Hydrogeological Investigation

441 Maple Avenue, Burlington, ON

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BRM-00639350

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1 Introduction

1.1 Project Description

EXP Services Inc. (EXP) was retained by Better Life Retirement Residence Inc. to prepare a Hydrogeological Investigation Report associated with the proposed development located at 441 Maple Avenue, Burlington, Ontario (hereinafter referred to as the 'Site').

The Site is currently occupied by a low-rise commercial structure. It is our understanding that the proposed development plan consists of a multi-storey structure (17 to 24 levels) with three (3) levels of underground parking. The Site location plan is shown on Figure 1.

Terraprobe conducted a previous Geotechnical Investigation dated December 18, 2017. The pertinent information gathered from the noted investigations is utilized for this report.

1.2 Project Objectives

The main objectives of the Hydrogeological Investigation are as follows:

- Establish the local hydrogeological settings within the Site;
- Estimate construction dewatering flow rates and assess potential impacts;
- Assess groundwater qality; and
- Prepare a Hydrogeological Investigation Report.

1.3 Scope of Work

To achieve the investigation objectives, EXP has completed the following scope of work:

- Review available geological and hydrogeological information for the Site;
- Develop and conduct Single Well Response Tests (SWRT) on all previously installed monitoring wells and previously installed wells on site to evaluate hydraulic properties of the saturated stratigraphic units at the Site;
- Complete two (2) rounds of groundwater level measurements at all monitoring wells;
- Collect one (1) groundwater sample for the Region of Halton/City of Burlington Sanitary and Storm Sewer By-Law parameters;
- Evaluate the information collected during the field investigation program, including borehole geological information, SWRT results, groundwater level measurements and groundwater water quality;
- Prepare site plans, cross sections, geological mapping and groundwater contour mapping for the Site;
- Estimate construction dewatering flow rates;
- Assess potential impacts and recommend mitigation measures, if required; and
- Prepare a Hydrogeological Investigation Report.

The Hydrogeological Investigation was prepared in accordance with the Ontario Water Resources Act, Ontario Regulation 387/04, and Toronto Municipal Code 681-Sewers. The scope of work outlined above

is conceived to assess construction dewatering and does not include a review of Environmental Site Assessments (ESA).

1.4 Review of Previous Reports

The following report was reviewed as part of this Hydrogeological Investigation:

- **Terraprobe.** (December 18, 2017), *Geotechnical Investigation and Engineering Design Report*, 441 Maple Avenue, Burlington, ON, prepared for Mr. Sam Badawi.

2 Hydrogeological Setting

2.1 Regional Setting

2.1.1 Regional Physiography

The Site is located within a physiographic region named Iroquois Plain, and a physiographic landform known as the Sand Plains. The South Slope, another physiographic region, lies to the north/east and the Niagara Escarpment and is situated North/West of the Iroquois Plain (Chapman & Putnam, 2007).

The Iroquois Plain was created along the shores of former Lake Iroquois, an ancient glacial lake. The noted Plain primarily consists of shallow water sandy deposits. The topography of the Iroquois Plain is relatively flat with a gradual slope to the south, toward Lake Ontario.

2.1.2 Regional Geology and Hydrogeology

The surficial geology can be described as coarse textured glaciolacustrine deposits consisting of sand, gravel, minor silt and clay (Ministry of Northern Development and Mines, 2012). The surficial geology of the Site and surrounding areas is shown on Figure 2.

Bedrock of the region is predominately shale of the Queenston Formation (Upper Ordovician). The Queenston Formation consists of shale with interbeds of limestone and calcareous siltstone (Ministry of Northern Development and Mines, 2012).

Regional groundwater flow across the area is expected to be directed south, towards Lake Ontario. Local deviation from the regional groundwater flow pattern may occur in response to changes in topography and/or soils, as well as the presence of surface water features and/or existing subsurface infrastructure.

2.1.3 Existing Water Well Survey

Well Records from the Ministry of the Environment, Conservation and Parks (MECP) Water Well Record (WWR) Database were reviewed to determine the number of water wells present within a 500-m radius of the Site boundaries. The MECP WWR database indicates that nine (9) records within a 500 m radius from the Site centroid. The locations of the well records are shown on Figure 3. A summary of the WWR is included in Appendix A.

The database indicates that the offsite wells are at an approximate distance of one hundred and twenty-one (121) m or greater from the Site centroid. All offsite wells were reportedly identified as observation wells, water supply wells, abandoned and/or listed with unknown use. The reported water levels ranged from depths of 1.3 m to 16.8 meters below ground surface (mbgs). The area is municipally serviced.

2.2 Site Setting

2.2.1 Site Topography

The Site is in an urbanized land use setting. The topography is considered relatively flat, with a regional gradual southeasterly slope towards Lake Ontario.

As indicated on the borehole logs included in Appendix B, the surface elevation of the Site ranges between approximately 82.3 to 83.1 meters above sea level (masl).

2.2.2 Local Surface Water Features

The Site sits near the divide between the Northshore Watershed Area and the watershed of the Burlington Urban Creeks. Indian Creek is approximately 0.8 km SW of the Site. The nearest surface water feature is Lake Ontario. Lake Ontario is approximately 0.6 km from the Site boundary to the southeast. No surface water features are located onsite.

2.2.3 Local Geology and Hydrogeology

A summary of subsurface soil stratigraphy is provided in the following paragraphs. The soil descriptions are based on the Geotechnical Investigation Report (Terraprobe, 2017) and they are summarized for the hydrogeological interpretations. As such, the information provided in this section shall not be used for the construction design purposes.

The detailed soil profiles encountered in each borehole and the results of moisture content determinations are presented on the attached borehole logs (Appendix B). It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones for the hydrogeological investigation and shall not be interpreted as exact planes of geological change.

The "Notes on Sample Description" preceding the borehole logs form an integral part of and should be read in conjunction with this report. The following is a brief description of the soil conditions encountered during the investigation.

Based on the results of the geotechnical investigation, the general subsurface soil stratigraphy consists of the following units from top to maximum depth of investigation onsite as follows:

Asphalt and Pavement

Asphalt of about 50 to 75 mm thick was encountered at the ground surface of all boreholes.

Fill

Underlying the asphalt, fill comprising predominantly sand to clayey silt, was encountered. The fill extended to depths of 0.28 to 2.3 mbgs.

Sand

A sand deposit was encountered below the fill in Borehole 1. This deposit is reddish-brown in color, moist and exists in a dense state. The sand extends to about 2.5 m below existing grade (80.5 masl).

Silt

A silt deposit was encountered below the fill in Boreholes 2, 3 and 4 and below the silt in Borehole 1. The silt contained trace clay, was reddish-brown in color, moist and exists in a dense state. The sand extends to about 2.3 to 4.5 m below existing grade (80 to 78.6 masl).

Shale Bedrock

Shale of the Queenston Formation was encountered below the silt in Borehole locations at elevations of 78.6 to 80 masl. The bedrock predominantly consists of thickly bedded to massive red shale of Ordovician age. The formation contains interbeds of light grey / green calcareous shale, siltstone, sandstone, and limestone/dolostone which are discontinuous and nominally 50 to 300 mm thick. The shale is a rock of weak strength, whereas the harder calcareous and limestone/dolostone beds are considered to have medium strength and to be hard layers.

3 Results

3.1 Monitoring Well Details

The monitoring well network installed at the Site as part of the Geotechnical Investigation and Engineering Design Report by Terraprobe (2017) consists of the following:

- Four (4) shallow overburden monitoring wells (BH 1-S, BH 2, BH 3, and BH 4);
- One (1) deep bedrock monitoring well (BH 1-D);
- Diameter of all monitoring wells is 50 mm;
- All wells installed with a flush mount well protective casing; and
- Borehole logs and monitoring well installation details are provided in Appendix B. The monitoring well locations are shown on Figure 4.

3.2 Water Level Monitoring

As part of the Hydrogeological Investigation, static water levels in the monitoring wells were recorded in two (2) monitoring events, including February 14 and 22, 2019. All static water level data as it relates to the elevation survey is summarized in Table 3-1 below.

The groundwater elevation recorded in the intermediate wells ranged from 79.05 masl (3.55 mbgs) at BH 4 on February 14, 2019 to 80.97 masl (2.13 mbgs) at BH 1-S on February 14, 2019. Furthermore, the groundwater elevation recorded for the deep well (BH1-D) ranged from 75.10 masl (8.00 mbgs) on February 14, 2019 to 76.36 masl (6.74 mbgs) on February 22, 2019.

Table 3-1: Summary of Measured Groundwater Elevations

Monitoring Well ID	Ground Surface Elevation (masl)	Approximate Full Well Depth (mbgs)*	Depth	Feb 14, 2019	Feb 22, 2019
BH 1-D	**83.1**	**17.29**	mbgs	8.00	6.74
			masl	75.10	76.36
BH 1-S	**83.1**	**4.74**	mbgs	2.13	2.17
			masl	80.97	80.94
BH 2	**83.1**	**4.24**	mbgs	3.56	3.54
			masl	79.54	79.57
BH 3	**82.3**	**4.52**	mbgs	2.89	3.04
			masl	79.41	79.26
BH 4	**82.6**	**4.16**	mbgs	3.55	3.48
			masl	79.05	79.12

Notes:
mbgs: meters below ground surface
masl: meters above mean sea level
* Based on field measurements

A groundwater contour map is delineated for the intermediate and deep water-bearing zones for the Site (Figure 5). Accordingly, the groundwater flow directions in the intermediate and deep zones are interpreted to be towards the east, southeast, towards Lake Ontario.

It should be noted that groundwater levels are expected to show seasonal fluctuations and vary in response to prevailing climate conditions; this may also affect the direction and rate of flow. It is recommended to conduct recurrent groundwater level measurements to provide more information on seasonal groundwater level fluctuations.

3.3 Hydraulic Conductivity Testing

Five (5) Single Well Response Tests (SWRT's) were completed on monitoring wells BH 1-D, BH 1-S, BH 2, BH 3 and BH 4 on February 14, 2019. The tests were completed to estimate the saturated hydraulic conductivity (K) of the soils at the well screen depths.

The static water level within each monitoring well was measured prior to the start of testing. Prior to performing SWRTs, each monitoring well underwent development to remove fines introduced into the screens following construction. The development process involved purging of the monitoring wells to induce the flow of fresh formation water through the screen. Each monitoring well was permitted to fully recover prior to performing SWRTs.

Hydraulic conductivity values were calculated from the SWRT and constant rate test data as per Hvorslev's solution included in the Aqtesolv Pro. V.4.5 software package. The semi-log plots for normalized drawdown versus time are included in Appendix D.

A summary of the hydraulic conductivity (K) values estimated from the SWRTs are provided in Table 3-2.

Table 3-2: Summary of Hydraulic Conductivity Testing

Monitoring Well	Well Depth (mbgs)*	Screen Interval (mbgs)		Soil Formation Screened **	Estimated Hydraulic Conductivity (m/s)
		from	to		
BH 1-D	17.29	14.29	17.29	Shale	2.3×10^{-7}
BH 1-S	4.74	1.74	4.74	Fill to Sand to Silt	2.2×10^{-6}
BH 2	4.24	1.24	4.24	Fill to Silt	8.3×10^{-6}
BH 3	4.52	1.52	4.52	Fill to Silt	6.1×10^{-7}
BH 4	4.16	1.16	4.16	Silt to inferred Bedrock	1.8×10^{-6}
				Highest Estimated K Value	8.3×10^{-6}
				Geometric Mean of Estimated K Values	2.6×10^{-6}

Notes:
*Well depth is based on the field measurements
** Soil descriptions are based on the borehole logs.

SWRTs provide estimates of K for the geological formation in the immediate zone surrounding the well screens and may not be representative of bulk formation hydraulic conductivity. As shown in Table 3-1,

the highest K for the tested water-bearing zones is estimated to be 8.3×10^{-6} m/s, and the geometric mean of the K values is to be 2.6×10^{-6} m/s.

3.4 Groundwater Quality

To assess the suitability for discharge of pumped groundwater to Halton Region Sanitary and Storm Sewer during dewatering activities, one (1) groundwater sample was collected from monitoring well BH 1-S on February 22, 2019 using a peristaltic pump. Prior to the collection of the noted water sample, approximately three (3) standing well volumes of groundwater were purged from the referred well.

The sample was collected unfiltered and placed into pre-cleaned laboratory-supplied vials and/or bottles provided with analytical test group specific preservatives, as required. Dedicated nitrile gloves were used during sample handling. The groundwater samples were submitted for analysis to Maxxam Analytics Inc., a CALA certified independent laboratory, in Mississauga, Ontario.

When compared to the Sanitary Sewer By-Law Limits (Table 1) the laboratory Certificate of Analysis (CofA) showed that all parameters were detected at concentrations below the Sanitary By-Law limits (Table 1).

When compared to the Storm Sewer By-Law Limits (Table 2), all parameters were also reported below the Storm Sewer Use By-Law criteria.

For the short-term dewatering system (construction phase), it is anticipated that TSS levels and some other parameters (for example, Total Metals) in the pumped groundwater may become elevated and exceed both, Sanitary and Storm By-Law limits. To control the concentration of TSS and associated metals, it is recommended that a suitable treatment method be implemented (filtration or decantation facilities and/ or any other applicable treatment system) during construction dewatering activities to discharge to the applicable sewer system. The specifications of the treatment system will need to be adjusted to the reported water quality results by the treatment contractor/process engineer.

For the long-term dewatering discharge to the Storm or Sanitary sewer system (post-development phase) and based on the water quality test results, the water is suitable to discharge without a treatment system. It is noted that the water quality results presented in this report are not representative of the long-term condition of groundwater quality onsite. As such, regular water quality monitoring is recommended for the post-construction phase.

It is also remarked that an agreement to discharge to the City of Burlington/Region of Halton will be required prior to discharging dewatering effluent.

Furthermore, the Environmental Site Assessment Report(s) shall be reviewed for more information on the groundwater quality conditions at the Site.

4 Construction Dewatering Assessment

4.1 Construction Dewatering Rate Assumptions

It is our understanding that the proposed development plan is consists of a multi-storey structure (17 to 24 levels) with three (3) levels of underground parking.

It should be noted that shoring drawings were not available at the time of writing this report. For this assessment, it was assumed that the proposed construction plans include an excavation with shoring extending to the Site boundaries. EXP should be retained to review the assumptions outlined in this section, should the assumed shoring design change.

Table 4-1 presents the assumptions used to calculate the dewatering rate for the Site.

Table 4-1 Dewatering Estimate Assumptions

Input Parameter	Assumption	Notes
Ground surface elevation	83.0 masl	Approximate elevation based on the borehole logs and site rounded
Groundwater elevation	81.0 masl	The highest representative groundwater elevation measured across the site (rounded up).
Lowest slab elevation (P3)	73.0 masl	Based on the geotechnical report (Terraprobe, 2017), the slab is anticipated to be rested at a depth of 10 mbgs.
Lowest footing elevation	71.5 masl	Assumed to approximately 1.5 m below the slab.
Dewatered elevation target	70.5 masl	Assumed to be approx. 1 m below the lowest footing elevation.
Base of the Water-Bearing Zone	69.5 masl	Assumed to be approx. 1 m below the dewatered elevation target elevation.
Excavation Area	95 m x 35 m	Approximate Site extent for the proposed development
Hydraulic Conductivity (K)	2.6×10^{-6} m/s	Representative K values (Geometric Mean) for the Site.

4.1.1 Dewatering Flow Rate Estimate and Zone of Influence

The Dupuit equation for steady linear flow to both sides of an excavation through an unconfined aquifer resting on a horizontal impervious surface was used to obtain a flow rate estimate. Dewatering flow rate is expressed as follows:

$$Q_w = xK(H^2 - h^2)/Lo$$

Where:
Qw = Rate of pumping (m^3/sec)
X = Length of excavation (m)
K = Hydraulic conductivity (m/sec)
H = Head beyond the influence of pumping (static groundwater elevation) (m)
h = Head above the base of aquifer in an excavation (m)
Lo = Distance of influence (m)

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

4.1.2 Radius of Influence

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

The estimated radius of influence (R_o) of pumping based on the Sichardt formula is described as follows:

$$\mathrm{R_o} = C(H - h)\sqrt{(K)}$$

Where:
Ro = Estimated radius of influence (m)
H = Head in aquifer (static water level or saturated depth) (m)
h = Dynamic water level (m)
K = Hydraulic Conductivity (m/sec)
C = Constant (3,000)

Based on the Sichardt formula and the highest K value, the calculated zone of influence ($L_o = R_o/2$) would be approximately 25 m from the sides of the excavation.

The calculations for radius of influence are provided in Appendix E (Table E-1).

4.2 Rainfall

Additional pumping capacity may be required to maintain dry conditions within the excavation during and following significant precipitation events. Therefore, the dewatering rates at the Site should also include removing direct input of rain water into the excavation.

