.450
1.625	11.25	-0.075	-0.180	0.417
1.750	11.25	-0.072	-0.180	0.400
1.875	11.25	-0.069	-0.180	0.383
2.000	11.26	-0.066	-0.180	0.367
2.125	11.26	-0.063	-0.180	0.350
2.250	11.26	-0.060	-0.180	0.333
2.375	11.27	-0.057	-0.180	0.317
2.500	11.27	-0.057	-0.180	0.317
2.625	11.27	-0.054	-0.180	0.300
2.750	11.27	-0.054	-0.180	0.300
2.875	11.27	-0.051	-0.180	0.283
3.000	11.27	-0.051	-0.180	0.283
3.125	11.27	-0.048	-0.180	0.267
3.250	11.27	-0.048	-0.180	0.267
3.375	11.28	-0.045	-0.180	0.250
3.500	11.28	-0.045	-0.180	0.250
3.625	11.28	-0.045	-0.180	0.250
3.750	11.28	-0.045	-0.180	0.250
3.875	11.28	-0.042	-0.180	0.233
4.000	11.28	-0.042	-0.180	0.233
4.125	11.28	-0.042	-0.180	0.233
4.250	11.28	-0.042	-0.180	0.233
4.375	11.28	-0.039	-0.180	0.217
4.500	11.28	-0.039	-0.180	0.217

4.625	11.28	-0.042	-0.180	0.233
4.750	11.28	-0.039	-0.180	0.217
4.875	11.28	-0.039	-0.180	0.217
5.000	11.28	-0.039	-0.180	0.217
5.125	11.28	-0.039	-0.180	0.217
5.250	11.29	-0.036	-0.180	0.200
5.375	11.29	-0.036	-0.180	0.200
5.500	11.29	-0.036	-0.180	0.200
5.625	11.29	-0.036	-0.180	0.200
5.750	11.29	-0.036	-0.180	0.200
5.875	11.29	-0.036	-0.180	0.200
6.000	11.29	-0.033	-0.180	0.183
6.125	11.29	-0.033	-0.180	0.183
6.250	11.29	-0.033	-0.180	0.183
6.375	11.29	-0.033	-0.180	0.183
6.500	11.29	-0.033	-0.180	0.183
6.625	11.29	-0.033	-0.180	0.183
6.750	11.29	-0.033	-0.180	0.183
6.875	11.29	-0.033	-0.180	0.183
7.000	11.29	-0.033	-0.180	0.183
7.125	11.29	-0.033	-0.180	0.183
7.250	11.29	-0.030	-0.180	0.167
7.375	11.29	-0.030	-0.180	0.167
7.500	11.29	-0.030	-0.180	0.167
7.625	11.29	-0.030	-0.180	0.167
7.750	11.29	-0.030	-0.180	0.167
7.875	11.29	-0.030	-0.180	0.167
8.000	11.29	-0.030	-0.180	0.167
8.125	11.29	-0.030	-0.180	0.167
8.250	11.29	-0.030	-0.180	0.167
8.375	11.29	-0.030	-0.180	0.167
8.500	11.29	-0.030	-0.180	0.167
8.625	11.29	-0.030	-0.180	0.167
8.750	11.29	-0.030	-0.180	0.167
8.875	11.29	-0.030	-0.180	0.167
9.000	11.30	-0.027	-0.180	0.150
9.125	11.30	-0.027	-0.180	0.150
9.250	11.30	-0.027	-0.180	0.150
9.375	11.30	-0.027	-0.180	0.150
9.500	11.30	-0.027	-0.180	0.150
9.625	11.30	-0.027	-0.180	0.150
9.750	11.30	-0.027	-0.180	0.150
9.875	11.30	-0.027	-0.180	0.150
10.000	11.30	-0.027	-0.180	0.150
10.125	11.30	-0.027	-0.180	0.150
10.250	11.30	-0.027	-0.180	0.150
10.375	11.30	-0.027	-0.180	0.150
10.500	11.30	-0.027	-0.180	0.150


In-Situ Hydraulic Conductivity Analyses - BH5 (Rising Head Test)
1.00
0.37
0.10
(H-h)/(H-H0)
To(early)=3.48
To(early)=1.74
0.000
1.000
2.000
3.000
4.000
5.000
6.000
7.000
8.000
9.000
10.000
11.000
12.000
Elapsed Time (s)

Appendix D – Certificate of Analysis

COLE ENGINEERING GROUP LTD
ATTN: ARON ZHAO
2620 Bristol Circle #300
Oakville ON L6H 6Z7

Date Received: 16-MAR-20
Report Date: 20-MAR-20 11:48 (MT)
Version: FINAL

Client Phone: 905-940-6161

Certificate of Analysis

Lab Work Order #: L2428339

Project P.O. #: NOT SUBMITTED
Job Reference: 2018-0390
C of C Numbers:
Legal Site Desc:

