HYDROGEOLOGICAL INVESTIGATION
PROPOSED BRIARWOOD HILLSBURGH DEVELOPMENT
5916 Trafalgar Road North, Town of Erin, Ontario

Prepared for:

Hillsburgh Heights Inc.

636 Edward Avenue, Suite 14
Richmond Hill, Ontario L4C 0V4

Prepared by:

HLV2K
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Project No. 2100428AH

November 17, 2021

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Hillsburgh Heights Inc.
636 Edward Avenue, Suite 14
Richmond Hill, Ontario L4C 0V4

Email: Fausto@briarwoodhomes.ca

Attention: Mr. Fausto Saponara

Dear Mr. Saponara

RE: Hydrogeological Investigation for Proposed Briarwood Hillsburgh Development
5916 Trafalgar Road North, Town of Erin, Ontario

HLV2K Engineering Limited (HLV2K) is pleased to provide the hydrogeological investigation report for the above mentioned project. The report presents HLV2K's understanding of the hydrogeological setting of the study area based on exploratory drilling, data collection, analyses, and review.

We trust that this information meets your present requirements. If we can be of additional assistance in this regard, please contact this office.

For and on behalf of HLV2K Engineering Limited,

K. Mohamadi

President & Principal Engineer

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LIST OF ACRONYMS AND DEFINITIONS

BH	Borehole
EASR	Environmental Activity and Sector Registry
K	Hydraulic Conductivity
GPM	Gallon per Minute
mbgs	Metres Below Ground Surface
MECP	Ontario Ministry of the Environment, Conservation and Parks
O.Reg.903	Ontario’s Wells Regulation
PTTW	Permit To Take Water

1 INTRODUCTION

1.1 General

HLV2K Engineering Limited (HLV2K) was retained by Hillsburgh Heights Inc. (the Client) with a proposal to conduct the hydrogeological investigations for the proposed Briarwood Hillsburgh Development located at 5916 Trafalgar Road North, Town of Erin, Ontario (the Site). The Site is situated in a mixed rural, residential, and agricultural area. It is on the west side of Trafalgar Road, between Sideroad 27 to the north and Upper Canada Drive to the south. The Site is surrounded by residential housing, agricultural fields, and forested area.

At the time of investigation, the Site was vacant and covered by grass. There are two residential houses within the property. The total area of the Site is approximately 46.9 hectares (ha).

Based on the information provided by the client, the proposed development will consist of 288 single family residential lots, 44 townhouse units, new private roads, two storm water management (SWM) facilities, and a park with total area of 40.4 ha. The subdivision will be fully connected to municipal services (municipal water and sanitary sewers). The location of the Site is shown on **Figure 1**.

1.2 Purpose

The purpose of the hydrogeological investigation was to characterize the existing hydrogeological conditions at and in the vicinity of the Site, assess the need for, and options for, groundwater control in association with the proposed construction, evaluate potential impacts to the local groundwater regime resulting from the proposed construction, and identify appropriate mitigative measures, as warranted.

This hydrogeological study may be utilized in support for an application for a Permit to Take Water (PTTW) for dewatering purposes during construction or registering in Environmental Activity and Sector Registry (EASR), if necessary. The purpose of completing the PTTW / EASR application is to conduct the work in compliance with Ontario Regulation 387/04 (as amended) and the Ontario Water Resources Act (OWRA). The water taking EASR is for construction projects that require more than 50,000 liters per day (L/day) of water and less than 400,000 L/day under normal conditions. A PTTW is required for any surface water or groundwater taking during construction in excess of 400 cubic metres per day (m^3/day).

2 METHOD OF INVESTIGATION

2.1 General

This hydrogeological study began with a review of previously completed geotechnical and environmental reports and published information for the study area, including previously published regional physiographic and geologic mapping and watershed planning reports. Many of these documents are referred to throughout various sections of this report and the relevant details can be found in the References section following the text of the report.

In particular, the work completed in association with this hydrogeological study consisted of the following tasks:

- Reviewing and interpreting available reports and published data;
- Developing Health & Safety and Sampling and Analysis Plans for work at the Site;
- Assessing the current Site conditions, and areas of interest;
- Installing five (5) monitoring wells;
- Reviewing water well records available from the Ministry of the Environment, Conservation and Parks (MECP);
- Developing the groundwater monitoring wells installed on the Site by removing at least three well volumes of groundwater or two times to dry;
- Performing in-situ hydraulic conductivity testing (slug tests) to assess the aquifer permeability;
- Measuring groundwater levels in each of the monitoring wells located at the Site;
- Evaluating proposed construction dewatering requirements; and
- Prepare a final report on the findings of this investigation.

2.2 Boreholes and Monitoring Wells

HLV2K drilled five (5) boreholes on September 1 and 7, 2021 and installed five (5) monitoring wells (MW1 to MW5) for groundwater monitoring and sampling. One monitoring well (MW1) was installed at approximate depth of 10 m below ground surface (mbgs) and others were installed at approximately 6.2 mbgs. Borehole logs for all boreholes are provided in **Appendix A**. One piezometer to approximate depth of 1 mbgs was installed close to the wetland to monitor the shallow water level close to the wetland. In addition, HLV2K drilled 4 test holes to approximate depth of 2.4 mbgs for percolation tests.