A 15 mm precipitation event was utilized for the estimate. Given that the total area of the excavation is approximately 3,300 m^2 the estimated volume of direct precipitation to be collected in the excavation is approximately 50 m^3 for a 15 mm precipitation event. The calculations for the rainfall input estimate is included in Appendix E (Table E-2).

It is noted that a two (2) year storm event over a 24-hour period is approximately 57 mm. During large precipitation events, the water should be retained onsite to not exceed the allowable water taking and discharge limits as necessary.

4.3 Results of Construction Dewatering Rate Estimate

Based on the assumptions provided in this report, the results of the dewatering rate estimate can be summarized as follows:

Table 4-1 Summary of Dewatering Flow Rate Estimate

Location	Peak Dewatering Flow Rate Including Safety Factor and Precipitation (m^3/day)
Site Extents	350

Construction dewatering flow rate estimate is provided in Appendix E (Table E-1).

This peak dewatering flow rates accounts for accumulation of some precipitation, seasonal fluctuations in the groundwater table, flow from beddings of existing sewers, and variation in hydrogeological properties beyond those encountered during this study. This peak dewatering flow rate also provides additional capacity for the dewatering contractor.

It is noted that the maximum flow estimate equation calculated with a representative K value, provides a conservative estimate to account for higher than expected flow rates during the construction dewatering.

Please note that it is the responsibility of the contractor to ensure dry conditions are always maintained at all costs within the excavation.

4.4 Construction MECP Water Taking Permit

In accordance with the Ontario Water Resources Act, if the water taking for the construction dewatering will be more than 50 m^3/day but less than 400 m^3/day, an application for registration with the Environmental Activity and Sector Registry (EASR) with MECP is required. If groundwater dewatering rates onsite exceed 400 m^3/day, a Category 3 Permit to Take Water (PTTW) would be required from the MECP.

It is recognized that the maximum flow estimate equation calculated with a representative K value, provides a conservative estimate to account for higher than expected flow rates during the construction dewatering.

Based on the dewatering estimate of approximately 350 m^3/day for this project, an EASR would be required to facilitate the construction dewatering program for the Site.

5 Sub-Drain Discharge Estimate

5.1 Long-Term Dewatering Rate Assessment

It is our understanding that the development plan includes a permanent foundation sub-drain system that will ultimately discharge to the municipal sewer system if conventional footings are installed.

To estimate the groundwater flow to the future sub-drain the Theim equation for steady radial flow to an excavation through a confined aquifer resting on a horizontal impervious surface was used to obtain a flow rate was used. Dewatering flow rate is expressed as follows:

$$Q_w = 2piKD(H - hw)/Ln(\frac{Ro}{re})$$

Where:
Q_w = Rate of pumping (m^3/sec)
r_e = Effective Radius (m); re = (a+b)/π
K = Hydraulic conductivity (m/sec)
H = Hydraulic head beyond the influence of pumping (static groundwater elevation in m)
h_w = Hydraulic head above the base of aquifer in an excavation (m)
Ro = Radius of influence (m)
D = Aquifer thickness (m)
a = Length of excavation (m)
b = Width of excavation (m)

The calculation for the estimated flow to the future sub-drain system (with no cut-off walls) is provided in Appendix F. The dewatering target for the foundation drainage system is taken at 0.5 m below the lowest slab elevation.

The foundation drain analysis provides a preliminary flow rate estimate. Actual flow rate measurements of the sump discharge, once it is built, will be required to confirm these flow rates.

5.2 Cooper-Jacob's Radius of Influence

The radius of influence (Rcj) for the construction dewatering was calculated based on Cooper-Jacob equation. This equation is used to predict the distance at which the drawdown resulting from pumping is negligible. This equation was derived for confined aquifers, however, can be used in unconfined aquifers where the drawdown is not a large portion of the original saturated thickness.

The estimated radius of influence due to pumping is based on Cooper-Jacob formula as follows:

$$\mathrm{R}_{cj} = \sqrt{2.25KDt/s}$$

Where:
Ro = Estimated radius of influence (m)
D = Aquifer thickness (original saturated thickness) (m)
K = Hydraulic conductivity (m/sec)
S = Storage coefficient
t = Duration of pumping (s)

5.3 Sub-Drain Flow Rate Estimate

Based on the assumptions provided in this report, the results of the sub-drain discharge volume estimate are summarized in Appendix F. Seasonal and daily fluctuations are expected. These estimates may be affected by hydrogeological conditions beyond those encountered at this time, fluctuations in groundwater regimes, surrounding Site alterations, and existing and future infrastructures.

For the design of water foundations without perimeter and foundation drainage systems, shallower wells need to be considered to evaluate the shallow groundwater table. The hydrogeologist needs to be consulted during the design process.

Intermittent cycling of sump pumps and seasonal fluctuation in groundwater regimes should be considered for pump specifications. A safety factor was applied to the flow rate to account for water level fluctuations due to seasonal changes.

These estimates assume that pits (elevator, sump pits) are made as watertight structures (without drainage) if their depths extend below the dewatering target, as previously stated. The dewatering assumptions are based on using shoring system without open cuts. Open cuts can act as preferential groundwater pathways in the long term and cause foundation drainage volumes to increase.

If caisson walls are used for decreasing long-term dewatering rates, these should be designed as permanent structures to allow for groundwater cutoff in the long-term. All perforations should be sealed permanently (ex: tiebacks, breaches and cold joints) with no leakages and inspected. Fillers should extend into low permeability deposits (ex: sound bedrock or till) to cutoff groundwater from water bearing zones. Inspections should be conducted to confirm the depth of low permeability deposits along shoring system and that the fillers are keyed into low permeability soil deposits.

The sub-drain rate estimate is based on the assumptions outlined in this report. Any variations in hydrogeological conditions beyond those encountered as part of this investigation may significantly influence the sub-drain discharge volumes. Once the sub-drain system is in place, it is recommended to

install a flow meter at the sump(s) to record daily discharge volumes during the commissioning stage of the system.

5.4 Post-Development MECP Water Taking Permit

In accordance with the Ontario Water Resources Act, if the water taking for the construction dewatering is more than 50 m3/day, then an application for a Category 3 Permit to Take Water (PTTW) will be required from the MECP.

It is recognized that the maximum flow rate calculated with a high K-value, provides a conservative estimate to account for higher than expected flow rates during the post-development dewatering. Based on the dewatering estimate of approximately 90 m^3/day for this project, a Category 3 Permit to Take Water (PTTW) will be required to facilitate the post-development phase.

6 Environmental Impact

6.1 Surface Water Features

The Site sits near the divide between the Northshore Watershed Area and the watershed of the Burlington Urban Creeks. Indian Creek is approximately 0.8 km SW of the Site.

No surface water features are located onsite. The nearest surface water feature is Lake Ontario. Lake Ontario is approximately 0.6 km from the Site boundary to the southeast.

Due to the limited extent of zone of influence and the distance of the nearest surface water feature, no impacts to surface water features are expected during construction activities.

6.2 Groundwater Sources

Well Records from the MECP Water Well Record (WWR) Database were reviewed to determine the number of water supply wells present within a 500 m radius of the Site boundaries. Given that the dewatering zone of influence, no dewatering related impact is expected on the water wells in the area.

6.3 Geotechnical Considerations

Under certain conditions, dewatering activities can cause settlements due to an increase in the effective stress in the dewatered soil.

A letter related to geotechnical issues (i.e. settlement) as it pertains to the Site is recommended to be completed under a separate cover.

6.4 Groundwater Quality

It is our understanding that the potential discharge from the dewatering system during the construction will be directed to the municipal sewer system. As such, the quality of groundwater discharge is required to conform the Region of Halton Sewer Use By-Law.

For the short-term dewatering system (construction phase), it is anticipated that TSS levels and some other parameters (for example, Total Metals) in the pumped groundwater may become elevated and exceed the both Sanitary and Storm By-Law limits. To control the concentration of TSS and associated metals, it is recommended that a suitable treatment method be implemented (filtration or decantation facilities and/ or any other applicable treatment system) during construction dewatering activities to discharge to the applicable sewer system. The specifications of the treatment system will need to be adjusted to the reported water quality results by the treatment contractor/process engineer.

For the long-term dewatering discharge to the Sanitary or Storm sewer system (post-development phase), and based on the water quality test results, the water is suitable to discharge without a treatment system.

It is noted that the water quality results presented in this report are not representative of the long-term condition of groundwater quality onsite. As such, regular water quality monitoring is recommended for the post-construction phase as required by the City of Burlington/Region of Halton.

It is noted that an agreement to discharge to the City of Burlington/Region of Halton will be required prior to discharging dewatering effluent.

Furthermore, the Environmental Site Assessment Report(s) should be reviewed for more information on the groundwater quality conditions at the Site.

6.5 Well Decommissioning

In conformance with Regulation 903 of the Ontario Water Resources Act, the installation and eventual decommissioning of any dewatering system wells or monitoring wells must be completed by a licensed well contractor. This will be required for all wells that are no longer in use.

7 Conclusions and Recommendations

Based on the findings of the Hydrogeological Investigation, the following summary of conclusions and recommendations is provided:

- The laboratory CofA showed that all parameters were detected at concentrations below the Sanitary and Storm Sewer By-Law limits.
- Based on the assumptions outlined in this report, the estimated peak construction dewatering rate is approximately 350 m^3/day. As the dewatering flow rate estimate is above the MECP EASR threshold of 50 m^3/day and less than 400 m^3/day, an EASR would be required to facilitate the construction dewatering program for the Site.
- The long-term flow rate of the foundation sub-drain is estimated to be 90 m^3/day. The exact volume discharged can be confirmed once the system is operational. It is recommended that once the sub-drain system is in place, a flow meter be installed at the sump(s) to record daily discharge volumes to provide more representative estimates during the commissioning stage of the system. Regular maintenance/cleaning of the sub-drain system is recommended to ensure its proper operation. A PTTW will be required for long-term discharge.
- The construction dewatering and long-term estimate of sub-drain discharge volumes are based on the assumptions outlined in this report. Any variations of the hydrogeological conditions beyond those encountered as part of this preliminary investigation may significantly influence the respective discharge volumes.
- For the short-term dewatering system (construction phase), it is anticipated that TSS levels and some other parameters (for example, Total Metals) in the pumped groundwater may become elevated and exceed both, Sanitary and Storm By-Law limits. To control the concentration of TSS and associated metals, it is recommended that a suitable treatment method be implemented (filtration or decantation facilities and/ or any other applicable treatment system) during construction dewatering activities to discharge to the applicable sewer system. The specifications of the treatment system will need to be adjusted to the reported water quality results by the treatment contractor/process engineer.
- For the long-term dewatering discharge to the sanitary sewer system (post-development phase) and based on the water quality test results, the water is suitable to discharge without a treatment system.
- As per the MECP technical requirement for PTTW and EASRs, the geotechnical assessment of the stability of the soils due to water taking (ex: settlement, soil loss, subsidence etc.) is required. The water taking should not have unacceptable interference on soils and underground structures (foundations, utilities etc.). A letter related to geotechnical issues as it pertains to the Site is required to be completed under a separate cover.
- The EASR registration allows construction dewatering discharge of up to 400 m3/day. A Discharge Plan (dewatering sketch, sewer discharge agreement) must be developed and applied for any discharges from the Site. The Discharge Plan and monitoring for both water quantity and water quality must be carried at the Site during the entire construction dewatering phase. The daily water

taking records must be maintained onsite for the entire construction dewatering phase. The EASR, Discharge Plan, hydrogeological investigation report, and geotechnical assessment of settlements must always also be available at the construction Site for the entire construction dewatering. EXP should be notified immediately about any changes to the construction dewatering schedule or design, since EASR will need to be updated to reflect these modifications. The hydrogeological report, EASR, Discharge Plan and geotechnical assessment constitutes the Water Taking Plan which needs to be available onsite for the duration of construction dewatering.

- In conformance with Regulation 903 of the Ontario Water Resources Act, the installation and eventual decommissioning of any dewatering system wells or monitoring wells must be completed by a licensed well contractor. This will be required for all wells that are no longer in use.

The conclusions and recommendations provided above should be reviewed in conjunction with the entirety of the report. They are based on the assumptions that the present design/concept described throughout the report will proceed to construction. The current hydrogeological assessment is based on information borehole information collected by Terraprobe and EXP does not take responsibility for the accuracy of this information. Furthermore, this report is solely intended for the construction and long-term dewatering assessments. Any changes to the design concept may result in a modification to the recommendations provided in this report.

8 Limitations

This report is based on a limited investigation designed to provide information to support an assessment of the current hydrogeological conditions within the study area. The conclusions and recommendations presented within this report reflect Site conditions existing at the time of the assessment. EXP must be contacted immediately if any unforeseen Site conditions are experienced during construction activities. This will allow EXP to review the new findings and provide appropriate recommendations to allow the construction to proceed in a timely and cost-effective manner.

Our undertaking at EXP, therefore, is to perform our work within limits prescribed by our clients, with the usual thoroughness and competence of the geoscience/engineering profession. No other warranty or representation, either expressed or implied, is included or intended in this report.

This report was prepared for the exclusive use of Better Life Retirement Residence Inc. This report may not be reproduced in whole or in part, without the prior written consent of EXP, or used or relied upon in whole or in part by other parties for any purposes whatsoever. Any use which a third party makes of this report, or any part thereof, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. EXP Services Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

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

Sincerely,

EXP Services Inc.



Tomson Hecky, M.Sc..P.Geo.
Hydrogeologist
Environmental Services

Francois Chartier M.Sc., P.Geo.
Head of Hydrogeology Group
Environmental Services

9 References

Cashman and Preene (2013) *Groundwater Lowering in Construction, 2nd Edition*.

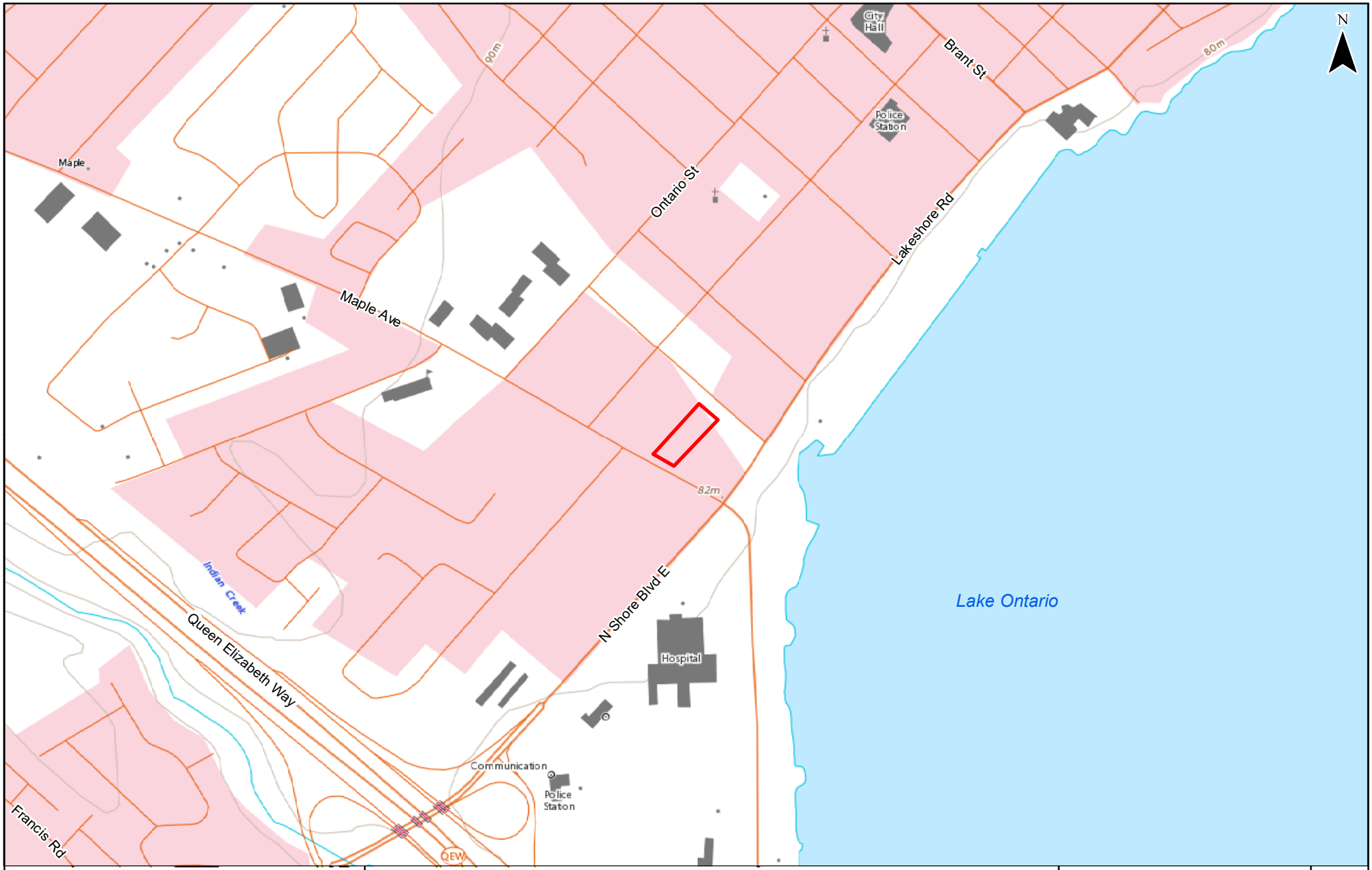
Chapman, L.J. and Putnam, D.F. (2007). Physiography of Southern Ontario, 3rd Edition, Ontario Geological Survey.