Emily Smith
Account Manager

Sample Details Grouping / Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	#2		
L2428339-1 BH4 Sampled By: AZ on 16-MAR-20 @ 12:00 Matrix: WATER									
Physical Tests									
Conductivity	0.550		0.0030	mS/cm	17-MAR-20				
pH	7.64		0.10	pH units	17-MAR-20				
Anions and Nutrients									
Chloride (Cl)	3.43		0.50	mg/L	18-MAR-20	790	790		
Cyanides									
Cyanide, Weak Acid Diss	<2.0		2.0	ug/L	18-MAR-20	66	66		
Dissolved Metals									
Dissolved Mercury Filtration Location	FIELD			No Unit	17-MAR-20				
Dissolved Metals Filtration Location	FIELD			No Unit	17-MAR-20				
Antimony (Sb)-Dissolved	<0.10		0.10	ug/L	18-MAR-20	6	6		
Arsenic (As)-Dissolved	<0.10		0.10	ug/L	18-MAR-20	25	25		
Barium (Ba)-Dissolved	46.7		0.10	ug/L	18-MAR-20	1000	1000		
Beryllium (Be)-Dissolved	<0.10		0.10	ug/L	18-MAR-20	4	4		
Boron (B)-Dissolved	12		10	ug/L	18-MAR-20	5000	5000		
Cadmium (Cd)-Dissolved	<0.010		0.010	ug/L	18-MAR-20	2.7	2.7		
Chromium (Cr)-Dissolved	<0.50		0.50	ug/L	18-MAR-20	50	50		
Cobalt (Co)-Dissolved	0.15		0.10	ug/L	18-MAR-20	3.8	3.8		
Copper (Cu)-Dissolved	0.38		0.20	ug/L	18-MAR-20	87	87		
Lead (Pb)-Dissolved	<0.050		0.050	ug/L	18-MAR-20	10	10		
Mercury (Hg)-Dissolved	<0.0050		0.0050	ug/L	18-MAR-20	0.29	1		
Molybdenum (Mo)-Dissolved	0.840		0.050	ug/L	18-MAR-20	70	70		
Nickel (Ni)-Dissolved	<0.50		0.50	ug/L	18-MAR-20	100	100		
Selenium (Se)-Dissolved	0.259		0.050	ug/L	18-MAR-20	10	10		
Silver (Ag)-Dissolved	<0.050		0.050	ug/L	18-MAR-20	1.5	1.5		
Sodium (Na)-Dissolved	5700		500	ug/L	18-MAR-20	490000	490000		
Thallium (Tl)-Dissolved	<0.010		0.010	ug/L	18-MAR-20	2	2		
Uranium (U)-Dissolved	0.202		0.010	ug/L	18-MAR-20	20	20		
Vanadium (V)-Dissolved	<0.50		0.50	ug/L	18-MAR-20	6.2	6.2		
Zinc (Zn)-Dissolved	<1.0		1.0	ug/L	18-MAR-20	1100	1100		
Speciated Metals									
Chromium, Hexavalent	<0.50		0.50	ug/L	17-MAR-20	25	25		

** Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
* Analytical result for this parameter exceeds Guideline Limit listed on this report. Guideline Limits applied:

Ontario Regulation 153/04 - April 15, 2011 Standards = [Suite] - T2-POTABLE-GROUNDWATER-ALL-TYPES-OF-PROPERTY-USE

#1: T2-Ground Water (Coarse Soil)-All Types of Property Use

#2: T2-Ground Water (Fine Soil)-All Types of Property Use

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference***
CL-IC-N-WT	Water	Chloride by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

CN-WAD-R511-WT	Water	Cyanide (WAD)-O.Reg 153/04	APHA 4500CN I-Weak acid Dist Colorimet

Weak acid dissociable cyanide (WAD) is determined by undergoing a distillation procedure. Cyanide is converted to cyanogen chloride by reacting with chloramine-T, the cyanogen chloride then reacts with a combination of barbituric acid and isonicotinic acid to form a highly colored complex.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

CR-CR6-IC-R511-WT	Water	Hex Chrom-O.Reg 153/04 (July 2011)	EPA 7199

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Method 7199, published by the United States Environmental Protection Agency (EPA). The procedure involves analysis for chromium (VI) by ion chromatography using diphenylcarbazide in a sulphuric acid solution. Chromium (III) is calculated as the difference between the total chromium and the chromium (VI) results.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

EC-R511-WT	Water	Conductivity-O.Reg 153/04 (July 2011)	APHA 2510 B

Water samples can be measured directly by immersing the conductivity cell into the sample.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