The well survey was conducted using a GPS unit (Sokkia GCX3 with SHC500 controller). The monitoring well, test holes, and piezometer locations are shown in **Figure 2**. The details of construction of the monitoring wells are summarized in **Table 1**.

It should be noted that the ground surface elevations noted on the appended borehole logs are approximate and were used for the purpose of relating borehole soil stratigraphy and should not be used or relied on for other purposes.

Table 1: Information on Boreholes and Groundwater Monitoring Wells

MW ID	Estimated Ground Surface Elevation (m)	Borehole Bottom		Well Screen Interval Depth (mbgs)		Well Screen Interval Elevation (m)	
		Depth (mbgs)	Elevation (m)	from	to	from	to
MW1	473.50	9.8	463.70	6.65	9.7	466.85	463.80
MW2	469.37	6.2	463.17	3.05	6.1	466.32	463.27
MW3	471.00	6.3	464.70	3.15	6.2	467.85	464.80
MW4	458.48	6.7	451.78	3.55	6.6	454.93	451.88
MW5	454.05	6.5	447.55	3.35	6.4	450.70	447.65
Piezometer	448.19	0.9	447.29	0.3	0.9	447.89	447.29

2.3 Groundwater Monitoring

As part of this investigation, HLV2K visited the site on September 17th and 30th to measure the groundwater levels in the monitoring wells. Groundwater was encountered only in MW5 and the rest of the wells were found dry.

2.4 In-Situ Hydraulic Conductivity Testing

Monitoring wells were dry except MW5. The depth of the water in MW5 was not enough to conduct hydraulic conductivity test. Wells will be revisited in spring when the high groundwater level is expected. If enough water is encountered in any of the wells, the hydraulic conductivity test will be conducted.

2.5 In-Situ Percolation Test

HLV2K's staff visited the Site on September 1st and 7th, 2021. After receiving utility locates, four (4) 150-mm borehole was drilled to approximate depth of 2.4 m below ground surface (mbgs). All loose material was removed from the sides and bottom of the hole. **Figure 2** shows the location of the test holes. Groundwater level was measured in the monitoring well in vicinity of the test hole.

The installed monitoring wells were used to measure the groundwater levels at the time of percolation tests. The borehole logs are provided in **Appendix A**.

The bottom of the hole was covered with 10 cm of sand and then the hole was filled with the water to a depth close to the surface (15 cm to 30 cm below ground surface). The water levels versus time were recorded. Field test measurements are provided in **Appendix B**.

3 SITE CONDITIONS

3.1 Physical Setting

The Site is situated in a mixed rural, residential, and agricultural area. It is on the west side of Trafalgar Road, between Sideroad 27 to the north and Upper Canada Drive to the south. The Site is surrounded by residential housing, agricultural fields, and forested area. According to the Oak Ridges Moraine Atlas which is available online at (http://www.mah.gov.on.ca/page334.aspx) and the Niagara Escarpment Plan (NEP) Maps available online at (http://www.escarpment.org/landplanning), the Site is not located within an area where either the Oak Ridges Moraine Conservation Plan or the Niagara Escarpment Plan would be applicable.

3.2 Climatic Conditions

Average monthly climate data from an Environment Canada climate station located at the Fergus Shand Dam (Station ID 6142400), approximately 14 km west of the Site, for the period between 1981 and 2010 is provided in **Table 2**, below (Environment Canada, 2021). The data indicates that the climate in the study area is typical continental with cold winters and warm summers and precipitation records showing local seasonal variation. As shown in **Table 2**, below, the mean annual precipitation is 945.7 mm/year, with annual mean rainfall of 797.8 mm/year (84% of total precipitation). Average monthly precipitation ranged from 55.9 mm in February to 96.6 mm in August. The mean annual daily temperature is 6.7 degrees Celsius (°C), ranging from -7.4 °C in January to 20.0 °C in July.

Table 2: Climate Data Summary (1981 – 2010) – Fergus Shand Dam Station (ID 6142400)

MONTH	Daily Average Temperature (°C)	Average Rainfall (mm)	Average Snow (cm)	Average Precipitation (mm)
January	-7.4	27.8	40.1	67.9
February	-6.3	25.3	30.6	55.9
March	-1.9	36.7	22.9	59.6
April	5.7	67.9	6.2	74.1
May	12.2	86.8	0.1	86.9
June	17.5	83.8	0.0	83.8
July	20.0	89.2	0.0	89.2
August	19.0	96.6	0.0	96.6
September	14.9	93.1	0.0	93.1
October	8.3	75.6	1.6	77.2
November	2.1	80.5	12.5	93.0
December	-3.9	34.7	33.9	68.6
Year	**6.7**	**797.8**	**147.8**	**945.7**

NOTE: Data was obtained from Environment Canada website (Environment Canada 2021).