J.P. Powers, A.B. Corwin, P.C. Schmall, and W.E. Kaeck (2007). *Construction Dewatering and Groundwater Control, Third Edition.*

Ministry of Northern Development and Mines (May, 2012). *OGS Earth.* Retrieved from http://www.mndm.gov.on.ca/en/mines-and-minerals/applications/ogsearth.

Terraprobe. (December 18, 2017), Geotechnical Investigation and Engineering Design Report, 441 Maple Avenue, Burlington, ON, prepared for Mr. Sam Badawi.

Figures



SCALE:
0 50 100 200 300 400 500 m

SOURCE:
TOPORAMA WEB MAP SERVICE, NATURAL RESOURCES CANADA

DRAWN BY: AC

CHECKED BY: CS

LEGEND:
APPROXIMATE SITE BOUNDARY

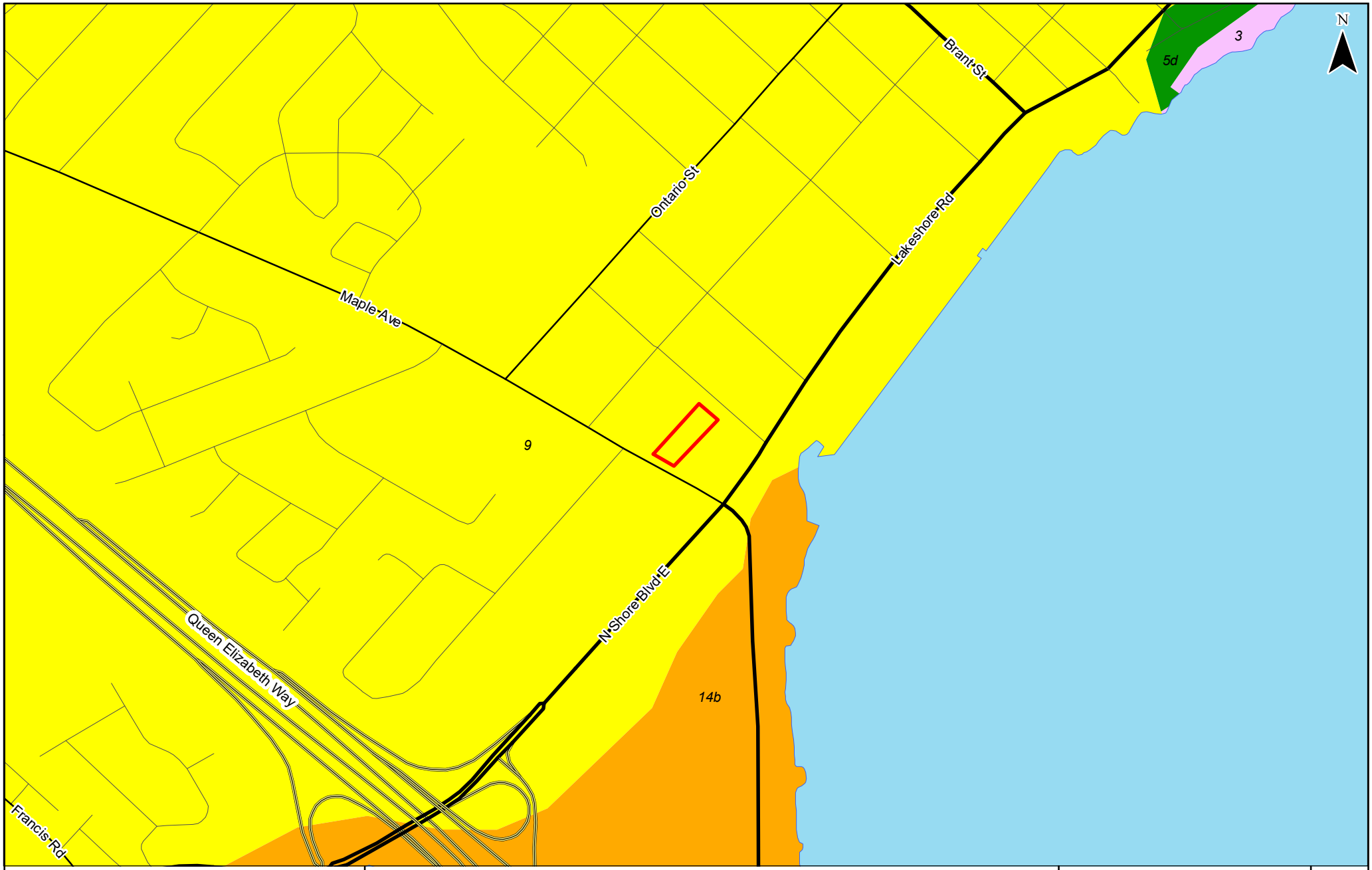
SITE LOCATION PLAN

FIGURE: 1

HYDROGEOLOGICAL INVESTIGATION
441 MAPLE AVENUE
BURLINGTON, ONTARIO

PROJECT NUMBER: BRM-00639350-B0

DATE: FEBRUARY 2019



SCALE:
0 50 100 200 300 400 500 m

SOURCE:
BASED ON ONTARIO GEOLOGICAL SURVEY DATA PUBLISHED IN 2010

exp.

DRAWN BY:	CHECKED BY:
AC	CS

LEGEND:
- APPROXIMATE SITE BOUNDARY
- 14B: COARSE-TEXTURED (LITTORAL-FORESHORE) LACUSTRINE DEPOSITS
- 9: COARSE-TEXTURED GLACIOLACUSTRINE DEPOSITS
- 5D: GLACIOLACUSTRINE-DERIVED SILTY TO CLAYEY TILL
- 3: PALEOZOIC BEDROCK

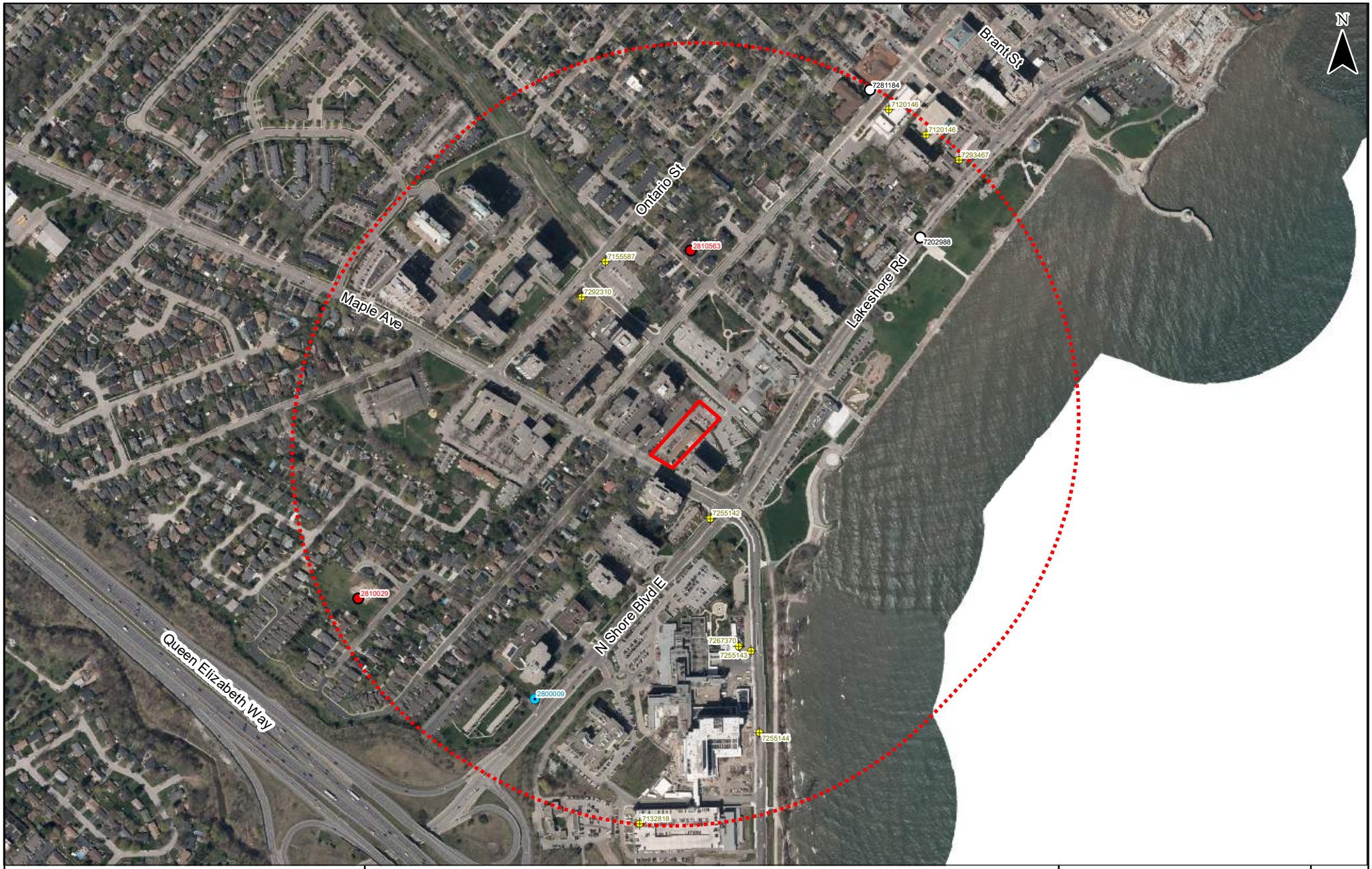
SURFICIAL GEOLOGY

FIGURE: 2

HYDROGEOLOGICAL INVESTIGATION
441 MAPLE AVENUE
BURLINGTON, ONTARIO

PROJECT NUMBER: BRM-00639350-B0

DATE: FEBRUARY 2019



SCALE:
0 60 120 180 240 300 m

SOURCE:
BASED ON GOOGLE EARTH IMAGERY DATED 2017,
AVAILABLE WELL RECORD INFORMATION AS OF SEPTEMBER 2017

exp.

DRAWN BY:	CHECKED BY:
AC	CS

LEGEND:

- MONITORING WELL / TEST HOLE
- WATER SUPPLY WELL
- ABANDONED WELL
- UNCLASSIFIED / UNFINISHED WELL
- APPROXIMATE SITE BOUNDARY
- 500 m ZONE

MECP WATER WELL RECORDS MAP

FIGURE: 3

HYDROGEOLOGICAL INVESTIGATION
441 MAPLE AVENUE
BURLINGTON, ONTARIO

PROJECT NUMBER: BRM-00639350-B0

DATE: FEBRUARY 2019



SCALE:

0 8 16 24 32 40 m

LEGEND:

- BOREHOLE / MONITORING WELL (TERRAPROBE, 2017)
- APPROXIMATE SITE BOUNDARY

DRAWN BY:	CHECKED BY:
AC	CS

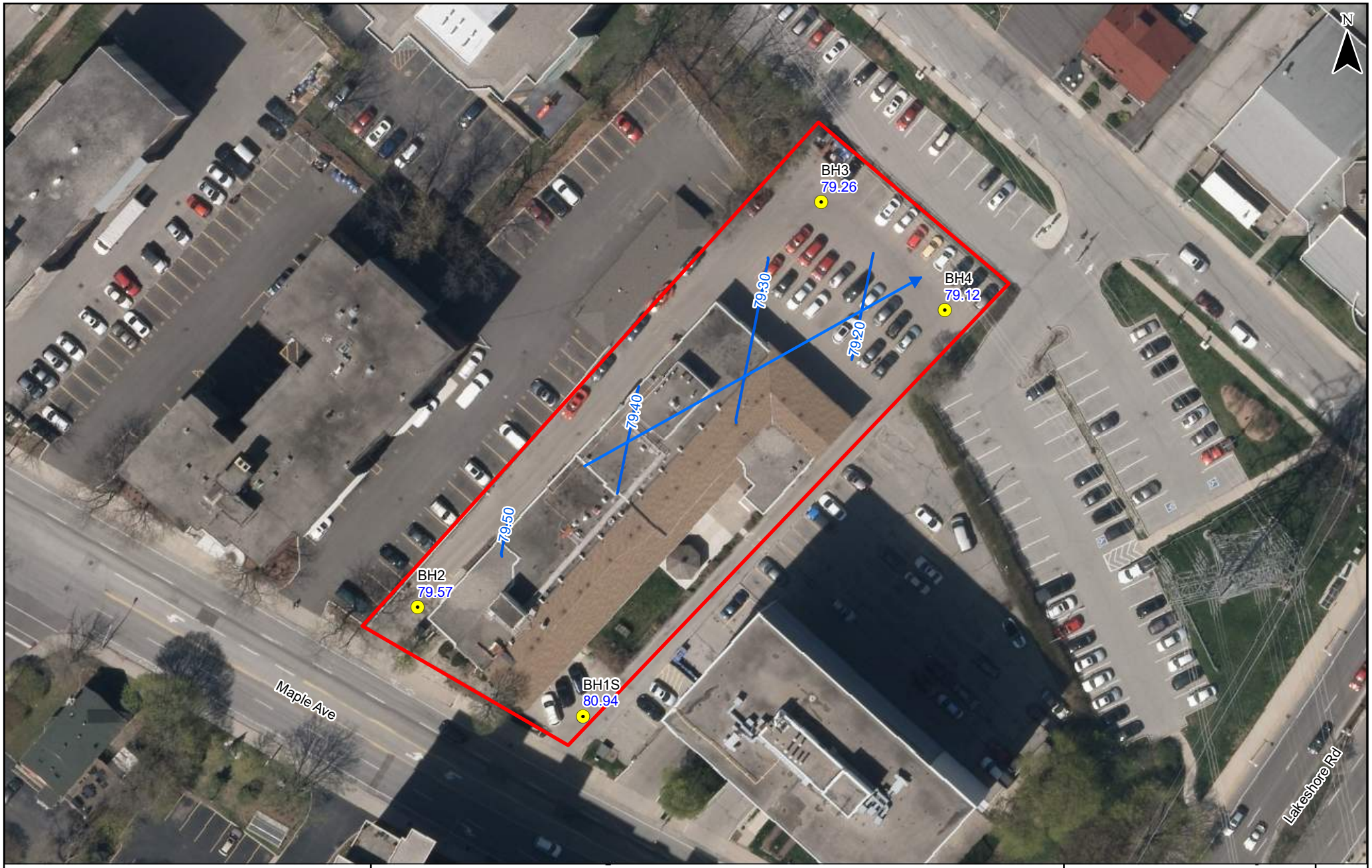
BOREHOLE / MONITORING WELL LOCATION PLAN

FIGURE: 4

HYDROGEOLOGICAL INVESTIGATION
441 MAPLE AVENUE
BURLINGTON, ONTARIO

PROJECT NUMBER: BRM-00639350-B0

DATE: MARCH 2019



SCALE:

0 8 16 24 32 40 m

Note:
1. Groundwater elevation at BH1S was not used in making the groundwater contours due to anomalous data.
2. Groundwater elevations were measured on February 22, 2019.

exp.