EC-SCREEN-WT	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HG-D-UG/L-CVAA-WT	Water	Diss. Mercury in Water by CVAAS (ug/L)	EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

MET-D-UG/L-MS-WT	Water	Diss. Metals in Water by ICPMS (ug/L)	EPA 200.8

The metal constituents of a non-acidified sample that pass through a membrane filter prior to ICP/MS analysis.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

PH-WT	Water	pH	APHA 4500 H-Electrode

Water samples are analyzed directly by a calibrated pH meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011). Holdtime for samples under this regulation is 28 days

*** ALS test methods may incorporate modifications from specified reference methods to improve performance.

Chain of Custody numbers:

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location	Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA		

Reference Information

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2428339 Report Date: 20-MAR-20

Client: COLE ENGINEERING GROUP LTD
2620 Bristol Circle #300
Oakville ON L6H 6Z7

Contact: ARON ZHAO

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-IC-N-WT	**Water**							
Batch R5032168								
WG3294509-15 DUP		**WG3294509-13**						
Chloride (Cl)		38.3	38.2		mg/L	0.1	20	18-MAR-20
WG3294509-12 LCS								
Chloride (Cl)			103.7		%		90-110	18-MAR-20
WG3294509-11 MB								
Chloride (Cl)			<0.50		mg/L		0.5	18-MAR-20
WG3294509-14 MS		**WG3294509-13**						
Chloride (Cl)			103.3		%		75-125	18-MAR-20
CN-WAD-R511-WT	**Water**							
Batch R5030909								
WG3294010-3 DUP		**L2428339-1**						
Cyanide, Weak Acid Diss		<2.0	<2.0	RPD-NA	ug/L	N/A	20	18-MAR-20
WG3294010-2 LCS								
Cyanide, Weak Acid Diss			100.7		%		80-120	18-MAR-20
WG3294010-1 MB								
Cyanide, Weak Acid Diss			<2.0		ug/L		2	18-MAR-20
WG3294010-4 MS		**L2428339-1**						
Cyanide, Weak Acid Diss			99.6		%		75-125	18-MAR-20
CR-CR6-IC-R511-WT	**Water**							
Batch R5029466								
WG3293794-4 DUP		**WG3293794-3**						
Chromium, Hexavalent		<0.50	<0.50	RPD-NA	ug/L	N/A	20	17-MAR-20
WG3293794-2 LCS								
Chromium, Hexavalent			98.4		%		80-120	17-MAR-20
WG3293794-1 MB								
Chromium, Hexavalent			<0.50		ug/L		0.5	17-MAR-20
WG3293794-5 MS		**WG3293794-3**						
Chromium, Hexavalent			94.4		%		70-130	17-MAR-20
EC-R511-WT	**Water**							
Batch R5029321								
WG3293748-4 DUP		**WG3293748-3**						
Conductivity		1.60	1.60		mS/cm	0.1	10	17-MAR-20
WG3293748-2 LCS								
Conductivity			99.1		%		90-110	17-MAR-20
WG3293748-1 MB								
Conductivity			<0.0030		mS/cm		0.003	17-MAR-20
HG-D-UG/L-CVAA-WT	**Water**							

Quality Control Report

Client: COLE ENGINEERING GROUP LTD
2620 Bristol Circle #300
Oakville ON L6H 6Z7
Contact: ARON ZHAO