DRAWN BY:	CHECKED BY:
AC	CS

LEGEND:

- BOREHOLE / MONITORING WELL (TERRAPROBE, 2017)
- SHALLOW GROUNDWATER CONTOUR
- XX.XX GROUNDWATER ELEVATION (m ASL) Note: Groundwater elevations measured on February 22, 2019.
- GROUNDWATER FLOW DIRECTION
- APPROXIMATE SITE BOUNDARY

SHALLOW GROUNDWATER CONTOURS

FIGURE: 5

HYDROGEOLOGICAL INVESTIGATION
441 MAPLE AVENUE
BURLINGTON, ONTARIO

PROJECT NUMBER: BRM-00639350-B0

DATE: MARCH 2019

Appendix A:
MECP WWR Summary Table

Off-Site													
BORE_HOLE_	WELL_ID	DATE	EAST83	NORTH83	ELEVATION (m ASL)	LOCATION ACCURACY	STREET	CITY	DISTANCE TO SITE CENTROID (m)	WATER FOUND (m BGS)	1st USE	2nd USE	FINAL STATUS
10146566	2800009	6/28/1958	596895	4796701	81.5	UTM very unreliable			424	16.8	Domestic		Water Supply
11174646	2810029	7/21/2004	596649	4796841	84.7	margin of error : 10 - 30 m	1167 BELLVIEW CRES	BURLINGTON	510	4.8	Not Used		Observation Wells
11552473	2810563	6/14/2006	597112	4797327	85.4	margin of error : 10 - 30 m	473 NELSON AVE	BURLINGTON	258	1.3	Not Used		Abandoned-Other
1002774627	7132818	9/16/2009	597041	4796527	77.7	margin of error : 30 m - 100 m	1205 LAKESHORE RD.	BURLINGTON	546		Test Hole		Test Hole
1005850664	7255142	11/5/2015	597139	4796953	82.5	margin of error : 30 m - 100 m	NORTH SHORE BLVD. E. & LAKESHORE RD. (NORTHWEST CORNER APPROX. 15 W OF LAKESHORE)	BURLINGTON	121		Monitoring		Observation Wells
1005850667	7255143	11/5/2015	597196	4796768	77.2	margin of error : 30 m - 100 m	LAKESHORE RD. (APPROX 0.2 KM SOUTH OF NORTH SHORE BLVD. E)	BURLINGTON	314		Monitoring		Observation Wells
1005850670	7255144	11/5/2015	597208	4796654	76.2	margin of error : 30 m - 100 m	LAKESHORE RD. (APPROX 0.3 KM SOUTH OF NORTH SHORE BLVD. E)	BURLINGTON	427		Monitoring		Observation Wells
1006159664	7267370	3/13/2015	597179	4796775	78.0	margin of error : 30 m - 100 m	1230 NORTHSHORE BLVD.	BURLINGTON	303	2.1	Monitoring and Test Hole		Observation Wells
1006705749	7292310	5/18/2017	596960	4797262	85.4	margin of error : 30 m - 100 m	ONTARIO ST BROCK AVE		242		Monitoring		Observation Wells
1006715114	7293467	6/12/2017	597486	4797454	80.8	margin of error : 30 m - 100 m	1447 LAKESHORE ROAD	Burlington	541	5.8	Test Hole		Monitoring and Test Hole
1002030550	7120146	4/27/2008	597440	4797489	83.1	margin of error : 30 m - 100 m	440 LUCUST STREET	Burlington	537		Monitoring		Test Hole
1002745955	7120146	4/8/2008	597388	4797524	83.9	margin of error : 10 - 30 m	440 LUCUST STREET	Burlington	536		Monitoring		Test Hole
1003431938	7155587	7/5/2010	596993	4797312	85.1	margin of error : 10 - 30 m	492 BROCK AVENUE ADJACENT	Burlington	268		Monitoring		Observation Wells
1004335838	7202988	5/29/2013	597432	4797345	82.4	margin of error : 30 m - 100 m	1407 LAKESHORE RD	Burlington	428				
1006353527	7281184	5/25/2016	597362	4797551	85.1	margin of error : 30 m - 100 m			546				

Appendix B: Borehole Logs

Terraprobe

LOG OF BOREHOLE 1

Project No. : 1-17-0801-01 | Client : Sam Badawi | Originated by : AR

Date started : November 14, 2017 | Project : 441 Maple Avenue | Compiled by : NN

Sheet No. : 1 of 2 | Location : Burlington, Ontario | Checked by : JC

Position : E: 597088, N: 4797029 (UTM 17T) | Elevation Datum : Geodetic | Core Diameter : HQ, OD=96mm, ID=64mm

Rig type : Truck-mounted | Drilling Method : Solid stem augers, HQ rock coring

Depth Scale (m)	Elev / Depth (m)	Description	Graphic Log	Sample Number	Sample Type	SPT 'N' Value	Elevation Scale (m)
0	83.1	**GROUND SURFACE**					83
		75mm **ASPHALTIC CONCRETE**					
	82.7	300mm **AGGREGATE**		1	SS	13	
	0.4	**FILL**, sand, some silt, trace gravel, trace clay, trace asphalt fragments, trace rock fragments, trace cinders, contains silt and clayey silt pockets, compact to dense, brown, moist ...at 0.8 m, wet		2	SS	17	82
2				3	SS	38	81
	80.8						
	2.3			4A	SS	36	
	80.5	**SAND**, trace silt, trace clay, dense, reddish brown, moist		4B			
	2.6	**SILT**, trace to some clay, trace to some sand, trace gravel, dense to very dense, reddish brown to reddish grey, moist		5	SS	50 / 125mm	80
4	78.6						79
	4.5	**INFERRED BEDROCK**, shale, red		6	SS		
	78.1						78
5	5.0	**QUEENSTON FORMATION** (See rock core log for details) ...at 5.4 m, transition to sound bedrock		1	RUN		
6							77
7				2	RUN		76
8							75
9				3	RUN		74
10				4	RUN		73

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

Undrained Shear Strength (kPa): O Unconfined, + Field Vane, ● Pocket Penetrometer, ■ Lab Vane; 40 80 120 160

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

Headspace Vapour (ppm)

Instrument Details: W1 W2

Unstabilized Water Level

Lab Data and Comments

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

...at 4.5m, auger refusal

...at 4.9m, casing installed, stared rock coring

(continued next page)

Terraprobe

LOG OF BOREHOLE 1

Project No. : 1-17-0801-01 | Client : Sam Badawi | Originated by : AR

Date started : November 14, 2017 | Project : 441 Maple Avenue | Compiled by : NN

Sheet No. : 2 of 2 | Location : Burlington, Ontario | Checked by : JC

Position : E: 597088, N: 4797029 (UTM 17T) | Elevation Datum : Geodetic | Core Diameter : HQ, OD=96mm, ID=64mm

Rig type : Truck-mounted | Drilling Method : Solid stem augers, HQ rock coring

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Sample Number	Sample Type	SPT 'N' Value	Elevation Scale (m)
		(continued)					
11		**QUEENSTON FORMATION** (See rock core log for details) *(continued)*		4	RUN		72
12				5	RUN		71
13				6	RUN		70
14							69
15				7	RUN		68
16				8	RUN		67
17	65.8 17.3						66

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

Undrained Shear Strength (kPa): ○ Unconfined + Field Vane; ● Pocket Penetrometer ■ Lab Vane; 40 80 120 160

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

Headspace Vapour (ppm)

Instrument Details: W1 W2

Unstabilized Water Level

Lab Data and Comments

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

END OF BOREHOLE

Water level and cave not measured upon completion of drilling.

W1: 50 mm dia. monitoring well installed.
W2: 50 mm dia. monitoring well installed.

W1 WATER LEVELS

Date	Water Depth (m)	Elevation (m)
Nov 30, 2017	2.2	80.9

W2 WATER LEVELS

Date	Water Depth (m)	Elevation (m)
Nov 30, 2017	4.9	78.2

Terraprobe

ROCK CORE LOG 1

Project No. : 1-17-0801-01 | Client : Sam Badawi | Originated by : AR

Date started : November 14, 2017 | Project : 441 Maple Avenue | Compiled by : NN

Sheet No. : 1 of 2 | Location : Burlington, Ontario | Checked by : JC

Position : E: 597088, N: 4797029 (UTM 17T) | Elevation Datum : Geodetic | Core Diameter : HQ, OD=96mm, ID=64mm

Rig type : Truck-mounted | Drilling Method : Solid stem augers, HQ rock coring

Depth (m)	Graphic Log	GENERAL DESCRIPTION	Run / Elev / Depth (m)	Recovery	Elevation (m)	Shale Weathering Zones	UCS (MPa) / Estimated Strength	Natural Fractures: Frequency	Natural Fractures: Spacing	Laboratory Testing	Comments	Elevation (m)
		Rock coring started at 5.0m below grade	78.1									
5		**QUEENSTON FORMATION** **Shale**, red, laminated to thinly bedded, weak; joints are horizontal, gapped to closed, planar, clean;	5.0		78			>10			**5.1m:** *250mm thick rubblized zone*	78
		interbedded with **limestone**, grey, medium strong ...at 5.4m, transition to sound bedrock	R1	TCR = 92% SCR = 75% RQD = 62%				5				
6		*Run 1 : 2% limestone* *98% shale*	76.6		77			1				77
			6.5					2				
			R2	TCR = 100% SCR = 100% RQD = 67%				0				
7					76			1				76
								0				
								1				
		Run 2 : 7% limestone *93% shale*	75.1					2			**7.7m:** *400mm long vertical joint, planar, closed clean, smooth*	
8			8.0		75			1			**8.0m:** *50mm thick rubblized zone*	75
			R3	TCR = 100% SCR = 97% RQD = 62%				4				
								4				
9					74			0				74
		Run 3 : 5% limestone *95% shale*	73.6					0				
			9.5					0				
10			R4	TCR = 97% SCR = 97% RQD = 97%	73			0				73
								0				
								1				
		Run 4 : 0% limestone *100% shale*	72.0					1				
11			11.1		72			2				72
								1				
			R5	TCR = 95% SCR = 95% RQD = 89%				0				
12					71			0				71
		Run 5 : 8% limestone *92% shale*	70.4					0				
			12.7					0				
13			R6	TCR = 97% SCR = 97% RQD = 97%	70			0				70
								0				
								0				
		Run 6 : 12% limestone *88% shale*	68.9					0				
14			14.2		69			0				69
			R7	TCR = 100% SCR = 97% RQD = 93%				0				
		Run 7 : 10% limestone *90% shale*						1				
15					68							68

(continued next page)

Terraprobe

ROCK CORE LOG 1

Project No. : 1-17-0801-01 | Client : Sam Badawi | Originated by : AR

Date started : November 14, 2017 | Project : 441 Maple Avenue | Compiled by : NN

Sheet No. : 2 of 2 | Location : Burlington, Ontario | Checked by : JC

Position : E: 597088, N: 4797029 (UTM 17T) | Elevation Datum : Geodetic | Core Diameter : HQ, OD=96mm, ID=64mm

Rig type : Truck-mounted | Drilling Method : Solid stem augers, HQ rock coring

Depth (m)	Graphic Log	GENERAL DESCRIPTION	Run / Elev / Depth (m)	Recovery	Elevation (m)	Shale Weathering Zones (Z1 Z2 Z3 Z4)	UCS (MPa) / Estimated Strength (R1 R2 R3 R4 R5 R6)	Natural Fractures: Frequency	Natural Fractures: Spacing	Laboratory Testing	Comments	Elevation (m)
		QUEENSTON FORMATION **Shale**, red, laminated to thinly bedded, weak; joints are horizontal, gapped to closed, planar, clean *Run 7 : 10% limestone 90% shale* interbedded with **limestone**, grey, medium strong	78.1 R7 67.4 15.7	TCR = 100% SCR = 97% RQD = 93%				0 0 0 3				
16			R8	TCR = 100% SCR = 100% RQD = 87%	67			0 2 8			16.5m: *rubblized zone (mechanical fracture)*	67
17		*Run 8 : 7% limestone 93% shale*	65.8		66			1 1				66
		END OF COREHOLE	17.3m									

Terraprobe

LOG OF BOREHOLE 2

Project No. : 1-17-0801-01 | Client : Sam Badawi | Originated by : AR

Date started : November 13, 2017 | Project : 441 Maple Avenue | Compiled by : NN

Sheet No. : 1 of 1 | Location : Burlington, Ontario | Checked by : JC

Position : E: 597067, N: 4797050 (UTM 17T) | Elevation Datum : Geodetic

Rig type : Truck-mounted | Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
0	83.1	**GROUND SURFACE**				
	82.9	75mm **ASPHALTIC CONCRETE**				
	0.2	150mm **AGGREGATE**		1	SS	9
		FILL, clayey silt, sandy, trace gravel, trace asphalt fragments, trace brick fragments, trace organics, loose to compact, brown, moist		2	SS	17
1	81.6					
	1.5	**SILT**, trace to some clay, trace to some sand, trace gravel, compact, reddish brown to reddish grey, moist		3	SS	20
2		...at 2.3 m, very dense		4A	SS	60
	80.4			4B		
	2.7	**SILT**, some clay, some sand, trace gravel, trace shale fragments, very dense, red, moist (RESIDUAL SOIL)		5	SS	50 / 75mm
3						
4	78.8					
	78.8	**INFERRED BEDROCK**, shale, red		6	SS	50 / 25mm
	4.3	**END OF BOREHOLE**				

Elevation Scale (m): 83, 82, 81, 80, 79

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

Undrained Shear Strength (kPa): O Unconfined, ● Pocket Penetrometer, + Field Vane, ■ Lab Vane; 40 80 120 160

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

Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR SA SI CL

11 14 57 18

Unstabilized water level measured at 4.0 m below ground surface; borehole caved to 4.1 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Nov 30, 2017	3.7	79.4

file: 1-17-0801-01_borehole_logs.gpj

Terraprobe

LOG OF BOREHOLE 3

Project No. : 1-17-0801-01	Client : Sam Badawi	Originated by : AR
Date started : November 13, 2017	Project : 441 Maple Avenue	Compiled by : NN
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by : JC

Position : E: 597124, N: 4797105 (UTM 17T) Elevation Datum : Geodetic

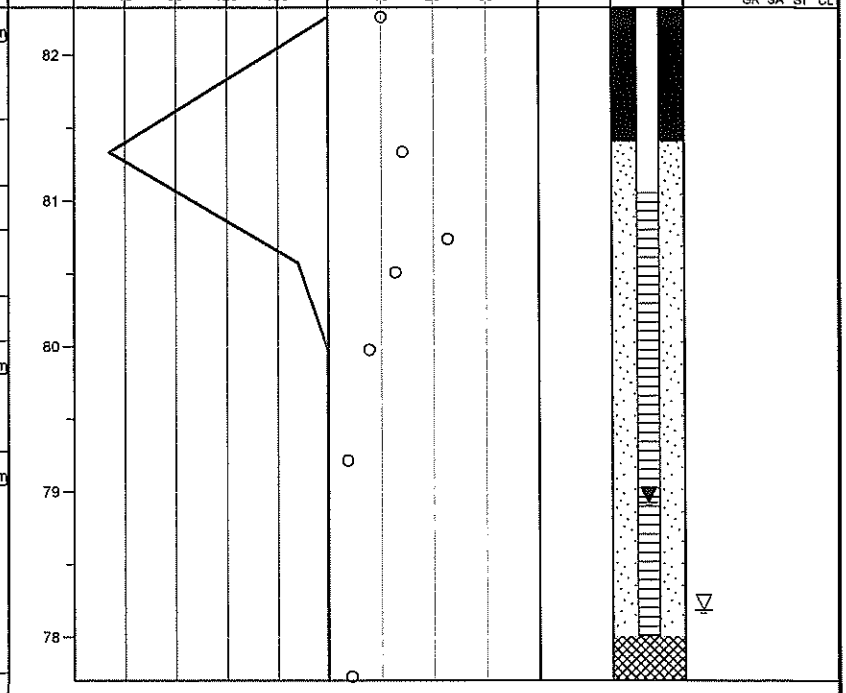
Rig type : Truck-mounted Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
	82.3	**GROUND SURFACE**				
0		50mm **ASPHALTIC CONCRETE**		1	SS	50 / 125mm
	81.9	325mm **AGGREGATE**				
	0.4 / 81.5	**FILL**, sand, trace gravel, trace silt, trace asphalt fragments, trace brick fragments, trace rock fragments, trace cinders, trace organics, very dense, dark brown, moist				
1	0.8			2	SS	7
		FILL, clayey silt, sandy, trace gravel, trace ashes, trace cinders, trace organics, trace clay, firm, mottled greyish brown to dark brown, moist				
	80.6			3A		
	1.7	**SILT**, trace sand, trace gravel, trace shale fragments, dense, red, moist (RESIDUAL SOIL)		3B	SS	44
2	80.0					
	2.3	**INFERRED BEDROCK**, shale, red		4	SS	50 / 125mm
				5	SS	50 / 125mm
3						
4						
	77.7 / 4.6			6	SS	50 / 50mm

END OF BOREHOLE

Unstabilized water level measured at 4.1 m below ground surface; borehole caved to 4.3 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.



WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Nov 30, 2017	3.4	78.9

file: 1-17-0801-01_borehole_logs.gpj

Terraprobe

LOG OF BOREHOLE 4

Project No. : 1-17-0801-01	Client : Sam Badawi	Originated by : AR
Date started : November 13, 2017	Project : 441 Maple Avenue	Compiled by : NN
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by : JC

Position : E: 597144, N: 4797086 (UTM 17T) Elevation Datum : Geodetic

Rig type : Truck-mounted Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
0	82.6	**GROUND SURFACE**				
		75mm **ASPHALTIC CONCRETE**				
		50mm **AGGREGATE**		1	SS	17
	81.8	**FILL**, sand, some silt, trace gravel, trace asphalt fragments, trace cinders, trace organics, compact, brown, moist				
1	0.8	**SILT**, trace to some clay, trace to some sand, trace gravel, compact to very dense, brownish grey, moist		2	SS	16
				3	SS	32
2						
		...at 2.3 m, clay and silt, trace sand, trace gravel, very dense		4	SS	50 / 100mm
3	79.6					
	3.0	**INFERRED BEDROCK**, shale, red		5	SS	50 / 75mm
4	78.0					
	4.6			6	SS	50 / 50mm

Elevation Scale (m): 82, 81, 80, 79

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

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

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

Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR	SA	SI	CL
2	6	42	50

END OF BOREHOLE

Borehole was dry and caved to 4.3 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.

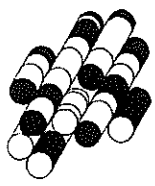
WATER LEVEL READINGS

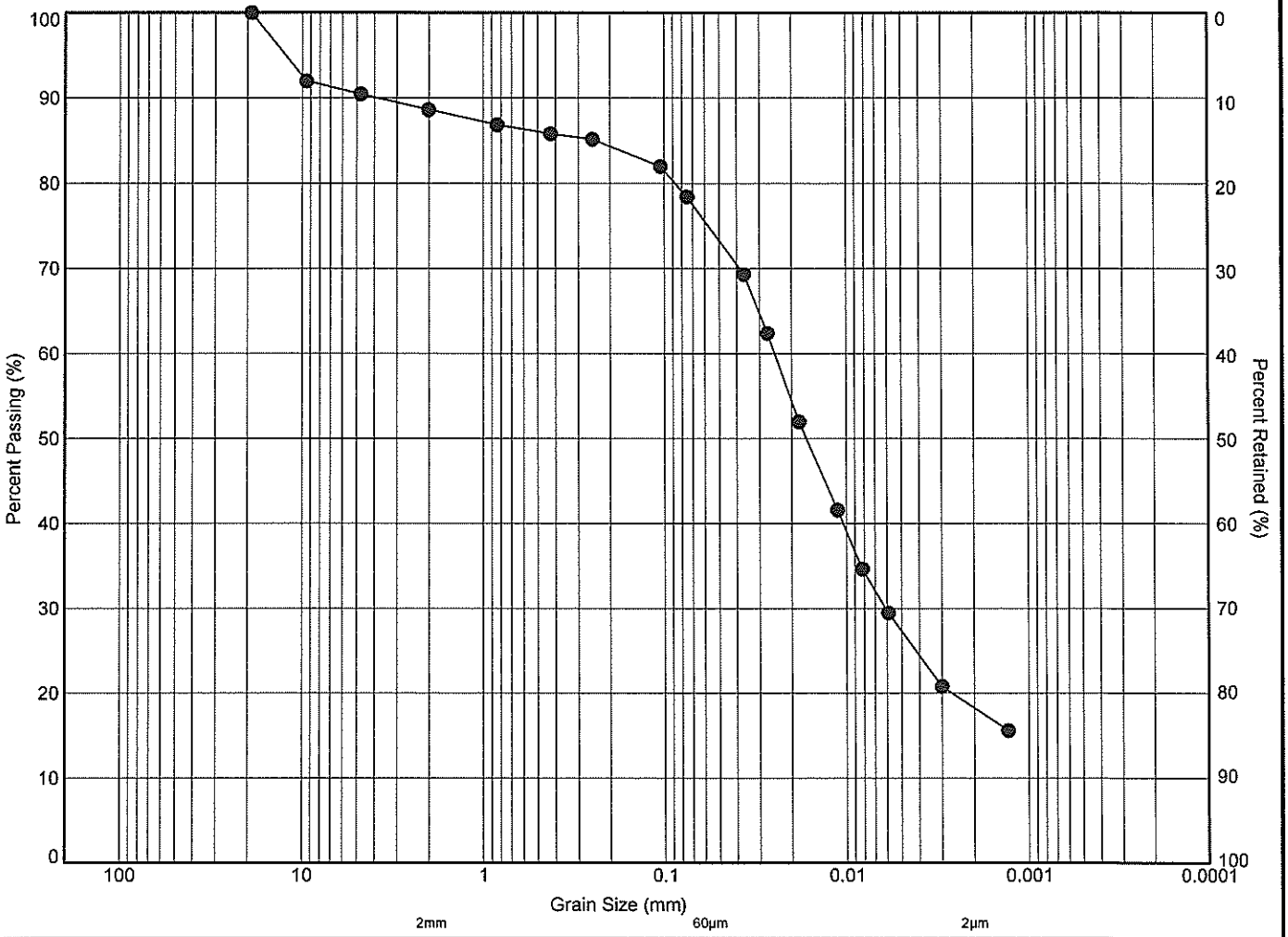
Date	Water Depth (m)	Elevation (m)
Nov 30, 2017	3.7	78.9

file: 1-17-0801-01_borehole_logs.gpj

APPENDIX B

TERRAPROBE INC.





MIT SYSTEM	COBBLES	GRAVEL			SAND			SILT	CLAY
		COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE		

MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	2	SS5	3.2	80.0	11	14	57	18	

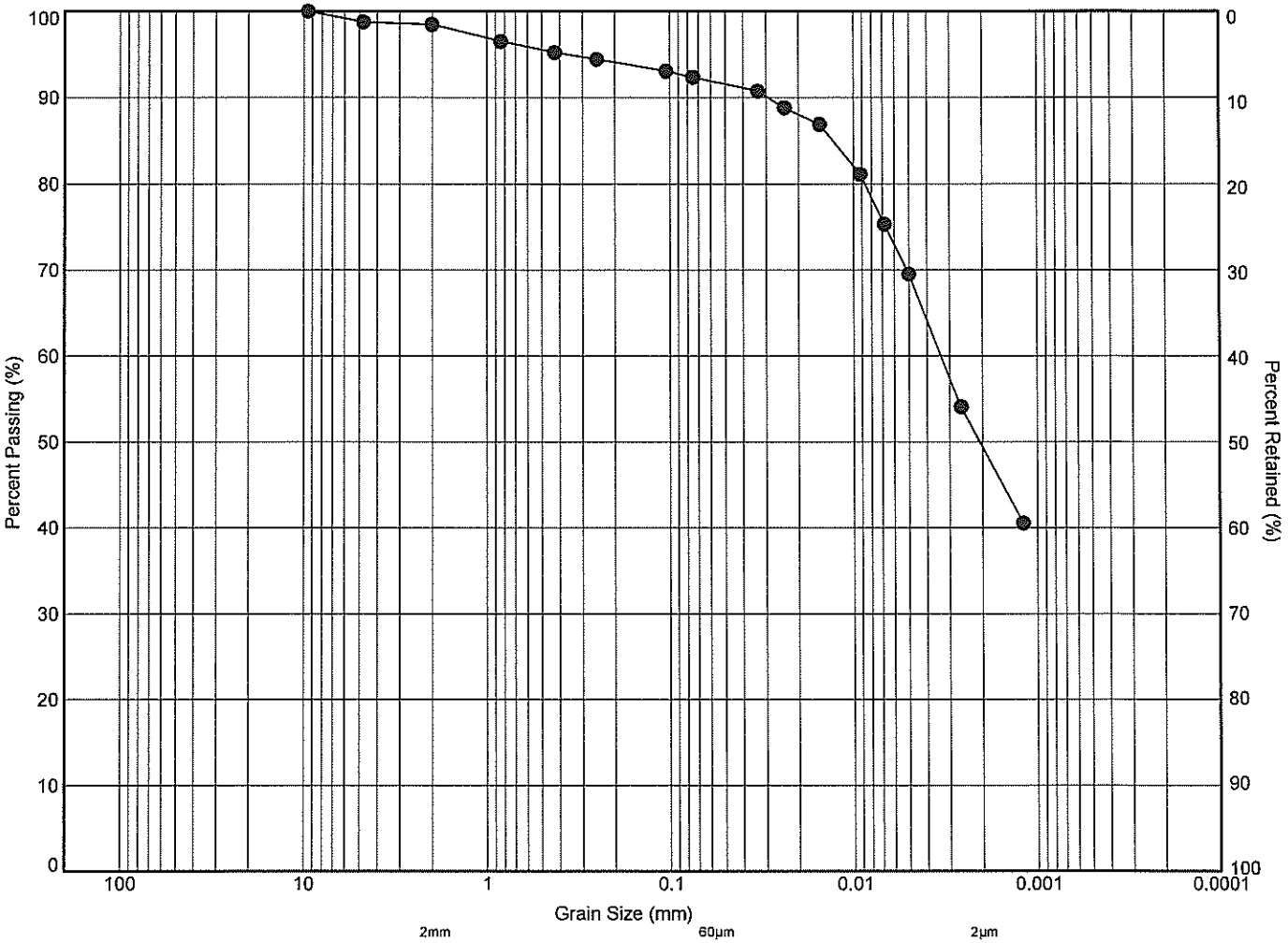
Terraprobe
11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION

SILT, SOME CLAY, SOME SAND, SOME GRAVEL, (RESIDUAL SOIL)

File No.: **1-17-0801-01**



MIT SYSTEM	COBBLES	GRAVEL			SAND			SILT	CLAY
		COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE		

MIT SYSTEM

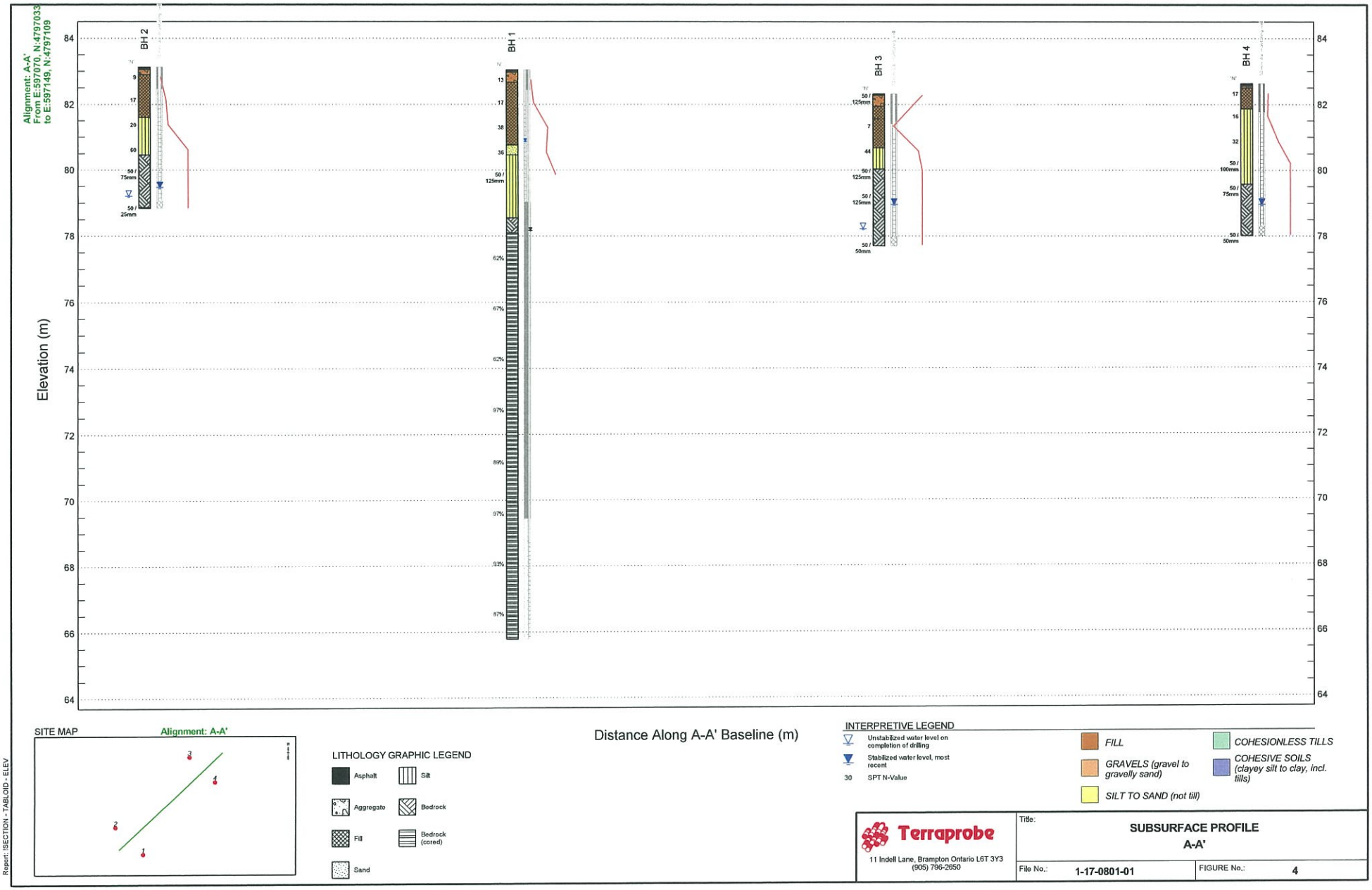
	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**4**	SS4	2.4	80.2	2	6	42	50	

Terraprobe
11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
CLAY AND SILT, TRACE SAND, TRACE GRAVEL

File No.: **1-17-0801-01**



SITE MAP

Alignment: A-A'

LITHOLOGY GRAPHIC LEGEND

- Asphalt
- Silt
- Aggregate
- Bedrock
- Fill
- Bedrock (cored)
- Sand

Distance Along A-A' Baseline (m)

INTERPRETIVE LEGEND

- Unstabilized water level on completion of drilling
- Stabilized water level, most recent
- 30 SPT N-Value

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

Terraprobe
11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

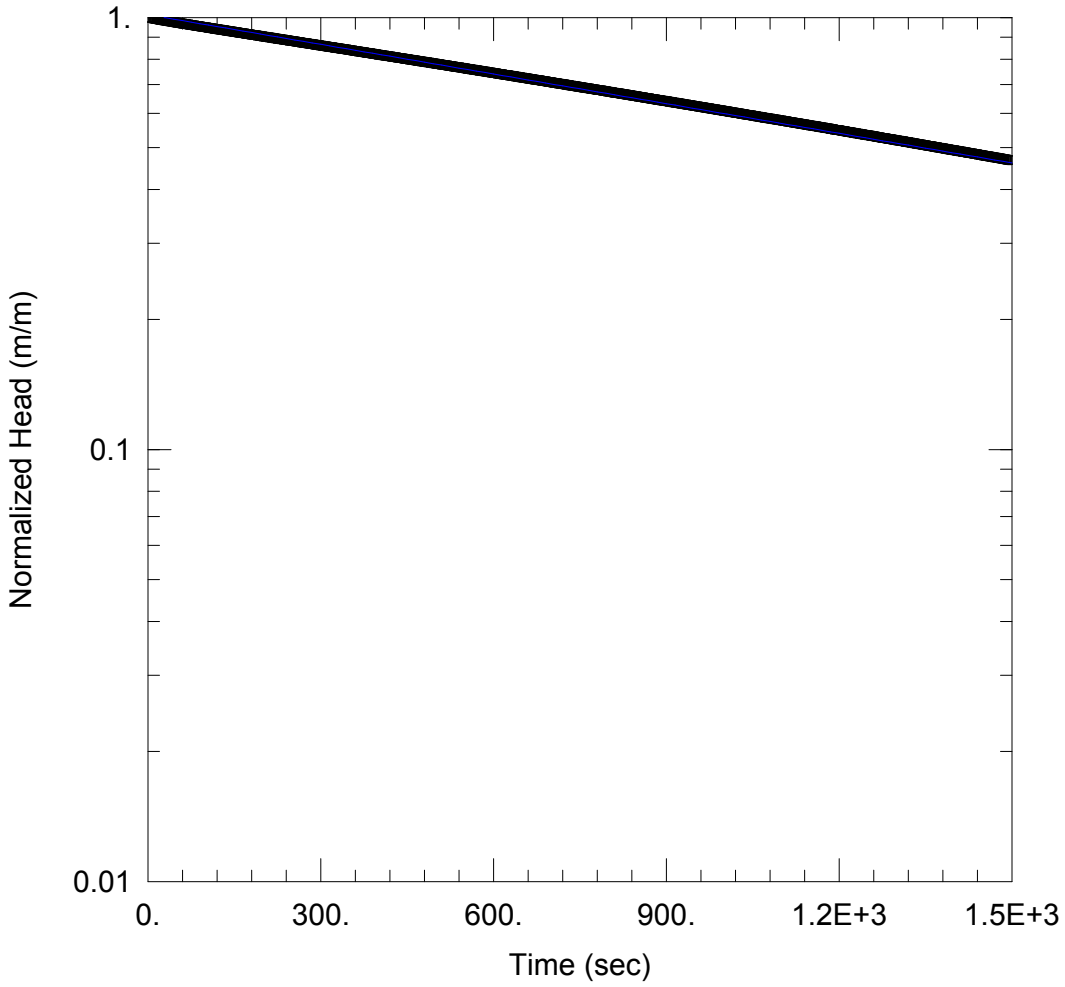
Title: **SUBSURFACE PROFILE A-A'**

File No.: **1-17-0801-01**

FIGURE No.: **4**

Report: ISECTION - TABLOID - ELEV

Appendix C:
SWRT Procedures and Results



SWRT - RISING HEAD - BH 1-D

Data Set: \...\BH1d.aqt
Date: 02/20/19 Time: 10:20:30

PROJECT INFORMATION

Company: EXP Services Inc
Client: Better Life Retirement
Project: BRM-00639350
Location: 441 Maple Avenue, Burlington
Test Well: BH 1-D
Test Date: February 14, 2019