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-D-UG/L-CVAA-WT	**Water**							
Batch R5029570								
WG3293582-3 DUP		**L2428132-12**						
Mercury (Hg)-Dissolved		<0.0050	<0.0050	RPD-NA	ug/L	N/A	20	18-MAR-20
WG3293582-2 LCS								
Mercury (Hg)-Dissolved			103.0		%		80-120	18-MAR-20
WG3293582-1 MB								
Mercury (Hg)-Dissolved			<0.0050		ug/L		0.005	18-MAR-20
WG3293582-4 MS		**L2428337-1**						
Mercury (Hg)-Dissolved			101.2		%		70-130	18-MAR-20
MET-D-UG/L-MS-WT	**Water**							
Batch R5028554								
WG3293428-4 DUP		**WG3293428-3**						
Antimony (Sb)-Dissolved		0.11	0.11		ug/L	0.6	20	18-MAR-20
Arsenic (As)-Dissolved		0.40	0.34		ug/L	15	20	18-MAR-20
Barium (Ba)-Dissolved		69.5	66.9		ug/L	3.8	20	18-MAR-20
Beryllium (Be)-Dissolved		<0.10	<0.10	RPD-NA	ug/L	N/A	20	18-MAR-20
Boron (B)-Dissolved		67	66		ug/L	2.3	20	18-MAR-20
Cadmium (Cd)-Dissolved		0.0194	0.0193		ug/L	0.5	20	18-MAR-20
Chromium (Cr)-Dissolved		1.37	1.22		ug/L	11	20	18-MAR-20
Cobalt (Co)-Dissolved		1.24	1.21		ug/L	2.2	20	18-MAR-20
Copper (Cu)-Dissolved		2.62	2.58		ug/L	1.5	20	18-MAR-20
Lead (Pb)-Dissolved		0.182	0.181		ug/L	0.4	20	18-MAR-20
Molybdenum (Mo)-Dissolved		1.53	1.59		ug/L	4.2	20	18-MAR-20
Nickel (Ni)-Dissolved		3.03	2.93		ug/L	3.5	20	18-MAR-20
Selenium (Se)-Dissolved		3.28	3.13		ug/L	4.7	20	18-MAR-20
Silver (Ag)-Dissolved		<0.050	<0.050	RPD-NA	ug/L	N/A	20	18-MAR-20
Sodium (Na)-Dissolved		42500	41700		ug/L	1.8	20	18-MAR-20
Thallium (Tl)-Dissolved		0.019	0.019		ug/L	3.2	20	18-MAR-20
Uranium (U)-Dissolved		1.15	1.12		ug/L	2.2	20	18-MAR-20
Vanadium (V)-Dissolved		<0.50	<0.50	RPD-NA	ug/L	N/A	20	18-MAR-20
Zinc (Zn)-Dissolved		4.5	4.2		ug/L	6.3	20	18-MAR-20
WG3293428-2 LCS								
Antimony (Sb)-Dissolved			100.7		%		80-120	18-MAR-20
Arsenic (As)-Dissolved			109.0		%		80-120	18-MAR-20
Barium (Ba)-Dissolved			105.0		%		80-120	18-MAR-20
Beryllium (Be)-Dissolved			103.4		%		80-120	18-MAR-20

Quality Control Report

Client: COLE ENGINEERING GROUP LTD
2620 Bristol Circle #300
Oakville ON L6H 6Z7
Contact: ARON ZHAO

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-UG/L-MS-WT	**Water**							
Batch	**R5028554**							
WG3293428-2	**LCS**							
Boron (B)-Dissolved			99.8		%		80-120	18-MAR-20
Cadmium (Cd)-Dissolved			107.2		%		80-120	18-MAR-20
Chromium (Cr)-Dissolved			109.5		%		80-120	18-MAR-20
Cobalt (Co)-Dissolved			105.5		%		80-120	18-MAR-20
Copper (Cu)-Dissolved			104.9		%		80-120	18-MAR-20
Lead (Pb)-Dissolved			99.9		%		80-120	18-MAR-20
Molybdenum (Mo)-Dissolved			99.1		%		80-120	18-MAR-20
Nickel (Ni)-Dissolved			105.6		%		80-120	18-MAR-20
Selenium (Se)-Dissolved			104.2		%		80-120	18-MAR-20
Silver (Ag)-Dissolved			100.3		%		80-120	18-MAR-20
Sodium (Na)-Dissolved			110.0		%		80-120	18-MAR-20
Thallium (Tl)-Dissolved			98.5		%		80-120	18-MAR-20
Uranium (U)-Dissolved			99.5		%		80-120	18-MAR-20
Vanadium (V)-Dissolved			109.4		%		80-120	18-MAR-20
Zinc (Zn)-Dissolved			106.8		%		80-120	18-MAR-20
WG3293428-1	**MB**							
Antimony (Sb)-Dissolved			<0.10		ug/L		0.1	18-MAR-20
Arsenic (As)-Dissolved			<0.10		ug/L		0.1	18-MAR-20
Barium (Ba)-Dissolved			<0.10		ug/L		0.1	18-MAR-20
Beryllium (Be)-Dissolved			<0.10		ug/L		0.1	18-MAR-20
Boron (B)-Dissolved			<10		ug/L		10	18-MAR-20
Cadmium (Cd)-Dissolved			<0.0050		ug/L		0.005	18-MAR-20
Chromium (Cr)-Dissolved			<0.50		ug/L		0.5	18-MAR-20
Cobalt (Co)-Dissolved			<0.10		ug/L		0.1	18-MAR-20
Copper (Cu)-Dissolved			<0.20		ug/L		0.2	18-MAR-20
Lead (Pb)-Dissolved			<0.050		ug/L		0.05	18-MAR-20
Molybdenum (Mo)-Dissolved			<0.050		ug/L		0.05	18-MAR-20
Nickel (Ni)-Dissolved			<0.50		ug/L		0.5	18-MAR-20
Selenium (Se)-Dissolved			<0.050		ug/L		0.05	18-MAR-20
Silver (Ag)-Dissolved			<0.050		ug/L		0.05	18-MAR-20
Sodium (Na)-Dissolved			<50		ug/L		50	18-MAR-20
Thallium (Tl)-Dissolved			<0.010		ug/L		0.01	18-MAR-20
Uranium (U)-Dissolved			<0.010		ug/L		0.01	18-MAR-20
Vanadium (V)-Dissolved			<0.50		ug/L		0.5	18-MAR-20