AQUIFER DATA

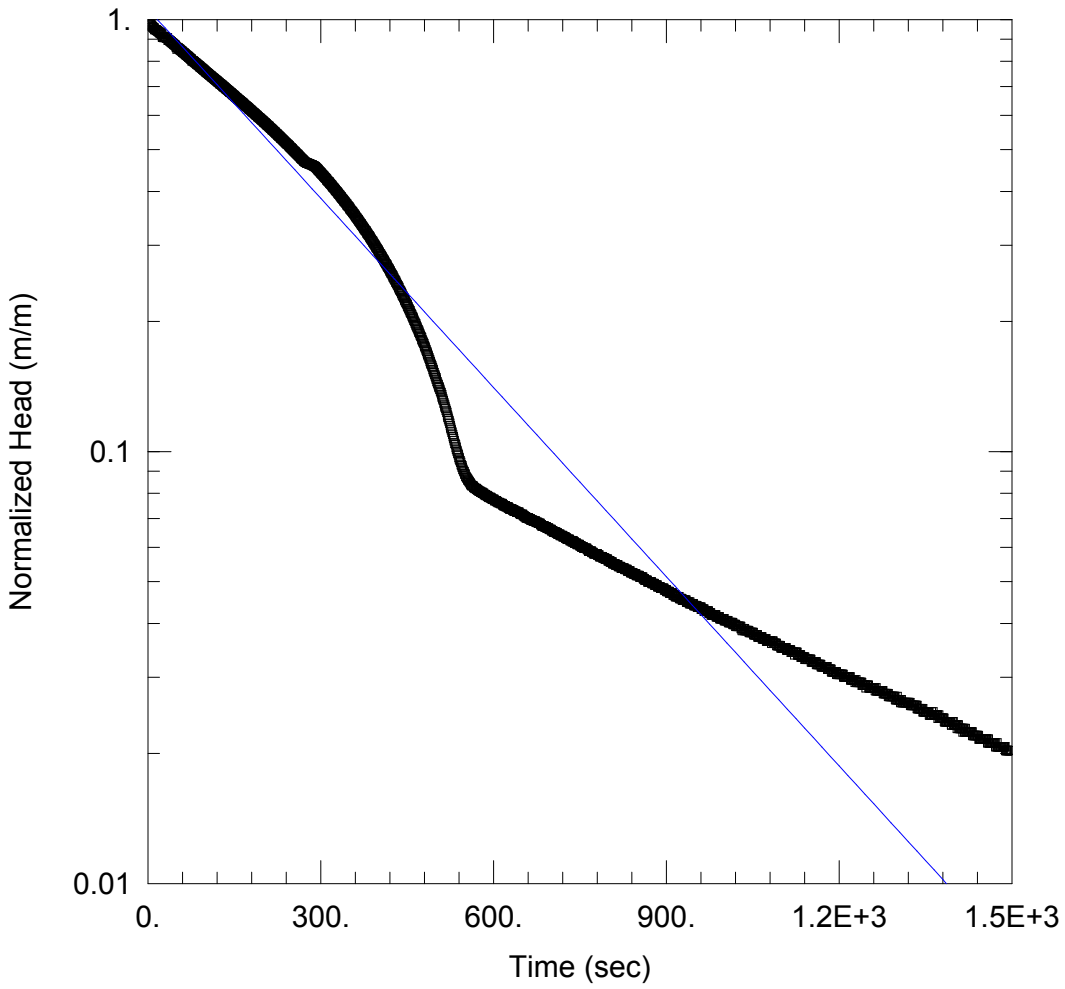
Saturated Thickness: 9.288 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH 1-D)

Initial Displacement: 5.441 m
Total Well Penetration Depth: 9.288 m
Casing Radius: 0.0254 m
Static Water Column Height: 9.288 m
Screen Length: 3. m
Well Radius: 0.1016 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 2.31E-7 m/sec
y0 = 5.522 m



SWRT - RISING HEAD - BH 1-S

Data Set: \...\BH1s.aqt
Date: 02/20/19 Time: 10:17:22

PROJECT INFORMATION

Company: EXP Services Inc
Client: Better Life Retirement
Project: BRM-00639350
Location: 441 Maple Avenue, Burlington
Test Well: BH 1-S
Test Date: February 14, 2019

AQUIFER DATA

Saturated Thickness: 2.6 m Anisotropy Ratio (Kz/Kr): 1.

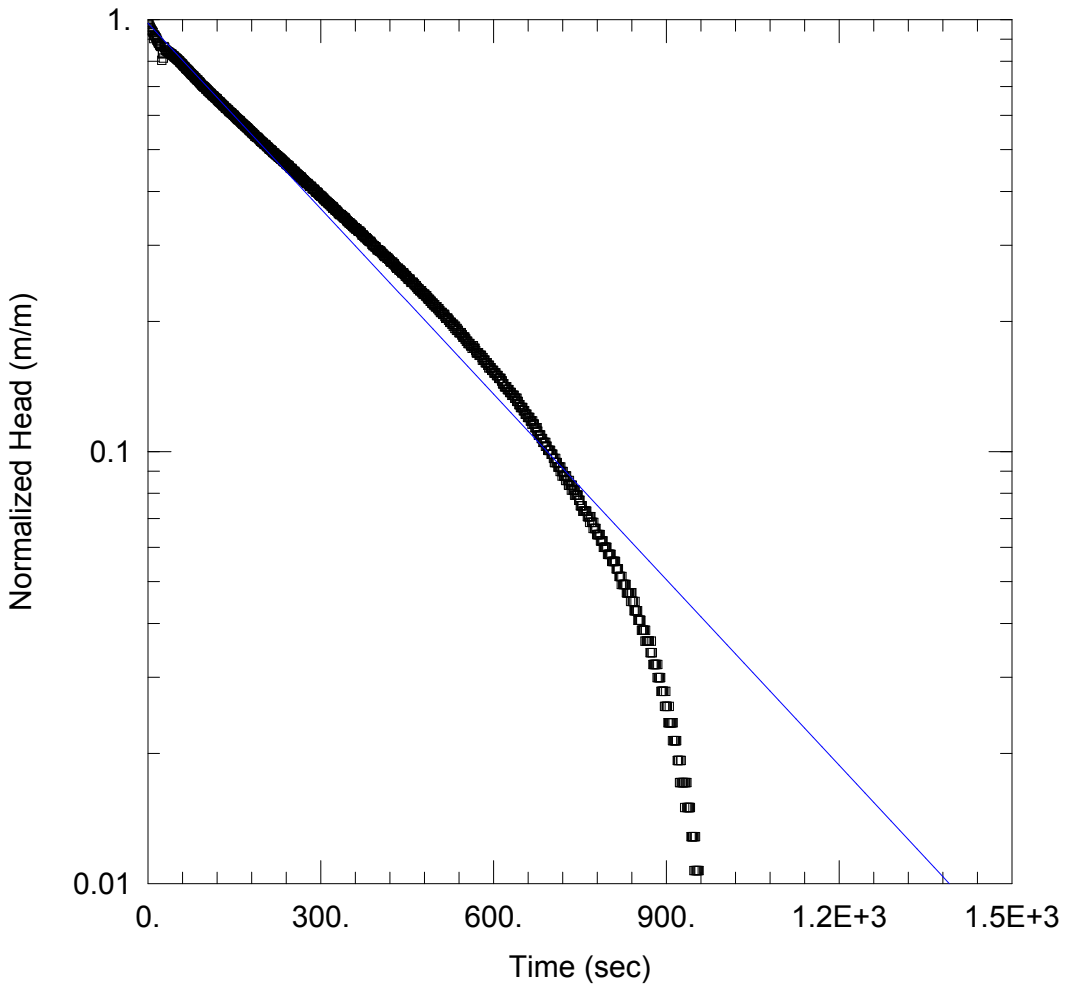
WELL DATA (BH 1-S)

Initial Displacement: 2.363 m
Total Well Penetration Depth: 3. m
Casing Radius: 0.0254 m
Static Water Column Height: 2.6 m
Screen Length: 3. m
Well Radius: 0.1016 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 2.21E-6 m/sec y0 = 2.498 m



SWRT - RISING HEAD - BH 2

Data Set: \...\BH2.aqt
Date: 02/20/19 Time: 10:24:36

PROJECT INFORMATION

Company: EXP Services Inc
Client: Better Life Retirement
Project: BRM-00639350
Location: 441 Maple Avenue, Burlington
Test Well: BH 2
Test Date: February 14, 2019

AQUIFER DATA

Saturated Thickness: 0.682 m Anisotropy Ratio (Kz/Kr): 1.

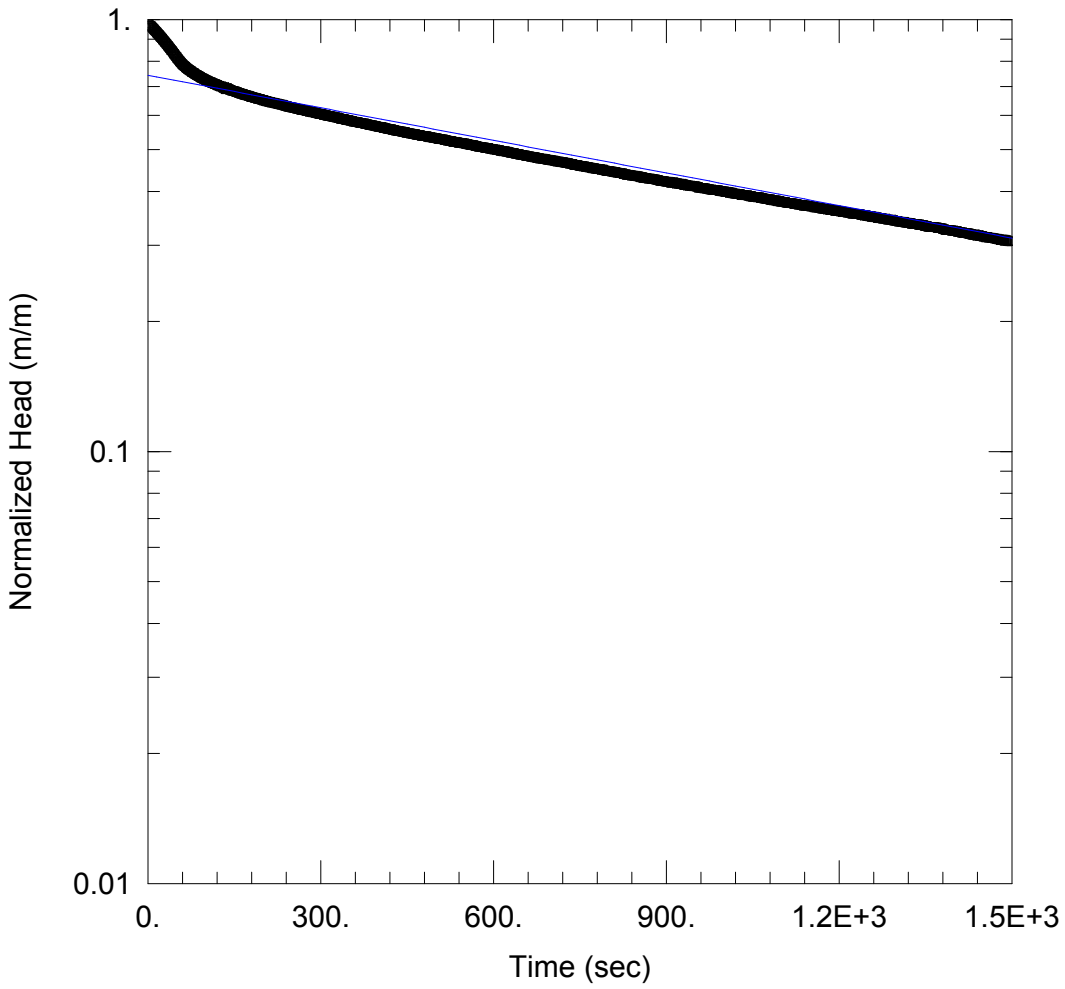
WELL DATA (BH 2)

Initial Displacement: 0.467 m
Total Well Penetration Depth: 3. m
Casing Radius: 0.0254 m
Static Water Column Height: 0.682 m
Screen Length: 3. m
Well Radius: 0.1016 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 8.26E-6 m/sec y0 = 0.458 m



SWRT - RISING HEAD - BH 3

Data Set: \...\BH3.aqt
Date: 02/20/19 Time: 10:27:36

PROJECT INFORMATION

Company: EXP Services Inc
Client: Better Life Retirement
Project: BRM-00639350
Location: 441 Maple Avenue, Burlington
Test Well: BH 3
Test Date: February 14, 2019

AQUIFER DATA

Saturated Thickness: 1.63 m Anisotropy Ratio (Kz/Kr): 1.

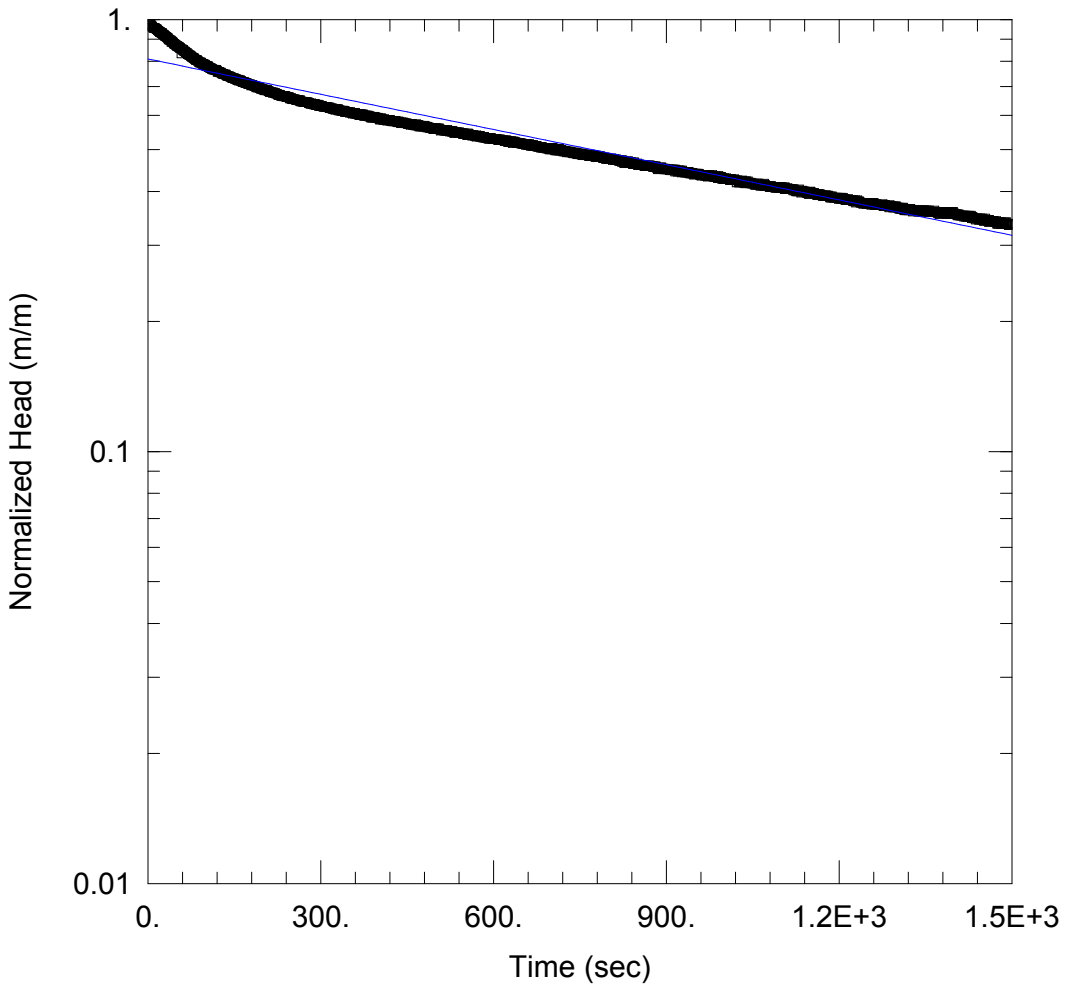
WELL DATA (BH 3)

Initial Displacement: 1.215 m
Total Well Penetration Depth: 3. m
Casing Radius: 0.0254 m
Static Water Column Height: 1.63 m
Screen Length: 3. m
Well Radius: 0.1016 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 6.07E-7 m/sec y0 = 0.9029 m



SWRT - RISING HEAD - BH 4

Data Set: \...\BH4.aqt
Date: 02/20/19 Time: 10:38:04

PROJECT INFORMATION

Company: EXP Services Inc
Client: Better Life Retirement
Project: BRM-00639350
Location: 441 Maple Avenue, Burlington
Test Well: BH 4
Test Date: February 14, 2019

AQUIFER DATA

Saturated Thickness: 0.608 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH 4)

Initial Displacement: 0.398 m
Total Well Penetration Depth: 3. m
Casing Radius: 0.0254 m
Static Water Column Height: 0.608 m
Screen Length: 3. m
Well Radius: 0.1016 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

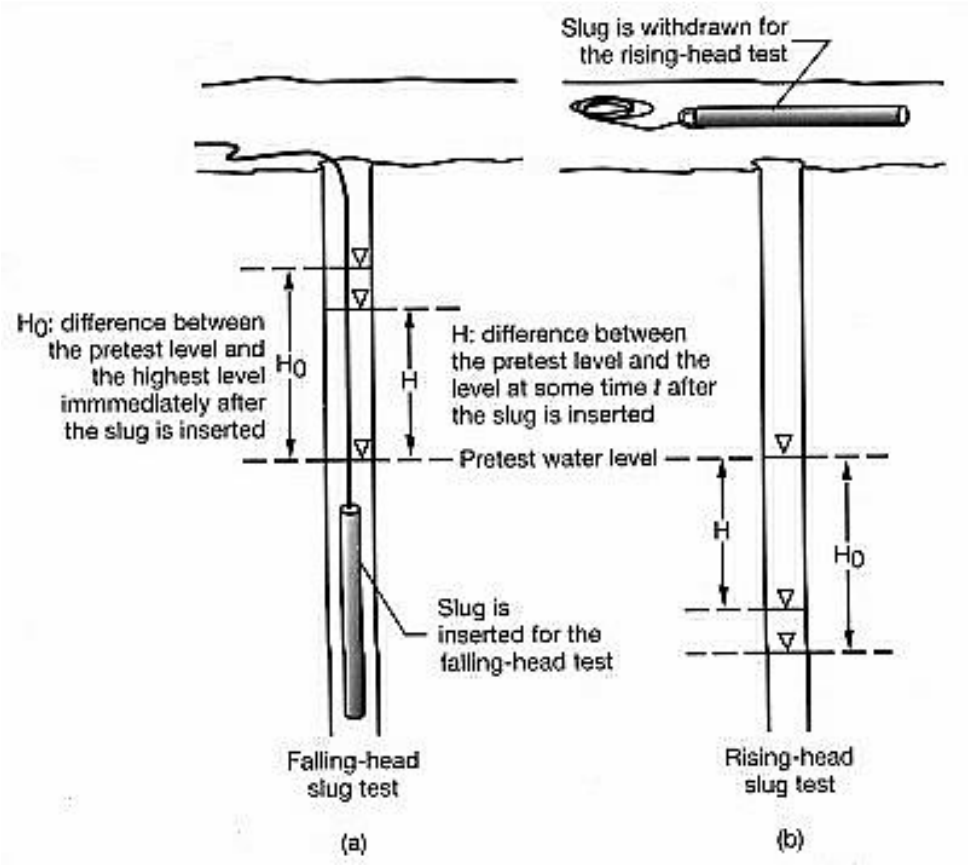
K = 1.76E-6 m/sec y0 = 0.3224 m

Single Well Response Test Procedure

A Single Well Response Test (SWRT), also known as a bail test or a slug test, is conducted in order to determine the saturated hydraulic conductivity (K) of an aquifer. The method of the SWRT is to characterize the change of groundwater level in a well or borehole over time.

In order to ensure consistency and repeatability, all **exp** employees are to follow the procedure outlined in this document when conducting SWRTs.

The figure below depicts a schematic of a slug and bail test and the respective water level changes.



Initials ___

Slug Test Procedure

Equipment Required

- Copy of a signed health and safety plan
- Copy of the work program
- PPE as required by Site-Specific HASP
- Copy of the monitoring well location plan/site plan
- Waterproof pen and bound field note book
- SWRT field data Entry form
- Disposable gloves
- Duct tape
- Deionized water
- Alconox (phosphate free detergent)
- Spray bottles
- Electronic water level meter and spare batteries
- Solid PVC or stainless steel slug of known volume or clean water
- String (nylon)
- Water pressure transducer (data logger) and baro-logger
- Watch or stop watch with second hand
- Plastic sheeting

Testing Procedure

1. Remove cap from well and collect static water level
2. Remove waterra tubing/bailer and place in garbage bag. Record static water level measurement again.
3. Lower the slug into the well and record the dynamic water level.
4. Record the drawdown (for the slug test) at set five (5) second intervals for the first five (5) minutes, then reduce to every one (1) minute.
5. Continue recording the drawdown until 95% recovery is reached. To calculate this value: Find the difference between the dynamic water level and the static water level, then multiply by 95% (.95). Add the resulting value to the dynamic water level.

   (Static Water Level – Dynamic Water Level).95 + Static Water Level = 95% Recovery Value
6. Once complete, replace the waterra tubing/bailer and re-secure the well cap.

Note: If the well is deep, more than one slug may be inserted by attaching the slugs to a series.

Slugs must be washed with methanol, then lab grade soap, and then rinsed with de-ionized water after each use.

Based on the recorded observations, the hydraulic conductivity (in m/s) of the aquifer will be determined. In order to determine the hydraulic conductivity; the well diameter, radius of the borehole and length of the screen will also be required.

Bail Test Procedure

Equipment Required

- 20 L (5 gal) Graduated pail
- Stop watch or watch with seconds
- Garbage bags
- Water level meter
- Field sheets/log book
- Latex Gloves
- Bailer and Rope

Procedure

1. Remove cap from well and collect static water level.
2. If using a **bailer**:
    a. Affix the rope to the bailer.
    b. Remove the waterra tubing and place in garbage bag
    c. Record static water level measurement again.
    d. Record how much water was removed by either counting the number of full bailers or emptying removed water into a container.
    e. Quickly lower the bailer into the well and remove.
    f. Continue this process until the water level will reduce no further.
    g. Record the dynamic water level.
3. If using **waterra** to bail the water:
    a. Pump the water into graduated bucket until the water level will reduce no further.
    b. Record how much water has been removed.
    c. Record the dynamic water level.
4. Record the recovery at set five (5) second intervals for the first (5) minutes, then reduce to every one (1) minute.
5. Continue recording the drawdown/recovery until 95% recovery is reached.
6. Once complete, replace any waterra tubing that may have been removed from the well and re-secure the well cap.

Appendix D:
Laboratory Certificates of Analysis

Maxxam
A Bureau Veritas Group Company

Your P.O. #: ENV-BRM
Your Project #: BRM-00639350
Site Location: 441 MAPLE AVENUE
Your C.O.C. #: 703945-01-01

Attention: Francois Chartier

exp Services Inc
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2019/02/28
Report #: R5610883
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B947566
Received: 2019/02/22, 12:31

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Carbonaceous BOD	1	2019/02/23	2019/02/28	CAM SOP-00427	SM 23 5210B m
Total Cyanide	1	2019/02/25	2019/02/25	CAM SOP-00457	OMOE E3015 5 m
Fluoride	1	2019/02/23	2019/02/25	CAM SOP-00449	SM 23 4500-F C m
Mercury in Water by CVAA	1	2019/02/26	2019/02/27	CAM SOP-00453	EPA 7470A m
Total Metals Analysis by Axial ICP	1	2019/02/25	2019/02/25	CAM SOP-00408	EPA 6010D m
E.coli, (CFU/100mL)	1	N/A	2019/02/22	CAM SOP-00552	MOE LSB E3371
Animal and Vegetable Oil and Grease	1	N/A	2019/02/27	CAM SOP-00326	EPA1664B m,SM5520B m
Total Oil and Grease	1	2019/02/27	2019/02/27	CAM SOP-00326	EPA1664B m,SM5520A m
PAH Compounds in Water by GC/MS (SIM)	1	2019/02/27	2019/02/28	CAM SOP-00318	EPA 8270D m
pH	1	N/A	2019/02/25	CAM SOP-00413	SM 4500H+ B m
Phenols (4AAP)	1	N/A	2019/02/25	CAM SOP-00444	OMOE E3179 m
Sulphate by Automated Colourimetry	1	N/A	2019/02/25	CAM SOP-00464	EPA 375.4 m
Total Kjeldahl Nitrogen in Water	1	2019/02/25	2019/02/26	CAM SOP-00938	OMOE E3516 m
Mineral/Synthetic O & G (TPH Heavy Oil) (1)	1	2019/02/27	2019/02/27	CAM SOP-00326	EPA1664B m,SM5520F m
Total Suspended Solids	1	2019/02/23	2019/02/25	CAM SOP-00428	SM 23 2540D m
Volatile Organic Compounds in Water	1	N/A	2019/02/26	CAM SOP-00228	EPA 8260C m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing. Maxxam is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam
A Bureau Veritas Group Company

Your P.O. #: ENV-BRM
Your Project #: BRM-00639350
Site Location: 441 MAPLE AVENUE
Your C.O.C. #: 703945-01-01

Attention: Francois Chartier

exp Services Inc
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2019/02/28
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CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B947566
Received: 2019/02/22, 12:31

dilution methods.
Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) Note: TPH (Heavy Oil) is equivalent to Mineral / Synthetic Oil & Grease

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Tanya Fidlin, Project Manager
Email: tfidlin@maxxam.ca
Phone# (905)817-5700
==========
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam Job #: B947566
Report Date: 2019/02/28

exp Services Inc
Client Project #: BRM-00639350
Site Location: 441 MAPLE AVENUE
Your P.O. #: ENV-BRM
Sampler Initials: CS

HALTON SANITARY & COMBINED SEWER (2-03)

Maxxam ID				JAU543		
Sampling Date				2019/02/22 09:00		
COC Number				703945-01-01		
	UNITS	Criteria	Criteria-2	BH1-S	RDL	QC Batch
Calculated Parameters						
Total Animal/Vegetable Oil and Grease	mg/L	150	-	1.0	0.50	5986322
Inorganics						
Total Carbonaceous BOD	mg/L	300	-	ND	2	5988432
Fluoride (F-)	mg/L	10	-	ND	0.10	5988509
Total Kjeldahl Nitrogen (TKN)	mg/L	100	-	1.3	0.20	5989953
pH	pH	6.0:10.0	6.5:8.5	7.66		5988510
Phenols-4AAP	mg/L	1	-	ND	0.0010	5989143
Total Suspended Solids	mg/L	350	-	15	10	5988444
Dissolved Sulphate (SO4)	mg/L	1500	-	160	1.0	5988598
Total Cyanide (CN)	mg/L	2	-	0.014	0.0050	5989244
Petroleum Hydrocarbons						
Total Oil & Grease	mg/L	-	-	1.0	0.50	5992989
Total Oil & Grease Mineral/Synthetic	mg/L	-	-	ND	0.50	5992990
Metals						
Total Aluminum (Al)	mg/L	50	-	ND	0.1	5989418
Total Antimony (Sb)	mg/L	5	-	ND	0.02	5989418
Total Arsenic (As)	mg/L	1	-	ND	0.01	5989418
Total Beryllium (Be)	mg/L	5	-	ND	0.0005	5989418
Total Cadmium (Cd)	mg/L	1	-	ND	0.002	5989418
Total Chromium (Cr)	mg/L	3	-	ND	0.01	5989418
Total Cobalt (Co)	mg/L	5	-	ND	0.002	5989418
Total Copper (Cu)	mg/L	3	-	ND	0.01	5989418
Total Iron (Fe)	mg/L	50	-	ND	0.02	5989418
Total Lead (Pb)	mg/L	3	-	ND	0.01	5989418
Total Manganese (Mn)	mg/L	5	-	ND	0.001	5989418
Mercury (Hg)	mg/L	0.05	-	ND	0.0001	5991371
Total Molybdenum (Mo)	mg/L	5	-	ND	0.005	5989418

No Fill	No Exceedance
Grey	Exceeds 1 criteria policy/level
Black	Exceeds both criteria/levels

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria: Halton Sanitary & Combined Sewer Bylaw (2-03)
Criteria-2: Halton Storm Sewer ByLaw
ND = Not detected

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam Job #: B947566
Report Date: 2019/02/28

exp Services Inc
Client Project #: BRM-00639350
Site Location: 441 MAPLE AVENUE
Your P.O. #: ENV-BRM
Sampler Initials: CS

HALTON SANITARY & COMBINED SEWER (2-03)

Maxxam ID				JAU543		
Sampling Date				2019/02/22 09:00		
COC Number				703945-01-01		
	UNITS	Criteria	Criteria-2	BH1-S	RDL	QC Batch
Total Nickel (Ni)	mg/L	3	-	ND	0.005	5989418
Total Phosphorus (P)	mg/L	10	-	ND	0.05	5989418
Total Selenium (Se)	mg/L	5	-	ND	0.02	5989418
Total Silver (Ag)	mg/L	5	-	ND	0.01	5989418
Total Tin (Sn)	mg/L	5	-	ND	0.02	5989418
Total Titanium (Ti)	mg/L	5	-	ND	0.005	5989418
Total Zinc (Zn)	mg/L	3	-	ND	0.005	5989418
Polyaromatic Hydrocarbons						
Naphthalene	ug/L	140	-	ND	0.050	5994135
Volatile Organics						
Benzene	ug/L	10	-	ND	0.50	5989074
Chloroform	ug/L	40	-	ND	0.50	5989074
1,4-Dichlorobenzene	ug/L	80	-	ND	1.3	5989074
Ethylbenzene	ug/L	160	-	ND	0.50	5989074
Methylene Chloride(Dichloromethane)	ug/L	2000	-	ND	5.0	5989074
Tetrachloroethylene	ug/L	1000	-	ND	0.50	5989074
Toluene	ug/L	16	-	ND	0.50	5989074
Trichloroethylene	ug/L	400	-	ND	0.50	5989074
Surrogate Recovery (%)						
D10-Anthracene	%	-	-	108		5994135
D14-Terphenyl (FS)	%	-	-	80		5994135
D8-Acenaphthylene	%	-	-	100		5994135
4-Bromofluorobenzene	%	-	-	96		5989074
D4-1,2-Dichloroethane	%	-	-	99		5989074
D8-Toluene	%	-	-	97		5989074

No Fill	No Exceedance
Grey	Exceeds 1 criteria policy/level
Black	Exceeds both criteria/levels

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria: Halton Sanitary & Combined Sewer Bylaw (2-03)
Criteria-2: Halton Storm Sewer ByLaw
ND = Not detected

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Maxxam Job #: B947566
Report Date: 2019/02/28

exp Services Inc
Client Project #: BRM-00639350
Site Location: 441 MAPLE AVENUE
Your P.O. #: ENV-BRM
Sampler Initials: CS

HALTON STORM SEWER BYLAW (2-03)

Maxxam ID			JAU543		
Sampling Date			2019/02/22 09:00		
COC Number			703945-01-01		
	UNITS	**Criteria**	**BH1-S**	**RDL**	**QC Batch**
Microbiological					
Escherichia coli	CFU/100mL	200	<10	10	5987721

No Fill	No Exceedance
Grey	Exceeds 1 criteria policy/level
Black	Exceeds both criteria/levels

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria: Halton Storm Sewer ByLaw

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Maxxam Job #: B947566
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Client Project #: BRM-00639350
Site Location: 441 MAPLE AVENUE
Your P.O. #: ENV-BRM
Sampler Initials: CS

TEST SUMMARY

Maxxam ID: JAU543
Sample ID: BH1-S
Matrix: Water

Collected: 2019/02/22
Shipped:
Received: 2019/02/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Carbonaceous BOD	DO	5988432	2019/02/23	2019/02/28	Hinal Shah
Total Cyanide	SKAL/CN	5989244	2019/02/25	2019/02/25	Xuanhong Qiu
Fluoride	ISE	5988509	2019/02/23	2019/02/25	Surinder Rai
Mercury in Water by CVAA	CV/AA	5991371	2019/02/26	2019/02/27	Medhat Nasr
Total Metals Analysis by Axial ICP	ICPX	5989418	2019/02/25	2019/02/25	Archana Patel
E.coli, (CFU/100mL)	PL	5987721	N/A	2019/02/22	Farhana Rahman
Animal and Vegetable Oil and Grease	BAL	5986322	N/A	2019/02/27	Automated Statchk
Total Oil and Grease	BAL	5992989	2019/02/27	2019/02/27	Francis Afonso
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5994135	2019/02/27	2019/02/28	Mitesh Raj
pH	AT	5988510	N/A	2019/02/25	Surinder Rai
Phenols (4AAP)	TECH/PHEN	5989143	N/A	2019/02/25	Bramdeo Motiram
Sulphate by Automated Colourimetry	KONE	5988598	N/A	2019/02/25	Alina Dobreanu
Total Kjeldahl Nitrogen in Water	SKAL	5989953	2019/02/25	2019/02/26	Shivani Shivani
Mineral/Synthetic O & G (TPH Heavy Oil)	BAL	5992990	2019/02/27	2019/02/27	Francis Afonso
Total Suspended Solids	BAL	5988444	2019/02/23	2019/02/25	Mandeep Kaur
Volatile Organic Compounds in Water	GC/MS	5989074	N/A	2019/02/26	Juan Pangilinan

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exp Services Inc
Client Project #: BRM-00639350
Site Location: 441 MAPLE AVENUE
Your P.O. #: ENV-BRM
Sampler Initials: CS

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	4.0°C

Sample JAU543 [BH1-S] : VOC Analysis: Due to the sample matrix, sample required dilution. Detection limits were adjusted accordingly.