Quality Control Report

Client: COLE ENGINEERING GROUP LTD
2620 Bristol Circle #300
Oakville ON L6H 6Z7
Contact: ARON ZHAO

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-UG/L-MS-WT	**Water**							
Batch R5028554								
WG3293428-1 MB								
Zinc (Zn)-Dissolved			<1.0		ug/L		1	18-MAR-20
WG3293428-5 MS		**WG3293428-6**						
Antimony (Sb)-Dissolved			103.5		%		70-130	18-MAR-20
Arsenic (As)-Dissolved			119.2		%		70-130	18-MAR-20
Barium (Ba)-Dissolved			N/A	MS-B	%		-	18-MAR-20
Beryllium (Be)-Dissolved			110.0		%		70-130	18-MAR-20
Boron (B)-Dissolved			N/A	MS-B	%		-	18-MAR-20
Cadmium (Cd)-Dissolved			114.3		%		70-130	18-MAR-20
Chromium (Cr)-Dissolved			114.5		%		70-130	18-MAR-20
Cobalt (Co)-Dissolved			108.0		%		70-130	18-MAR-20
Copper (Cu)-Dissolved			105.3		%		70-130	18-MAR-20
Lead (Pb)-Dissolved			99.8		%		70-130	18-MAR-20
Molybdenum (Mo)-Dissolved			109.5		%		70-130	18-MAR-20
Nickel (Ni)-Dissolved			105.4		%		70-130	18-MAR-20
Selenium (Se)-Dissolved			119.5		%		70-130	18-MAR-20
Silver (Ag)-Dissolved			102.9		%		70-130	18-MAR-20
Sodium (Na)-Dissolved			N/A	MS-B	%		-	18-MAR-20
Thallium (Tl)-Dissolved			100.2		%		70-130	18-MAR-20
Uranium (U)-Dissolved			N/A	MS-B	%		-	18-MAR-20
Vanadium (V)-Dissolved			117.5		%		70-130	18-MAR-20
Zinc (Zn)-Dissolved			109.8		%		70-130	18-MAR-20
PH-WT	**Water**							
Batch R5029321								
WG3293748-4 DUP		**WG3293748-3**						
pH		8.48	8.47	J	pH units	0.01	0.2	17-MAR-20
WG3293748-2 LCS								
pH			7.00		pH units		6.9-7.1	17-MAR-20

Quality Control Report

Workorder: L2428339 Report Date: 20-MAR-20

Client: COLE ENGINEERING GROUP LTD
2620 Bristol Circle #300
Oakville ON L6H 6Z7
Contact: ARON ZHAO

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Chain of Custody (COC) / Analytical Request Form

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2428339-COFC

COC Number: 17 -

Page of

Report To	Contact and company name below will appear on the final report
Company:	COLE ENGINEERING GROUP LTD
Contact:	Aron Zhao
Phone:	905-940-6161
	Company address below will appear on the final report
Street:	2620 Bristol Circle #300
City/Province:	Oakville
Postal Code:	L6H 6Z7
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☑ YES ☐ NO
Company:	Cole Engineering Group Ltd - AP
Contact:	cole.ap@coleengineering.ca

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report ☐ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax azhao@coleengineering.ca
Email 2 ahejazi@n
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax azhao@coleengineering.ca
Email 2 cole.ap@coleengineering.ca

Project Information

ALS Account # / Quote #: Q78138 (2020 SOA)
Job #: 2018-0390
PO / AFE:
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#
Major/Minor Code: Routing Code:
Requisitioner:
Location:

Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4-20%] ☐ | 3 day [P3-25%] ☐ | 2 day [P2-50%] ☐

EMERGENCY: 1 Business day [E - 100%] ☐ | Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

ALS Lab Work Order # (lab use only): L2428339RD

ALS Contact: Emily Smith Sampler: A.Z.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	Metals & Inorganics	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
	BH4	Mar 16 2020	12:00	GW	5	✓		

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human consumption/ use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

153/04 Table 2 residential

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☑ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C	FINAL COOLER TEMPERATURES °C
6.1	5.2

SHIPMENT RELEASE (client use)

Released by: Date: March 16, 2020 Time: 7:40

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: Date: March 16/20 Time: 14:40

FINAL SHIPMENT RECEPTION (lab use only)

Received by: Date: 3-16-2020 Time: 1800

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NOV 2018 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

CADUCEON™ ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G88035 **REPORT No. B21-02110**

Report To:

IBI Group - Markham
70 Valleywood Drive,
Markham ON L3R 4T5
Attention: Bradley Trinh

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

DATE RECEIVED: 20-Jan-21
DATE REPORTED: 26-Jan-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:

P.O. NUMBER: 2018-0390
WATERWORKS NO.

Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
Cyanide	1	Kingston	US	21-Jan-21	A-CN-001 (k)	SM 4500CN
A - Wet Chem	1	Kingston	TK	22-Jan-21	A-COD K	SM5220C
Anions	1	Holly Lane	bco	21-Jan-21	A-IC-01 (o)	SM4110C
pH	1	Holly Lane	SYL	21-Jan-21	A-PH-01 (o)	SM 4500H
Sulphide	1	Kingston	KD	21-Jan-21	A-S2	SM4500-S2
A - Wet Chem	1	Kingston	KD	21-Jan-21	A-TPTKN-001 (N)(k)	E3199A.1
A - Wet Chem	1	Kingston	KD	21-Jan-21	A-TPTKN-001 (P)(k)	E3199A.1
Total Suspended Solids	1	Kingston	TK	25-Jan-21	A-TSS-001 (k)	SM2540D
BOD	1	Kingston	JWF	21-Jan-21	C-BOD-001 (k)	SM 5210B
SVOC	1	Kingston	sge	22-Jan-21	C-NAB-W-001 (k)	EPA 8270
Oil & Grease	1	Kingston	SmT	22-Jan-21	C-O&G-001 (k)	SM 5520
Phenolics (4-aap)	1	Kingston	TK	22-Jan-21	C-PHEN-01 (k)	MOEE 3179
VOC's	1	Richmond Hill	FAL	21-Jan-21	C-VOC-02 (rh)	EPA 8260
Mercury	1	Holly Lane	PBK	25-Jan-21	D-HG-02 (o)	SM 3112 B
Metals - ICP-OES	1	Holly Lane	AHM	21-Jan-21	D-ICP-01 (o)	SM 3120
Metals-ICP-MS	1	Holly Lane	TPR	26-Jan-21	D-ICPMS Dissolved 7800	EPA 200.8
Metals - ICP-MS	1	Holly Lane	TPR	21-Jan-21	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

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G88035 **REPORT No. B21-02110**

Report To:

IBI Group - Markham
70 Valleywood Drive,
Markham ON L3R 4T5
Attention: Bradley Trinh

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

DATE RECEIVED: 20-Jan-21
DATE REPORTED: 26-Jan-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2018-0390
WATERWORKS NO.

	Client I.D.		BH4				Barrie Sanitary	
	Sample I.D.		B21-02110-1				Barrie-Sanitary/Combined	Barrie-Storm Sewer
	Date Collected		20-Jan-21					
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	13				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	0.15				10	
Cyanide (Total)	mg/L	0.005	< 0.005				1.2	
Chloride	mg/L	0.5	7.3				1500	
Fluoride	mg/L	0.1	< 0.1				10	
Sulphate	mg/L	1	7				1500	
Aluminum (total)	mg/L	0.01	4.55				50	
Antimony	mg/L	0.0001	0.0004				5.0	
Arsenic	mg/L	0.0001	0.0010				1.0	
Barium	mg/L	0.001	0.075				5.0	
Benzene	mg/L	0.0005	< 0.0005				0.01	
Bismuth	mg/L	0.02	< 0.02				5.0	
Cadmium	mg/L	0.000015	0.000045				0.7	0.001
Chromium	mg/L	0.002	0.017				2.0	0.08
Cobalt	mg/L	0.005	0.009				5.0	
Copper	mg/L	0.002	**0.017**				2.0	0.01
Dichlorobenzene,1,2-	mg/L	0.0005	< 0.0005				0.05	
Dichlorobenzene,1,4-	mg/L	0.0005	0.0007				0.08	

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

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

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G88035 **REPORT No. B21-02110**

Report To:

IBI Group - Markham
70 Valleywood Drive,
Markham ON L3R 4T5
Attention: Bradley Trinh

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

DATE RECEIVED: 20-Jan-21
DATE REPORTED: 26-Jan-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2018-0390
WATERWORKS NO.