Results relate only to the items tested.

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Maxxam Job #: B947566
Report Date: 2019/02/28

QUALITY ASSURANCE REPORT

exp Services Inc
Client Project #: BRM-00639350
Site Location: 441 MAPLE AVENUE
Your P.O. #: ENV-BRM
Sampler Initials: CS

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
5989074	4-Bromofluorobenzene	2019/02/26	102	70 - 130	102	70 - 130	99	%				
5989074	D4-1,2-Dichloroethane	2019/02/26	100	70 - 130	99	70 - 130	101	%				
5989074	D8-Toluene	2019/02/26	100	70 - 130	102	70 - 130	95	%				
5994135	D10-Anthracene	2019/02/27	105	50 - 130	106	50 - 130	100	%				
5994135	D14-Terphenyl (FS)	2019/02/27	85	50 - 130	87	50 - 130	79	%				
5994135	D8-Acenaphthylene	2019/02/27	100	50 - 130	101	50 - 130	93	%				
5988432	Total Carbonaceous BOD	2019/02/28					ND,RDL=2	mg/L	12	30	105	85 - 115
5988444	Total Suspended Solids	2019/02/25					ND, RDL=10	mg/L	18	25	95	85 - 115
5988509	Fluoride (F-)	2019/02/25	87	80 - 120	101	80 - 120	ND, RDL=0.10	mg/L	NC	20		
5988510	pH	2019/02/25			102	98 - 103			0.57	N/A		
5988598	Dissolved Sulphate (SO4)	2019/02/25	108	75 - 125	106	80 - 120	ND, RDL=1.0	mg/L	NC	20		
5989074	1,4-Dichlorobenzene	2019/02/26	96	70 - 130	98	70 - 130	ND, RDL=0.50	ug/L	NC	30		
5989074	Benzene	2019/02/26	99	70 - 130	99	70 - 130	ND, RDL=0.20	ug/L	NC	30		
5989074	Chloroform	2019/02/26	100	70 - 130	100	70 - 130	ND, RDL=0.20	ug/L	NC	30		
5989074	Ethylbenzene	2019/02/26	97	70 - 130	99	70 - 130	ND, RDL=0.20	ug/L	NC	30		
5989074	Methylene Chloride(Dichloromethane)	2019/02/26	95	70 - 130	95	70 - 130	ND, RDL=2.0	ug/L	NC	30		
5989074	Tetrachloroethylene	2019/02/26	96	70 - 130	99	70 - 130	ND, RDL=0.20	ug/L	NC	30		
5989074	Toluene	2019/02/26	97	70 - 130	99	70 - 130	ND, RDL=0.20	ug/L	NC	30		
5989074	Trichloroethylene	2019/02/26	98	70 - 130	99	70 - 130	ND, RDL=0.20	ug/L	NC	30		
5989143	Phenols-4AAP	2019/02/26	97	80 - 120	104	80 - 120	ND, RDL=0.0010	mg/L	1.7	20		
5989244	Total Cyanide (CN)	2019/02/25	102	80 - 120	99	80 - 120	ND, RDL=0.0050	mg/L	NC	20		
5989418	Total Aluminum (Al)	2019/02/26	99	80 - 120	99	80 - 120	ND, RDL=0.1	mg/L	NC	20		
5989418	Total Antimony (Sb)	2019/02/26	109	80 - 120	106	80 - 120	ND, RDL=0.02	mg/L	NC	20		
5989418	Total Arsenic (As)	2019/02/26	105	80 - 120	101	80 - 120	ND, RDL=0.01	mg/L	NC	20		
5989418	Total Beryllium (Be)	2019/02/26	104	80 - 120	103	80 - 120	ND, RDL=0.0005	mg/L	NC	20		
5989418	Total Cadmium (Cd)	2019/02/26	103	80 - 120	101	80 - 120	ND, RDL=0.002	mg/L	NC	20		
5989418	Total Chromium (Cr)	2019/02/26	99	80 - 120	99	80 - 120	ND, RDL=0.01	mg/L	NC	20		

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Maxxam Job #: B947566
Report Date: 2019/02/28

QUALITY ASSURANCE REPORT(CONT'D)

exp Services Inc
Client Project #: BRM-00639350
Site Location: 441 MAPLE AVENUE
Your P.O. #: ENV-BRM
Sampler Initials: CS

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
5989418	Total Cobalt (Co)	2019/02/26	97	80 - 120	99	80 - 120	ND, RDL=0.002	mg/L	NC	20		
5989418	Total Copper (Cu)	2019/02/26	102	80 - 120	100	80 - 120	ND, RDL=0.01	mg/L	8.6	20		
5989418	Total Iron (Fe)	2019/02/26	98	80 - 120	98	80 - 120	ND, RDL=0.02	mg/L	4.1	20		
5989418	Total Lead (Pb)	2019/02/26	95	80 - 120	99	80 - 120	ND, RDL=0.01	mg/L	NC	20		
5989418	Total Manganese (Mn)	2019/02/26	94	80 - 120	95	80 - 120	ND, RDL=0.001	mg/L	1.1	20		
5989418	Total Molybdenum (Mo)	2019/02/26	109	80 - 120	108	80 - 120	ND, RDL=0.005	mg/L	NC	20		
5989418	Total Nickel (Ni)	2019/02/26	100	80 - 120	105	80 - 120	ND, RDL=0.005	mg/L	NC	20		
5989418	Total Phosphorus (P)	2019/02/26	NC	80 - 120	107	80 - 120	ND, RDL=0.05	mg/L	8.9	20		
5989418	Total Selenium (Se)	2019/02/26	103	80 - 120	99	80 - 120	ND, RDL=0.02	mg/L	NC	20		
5989418	Total Silver (Ag)	2019/02/26	96	80 - 120	97	80 - 120	ND, RDL=0.01	mg/L	NC	20		
5989418	Total Tin (Sn)	2019/02/26	108	80 - 120	111	80 - 120	ND, RDL=0.02	mg/L	NC	20		
5989418	Total Titanium (Ti)	2019/02/26	99	80 - 120	98	80 - 120	ND, RDL=0.005	mg/L	NC	20		
5989418	Total Zinc (Zn)	2019/02/26	104	80 - 120	104	80 - 120	ND, RDL=0.005	mg/L	6.1	20		
5989953	Total Kjeldahl Nitrogen (TKN)	2019/02/26	93	80 - 120	106	80 - 120	ND, RDL=0.10	mg/L	6.2	20	107	80 - 120
5991371	Mercury (Hg)	2019/02/27	98	75 - 125	91	80 - 120	ND, RDL=0.0001	mg/L	NC	20		
5992989	Total Oil & Grease	2019/02/27			102	85 - 115	ND, RDL=0.50	mg/L	2.2	25		
5992990	Total Oil & Grease Mineral/Synthetic	2019/02/27			96	85 - 115	ND, RDL=0.50	mg/L	3.7	25		

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Maxxam Job #: B947566
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QUALITY ASSURANCE REPORT(CONT'D)

exp Services Inc
Client Project #: BRM-00639350
Site Location: 441 MAPLE AVENUE
Your P.O. #: ENV-BRM
Sampler Initials: CS

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
5994135	Naphthalene	2019/02/27	85	50 - 130	82	50 - 130	ND, RDL=0.050	ug/L	NC	30		

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

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Report Date: 2019/02/28

exp Services Inc
Client Project #: BRM-00639350
Site Location: 441 MAPLE AVENUE
Your P.O. #: ENV-BRM
Sampler Initials: CS

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Anastassia Hamanov, Scientific Specialist

Farhana Rahman

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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CHAIN OF CUSTODY RECORD

Page 1 of 1

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name:	#30554 exp Services Inc	Company Name:		Quotation #:	B45997. STREAM2	Maxxam Job #:	Bottle Order #:
Attention:	Central Services	Attention:	FChartier,THecky,CSimon,KBeck	P.O. #:	ENV-BRM		703945
Address:	1595 Clark Blvd Brampton ON L6T 4V1	Address:	TOMSON.HECKY@EXP.COM CHANTEL.SIMON@EXP.COM	Project:	BRM-00639350	COC #:	Project Manager:
Tel:	(905) 793-9800 Fax: (905) 793-0641	Tel:	(905) 793-9800 Ext: 2523 Fax:	Project Name:		C#703945-01-01	Tanya Fidlin
Email:	Karen.Burke@exp.com; Luizza.Jose@exp.com; AP@e	Email:	Francois.Chartier@exp.com,tomson.hecky@exp.com,n	Site #:	441 Maple Avenue		
				Sampled By:	CS		

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)	Other Regulations	Special Instructions
☐ Table 1 ☐ Res/Park ☐ Medium/Fine ☐ Table 2 ☐ Ind/Comm ☐ Coarse ☐ Table 3 ☐ Agri/Other ☐ For RSC ☐ Table ___	☐ CCME ☒ Sanitary Sewer Bylaw ☐ Reg 558 ☒ Storm Sewer Bylaw ☐ MISA Municipality Halton/Burlington ☐ PWQO ☐ Other	

Include Criteria on Certificate of Analysis (Y/N)? Y

Turnaround Time (TAT) Required:

Please provide advance notice for rush projects

Regular (Standard) TAT: ☒
(will be applied if Rush TAT is not specified)
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (If applies to entire submission)
Date Required: _____ Time Required: _____ ☐
Rush Confirmation Number: _____ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	ANALYSIS REQUESTED (PLEASE BE SPECIFIC): Halton/Burlington Sanitary & Storm Bylaw	# of Bottles	Comments
1		BH1-S	22/02/19	9:00AM	GW	N	X	15	5 DAY FIRM TURN AROUND TIME PLEASE
2									
3									
4									
5									
6									
7									
8									
9									
10									

22-Feb-19 12:31
Tanya Fidlin
B947566
URE ENV-751

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
Chantel Simon	19/02/22	12:30		2019/02/22	1231	

Laboratory Use Only					
Time Sensitive	Temperature (°C) on Rece	4 4 4 ICE	Custody Seal Present	Yes ✓	No
			Intact	✓	

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/WP-CONTENT/UPLOADS/ONTARIO-COC.PDF.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

White: Maxxa Yellow: Client

Maxxam Analytics International Corporation o/a Maxxam Analytics

Maxxam Job #: B947566
Report Date: 2019/02/28

exp Services Inc
Client Project #: BRM-00639350
Site Location: 441 MAPLE AVENUE
Your P.O. #: ENV-BRM
Sampler Initials: CS

Exceedence Summary Table – Halton Sanitary Sewer

Result Exceedences

Sample ID	Maxxam ID	Parameter	Criteria	Result	DL	Units
No Exceedences						

The exceedence summary table is for information purposes only and should not be considered a comprehensive listing or statement of conformance to applicable regulatory guidelines.

Exceedence Summary Table – Halton Storm Sewer

Result Exceedences

Sample ID	Maxxam ID	Parameter	Criteria	Result	DL	Units
No Exceedences						

The exceedence summary table is for information purposes only and should not be considered a comprehensive listing or statement of conformance to applicable regulatory guidelines.

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Appendix E:
Construction Flow Rate Calculations

APPENDIX E: Construction Dewatering Calculations

441 Maple Avenue, Burlington, ON
BRM-00639350

Table E-1: Flow all Sides of the Excavation

Parameters	Symbols	Unit	Value
Geological Formation	-	-	overburden and Shale
Ground Elevation	-	mASL	83.00
Highest Groundwater Elevation	-	mASL	81.00
Top of the Water-Bearing Zone	-	mASL	81.00
Base of the Water-Bearing Zone	-	mASL	69.50
Height of Static Water Table Above the Base of the Water-Bearing Zone	**H**	m	11.50
Dewatered Elevation Target	-	mASL	70.50
Height of Target Water Level Above the Base of Water-Bearing Zone	**h_w**	m	1.00
Hydraulic Conductivity	**K**	m/s	2.60E-06
Length of Excavation	-	m	95
Width of Excavation	-	m	35
Method to Calculate Radius of Influence	-	-	**Sichardt**
Radius of Influence from Sides of Excavation	**Ro**	m	50.79
Distance to Linear Source from Sides of excavation	**Lo=Ro/2**	m	25
Dewatering Flow Rate (unconfined linear flow component)	**Q**	m^3/day	150.9
Factor of Safety	**FS**	-	2.00
Dewatering Flow Rate (multiplied by factor of safety)	**Q.FS**	m^3/day	302

Table E-2: Precipitation Estimate

Location	Assumed Precipitation Event (mm)	Length of Excavation (m)	Width of Excavation (m)	Rainwater Collection (m^3)
Site Extent	15	95	35	50

Table E-3: Total Flow Estimate

Parameters	Symbols	Unit	Value
Dewatering Flow Rate **Without Safety Factor** (incluidng rainwater collection)	**Q (Total)**	m^3/day	201
Dewatering Flow Rate **With Safety Factor** (including rainwater collection)			352

Notes:
mASL - meters above sea level

Analytical Solution for Estimating Plane Flow from an Unconfined Aquifer to a Fully-Penetrating Excavation

$$Q_w = Kx\frac{H^2 - {h_w}^2}{L_o}$$

Where: (Based on the Dupuit Equation)

Q_w = Flow rate per unit length of excavation (m^3/s)

K = Hydraulic conductivity (m/s)

H = Height of static water table above base of water-bearing zone (m)

h_w = Height of target water level above the base of water-bearing zone (m)

L_o=Distance of Influence (m)

x=Length of excavation (m)

Appendix F:
Sub-Drain Flow Rate Calculations

APPENDIX F: Long-Term Flow Rate

441 Maple Avenue, Burlington, ON
BRM-00639350

Table F-1: Flow from Under-Slab Drain System

Parameters	Symbols	Unit	Value
Geological Formation	-	-	Glacial Deposit
Ground Elevation	-	mASL	83.00
Lowest Top Slab Elevation	-	mASL	73.00
Highest Groundwater Elevation	-	mASL	81.00
Lowest Footing Elevation	-	mASL	71.50
Base of the Water-Bearing Zone	-	mASL	69.50
Height of Static Water Table Above the Base of the Water-Bearing Zone	**H**	m	11.50
Dewatering Target Elevation	-	mASL	72.50
Height of Target Water Level Above the Base of Water-Bearing Zone	**h_w**	m	3.00
Hydraulic Conductivity	**K**	m/s	2.6E-06
Length of Excavation	-	m	95.00
Width of Excavation	-	m	35.00
Equivalent Radius (equivalent perimeter)	**r_e**	m	41.38
Method to Calculate Radius of Influence	-	-	**Cooper-Jacob**
Time (180 Days)	**t**	s	31536000
Specific Yield	**Sy**		0.10
Cooper-Jacob's Radius of Influence from Sides of Excavation	**Rcj**	m	145.66
Radius of Influence	**Ro**	m	187.04
Dewatering Flow Rate (unconfined radial flow component)	**Q**	m^3/day	57.66
Factor of Safety	**fs**	-	1.50
Dewatering Flow Rate (multiplied by factor of safety)	**Q.fs**	m^3/day	86
Dewatering Flow Rate **Without Safety Factor** (including stormwater collection)	-	m^3/day	58
Dewatering Flow Rate **With Safety Factor** (including stormwater collection)	-	m^3/day	90

Notes:
mASL - meters above sea level

Analytical Solution for Estimating Radial Flow from an Unconfined Aquifer to a Fully-Penetrating Excavation

$$Q_w = \frac{\pi K(H^2 - h^2)}{Ln\,[\frac{R_o}{r_e}]}$$

(Based on the Dupuit-Forcheimer Equation)

$$r_e = \frac{a+b}{\pi} \qquad R_o = R_{cj} + r_e \qquad R_{cj} = \sqrt{2.25KDt/S}$$

Where:

Q_w = Flow rate per unit length of excavation (m^3/s)

K = Hydraulic conductivity (m/s)

H = Height of static water table above base of water-bearing zone (m)

h_w = Height of target water level above the base of water-bearing zone (m)

Rcj=Cooper Jacob Radius of Influence (m)

R_o=Radius of influence (m)

re=Equivalent perimeter (m)