	Client I.D.		BH4				Barrie Sanitary	
	Sample I.D.		B21-02110-1				Barrie-Sanitary/Combined	Barrie-Storm Sewer
	Date Collected		20-Jan-21					
Parameter	**Units**	**R.L.**						
Ethylbenzene	mg/L	0.0005	< 0.0005				0.06	
Gold	mg/L	0.0007	< 0.0007				5.0	
Hexachlorobenzene	mg/L	0.0001	< 0.0001				0.0001	
Iron	mg/L	0.005	8.80				50	
Lead	mg/L	0.02	< 0.02				0.7	0.05
Manganese (Total)	mg/L	0.001	0.506				5.0	
Mercury	mg/L	0.00002	< 0.00002				0.01	
Dichloromethane (Methylene Chloride)	mg/L	0.005	< 0.005				0.09	
Molybdenum	mg/L	0.01	< 0.01				5.0	
Nickel	mg/L	0.01	< 0.01				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					

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

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G88035 **REPORT No. B21-02110**

Report To:

IBI Group - Markham
70 Valleywood Drive,
Markham ON L3R 4T5
Attention: Bradley Trinh

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

DATE RECEIVED: 20-Jan-21
DATE REPORTED: 26-Jan-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2018-0390
WATERWORKS NO.

	Client I.D.		BH4				Barrie Sanitary	
	Sample I.D.		B21-02110-1				Barrie-Sanitary/Combined	Barrie-Storm Sewer
	Date Collected		20-Jan-21					
Parameter	**Units**	**R.L.**						
Methylnaphthalene,1-	µg/L	0.05	< 0.05					
Methylnaphthalene,2-	µg/L	0.05	< 0.05					
Naphthalene	µg/L	0.05	< 0.05					
Phenanthrene	µg/L	0.05	< 0.05					
Pyrene	µg/L	0.05	< 0.05					
Phenolics	mg/L	0.002	< 0.002				0.1	
Platinum	mg/L	0.00004	< 0.00004				5.0	
Rhodium	mg/L	0.00002	< 0.00002				5.0	
Selenium	mg/L	0.001	< 0.001				1.0	
Silver	mg/L	0.005	< 0.005				0.4	
Sulphide	mg/L	0.01	< 0.01				1.0	
Tetrachloroethane,1,1,2,2-	mg/L	0.0005	< 0.0005				0.06	
Tetrachloroethylene	mg/L	0.0005	< 0.0005				0.06	
Toluene	mg/L	0.0005	< 0.0005				0.02	
Trichloroethylene	mg/L	0.0005	< 0.0005				0.05	
Xylene, m,p,o-	mg/L	0.0011	< 0.0011				0.3	
Tin	mg/L	0.05	< 0.05				5.0	
Vanadium	mg/L	0.005	0.011				5.0	
Zinc	mg/L	0.005	0.032				2.0	0.04

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

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G88035 **REPORT No. B21-02110**

Report To:

IBI Group - Markham
70 Valleywood Drive,
Markham ON L3R 4T5
Attention: Bradley Trinh

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

DATE RECEIVED: 20-Jan-21
DATE REPORTED: 26-Jan-21
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.:
P.O. NUMBER: 2018-0390
WATERWORKS NO.

Summary of Exceedances

Storm Sewer Guidelines		
BH4	Found Value	Limit
Copper (mg/L)	0.017	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

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.

TESTING REQUIREMENTS

- ☐ O.Reg 153 — Table ____ — ☐ Medium/Fine ☐ Coarse
- ☐ RPI ☐ ICC — ☐ Agricultural (O.Reg 153)
- ☐ Yes ☐ No — Record of Site Condition (O.Reg 153)
- ☐ Provincial Water Quality Objectives
- ☑ Sewer Use By-Law: Barrie
- ☐ MISA Guidelines
- ☐ O.Reg 558 Leachate Analysis
- Disposal Site: ____
- ☐ Landfill Monitoring
- ☐ Other: ____

REPORT NUMBER (Lab Use): B21-02110

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)

Indicate Laboratory Samples are submitted to: ☐ Kingston ☐ Ottawa ☐ Richmond Hill ☐ Windsor ☑ Barrie ☐ London

Organization: IBI Group	Address and Invoicing Address (if different): 70 Valleywood Dr, Markham, ON L3R 4T5
Contact: Bradley Trinh	
Tel: 4163166434	
Fax:	Quote No.:
Email: bradley.trinh@ibigroup.com	P.O. No.:
	Project Name: 2018-0390
	Additional Info: refer to project page on COC instead of on lab bottles

ANALYSES REQUESTED (Print Test in Boxes)

Storm/Sani - City of Barrie

Suspected Highly Contaminated

TURNAROUND SERVICE REQUESTED (see back page)

- ☐ 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 Identification	S.P.L.	Sample Matrix *	Date Collected (yy-mm-dd)	Time Collected	Indicate Test For Each Sample By Using A Check Mark In The Box Provided	✓	Field pH	Field Temp.	# Bottles/ Sample	Field Filtered(Y/N)
1	BH4		GW	20/01/20	2PM	✓				12	N
				21							
				correct date on pre-bottled COC							
	garden + Hg + metals + chromium +O										
	2×1L Amber + garden + nut + phenols + cyanide +TK										
	Vials +RH										

SAMPLE SUBMISSION INFORMATION

	Sampled by:	Submitted by:
Print:	Daniel Sin	Vallerand Vorce
Sign:		
	Date (yy-mm-dd)/Time:	Date (yy-mm-dd)/Time:

SHIPPING INFORMATION

- ☐ Client's Courier
- ☐ Caduceon's Courier
- ☑ Drop Off
- ☐ Caduceon (Pick-up)

Invoice: ☑

# of Pieces: 1

REPORTING / INVOICING

- ☐ Report by Fax
- ☑ Report by Email
- ☑ Invoice by Email
- ☐ Invoice by Mail

SAMPLE RECEIVING INFORMATION (LABORATORY USE ONLY)

- Received By (print): Ashley M Signature:
- Date Received (yy-mm-dd): 21/01/20 Time Received: 14:37
- Laboratory Prepared Bottles: ☑ Yes ☐ No
- Sample Temperature °C: 4.3
- Labeled by: ES

Comments:

Page ____ of ____

G 88035

White: Lab Copy / Yellow: Invoicing Copy / Pink: Client Copy

CofC, May 2019, Revision No: 22

Appendix E – Dewatering Calculations

Dewatering Calculations
Dewatering @ 1012 Yonge Street

Dewatering Rate Formula for an Unconfined Aquifer (Powers et al., 2007):

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

Where:

Q = Anticipated pumping rate (m^3/day)
K = Hydraulic Conductivity (m/day)
H = Distance from initial static water level to bottom of the saturated aquifer (m)
h = Depth of water in the well while pumping (m)
R_0 = Distance from a point of greatest drawdown to a point where there is no drawdown (Radius of influence) (m)
r_s = Distance to the wellpoints from the centre of the trench (m), assumed to be half of the trench width
x = Trench Length (m)
L = Distance from a line source to the trench, equivalent to R_o (m)

Parameter	Units	Value
Q	**m^3/day**	109.8
K	**m/day**	2.25
H	**m**	2.8
h	**m**	1.3
R_0	**m**	46.3
Trench width	**m**	2
r_s	**m**	1.0
x	**m**	310.0
L	**m**	46.3

Q (L/s) = 1.27

Considering a factor of safety of 2
Required Dewatering Rate:
Q = 439.0 m^3/day
Q = 5.08 L/s

Radius of Influence Formula (Bear, 1979):

$$R_0 = 2.45\sqrt{\frac{HK}{S_y}}\,t$$

Where:

R_0 = Radius of Influence (m), beyond which there is negligible drawdown
H = Distance from initial static water level to bottom of saturated aquifer (m)
K = Hydraulic conductivity (m/s)
S_y = Specific yield of the aquifer formation
t =Time (s) required to draw the static groundwater level to the desired level (assumed to be equivalent to 14 days)

Parameter	Units	Value	
R_0	**m**	46.3	
H	**m**	2.8	
K	**m/s**	2.6E-05	
S_y		0.25	(Johnson, 1967)
t	**s**	1209600	

Legend:

	Input
	Calculated Output

Passive Weeping Tile Flow Estimate @ 1012 Yonge Street, Barrie
Underground Parking

Dupuit Equation:

$$q' = \left[\frac{K \ (H^2 - h^2)}{2 \ L} \right]$$

Where:

q' = Flow per unit width (m^2/day)
K = Hydraulic Conductivity (m/day)
H = Distance from initial static water level to bottom of the saturated aquifer (m)
h = Depth of water in the well while pumping (m)
L = Distance from a line source to the trench, equivalent to R_0 (m)

Parameter	Units	Value
q	**m2/day**	0.07
K	**m/day**	2.246
H	**m**	2.8
h	**m**	2.3
R_0	**m**	46.3
Trench width	**m**	
r_s	**m**	
x	**m**	
L	**m**	46.3

Q (m3/d)	69.93
Q (L/s)	0.81

Considering a factor of safety of 2
Required Dewatering Rate:
Q = 139.9 m^3/day
Q = 1.62 L/s

Radius of Influence Formula (Bear, 1979):

$$R_0 = 2.45\sqrt{\frac{HK}{S_y}}t$$

Where:

R_0 = Radius of Influence (m), beyond which there is negligible drawdown
H = Distance from initial static water level to bottom of saturated aquifer (m)
K = Hydraulic conductivity (m/s)
S_y = Specific yield of the aquifer formation
t =Time (s), required to draw the static groundwater level to the desired level (assumed to be equivalent to 14 days)

Parameter	Units	Value	
R_0	**m**	46.3	
H	**m**	2.8	
K	**m/s**	2.6E-05	
S_y		0.25	(Johnson, 1967)
t	**s**	1209600	

Legend:

	Input
	Calculated Output