3.3 Physiography and Drainage

A review of the topographic map provided online by Natural Resources Canada (Toporama) depicts the Site as located within an area that is generally high relief at an approximate elevation of 450 m to 470 m. The project is located in the Little Credit River Watershed within the Credit Valley River Conservation

Authority (CVCA) jurisdiction. The watershed is approximately 1,000 square kilometers (km^2). The main branch of the Credit River originates north of Orangeville and flows southerly to Lake Ontario at Port Credit, Mississauga, ON (CVC, 2011).

According to the physiographic regions of Ontario identified by Chapman and Putnam (2007), the Site is located in Hillsburgh Sandhills (**Figure 3**). The Hillsburgh Sandhills physiographic region is found in the northwestern portion of the watershed and consists of coarse-grained sediments. It is an area of high relief with thick deposits of glacial outwash (sandy materials) overlying glacial tills and bedrock (CVC, 2011)

3.4 Geological Mapping

The geology of the Credit River watershed generally consists of ice-contact stratified drift (CVC, 2011). A regional description of the Quaternary geology for the area of the Site can be found on the Ontario Geological Survey Digital Map - Surficial geology of southern Ontario (OGS, 2010). A section of this map showing the surficial geology in the vicinity of the Site is presented on **Figure 4**.

As shown on **Figure 4**, the surficial deposits in the immediate vicinity of the Site are mapped as Orangeville Moraine with materials consisted of sand and gravel including some till or silt. The western side of the Site is modern alluvial deposits.

Bedrock is comprised of upper Silurian to lower Devonian of Guelph Formation. The bedrock surface is expected to be approximately 60 mbgs. None of the boreholes drilled for this investigation reached the bedrock. **Figure 5** shows the bedrock at the Site and its vicinity.

3.5 Subsurface Soil Conditions

The subsurface soil conditions encountered during boreholes advanced at the Site are shown on the borehole logs in **Appendix A**. A summary of the soil conditions is provided below.

Topsoil with approximate thickness of 200 to 300 mm was encountered in all boreholes. Below the topsoil, a layer of sandy silt to silty sand was encountered at all borehole locations and extended in general to approximately from 1.5 to 3.1 m below the existing ground surface. Organic matter, rootlets, gravel and cobbles were found in this layer. Below this layer, a layer of sand and gravel was encountered in all boreholes and extended to maximum explored depth of 9.8 m.

4 GROUNDWATER CONDITIONS

4.1 Regional Groundwater Recharge

Recharge is the process by which groundwater is replenished and involves the vertical infiltration of water through the subsoil deposits and geologic materials to the saturated zone. The major sources of recharge in the study area are a result of precipitation and freshet. The amount of groundwater recharge in a particular area depends on surficial geology, topography, and the extent of land development in that area. Generally, regional groundwater recharge is irregularly distributed temporally and spatially as interpreted from specific climatic conditions, local geology, and land development status.

The Site is a vacant land and is used for agriculture. Therefore, the groundwater recharge occurs under natural condition. A water balance analysis was completed for the site to estimate the change in water recharge pre and post development and will be presented in the following sections.

4.2 Groundwater Level Fluctuations

The groundwater level data collected from the monitoring wells are provided in **Table 3**, below. The screen elevations of these monitoring wells are shown in **Table 1** above and on the borehole logs provided in **Appendix A**.

A number of groundwater level monitoring rounds were completed in September and November 2021. As shown in **Table 3** below, the groundwater has found only in MW5 at approximate elevation of 449.3 m. The rest of the monitoring wells were dry. Groundwater level monitoring will be continued for one year.

the groundwater levels in the monitoring wells were measured at approximate elevation of 449 m. The observations and water level measurements showed except MW5, the rest of monitoring wells were in dry conditions. Water level monitoring will be continued for one year with bi-weekly readings. The results will be provided under a separate report.

Regional groundwater flow in the area typically reflects the local topography and generally occurs from topographic highs to topographic lows. The dominant regional groundwater flow direction is southerly, toward Lake Ontario.

It should be noted that groundwater conditions vary depending on factors such as temperature, season, precipitation, construction activity and other situations, which may be different from those encountered at the time of the monitoring. The possibility of groundwater level fluctuations at the Site should be considered when designing and developing the construction plans for the project.

Table 3: Summary of Groundwater Level Observations in Monitoring Wells

MW ID	Ground Surface Elevation (m)	Groundwater Level Observations					
		1 & 7 SEP-2021 (at completion)		17-SEP-2021		16-NOV-2021	
		Depth (mbgs)	Elevation (m)	Depth (mbgs)	Elevation (m)	Depth (mbgs)	Elevation (m)
MW1	473.50	Dry	-	Dry	-	Dry	-
MW2	469.37	Dry	-	Dry	-	Dry	-
MW3	471.00	Dry	-	Dry	-	Dry	-
MW4	458.48	Dry	-	Dry	-	Dry	-
MW5	454.05	Dry	-	4.78	449.27	4.67	449.38
P1	448.19	Dry	-	Dry	-	Dry	-

4.3 Percolation Test Results

Table 4 below is the summary of the percolation test results. The selected value for the test presented in the table is the average of final three percolation rates during each test which is closer to the steady-state infiltration rate. Detailed calculations are provided in **Appendix B**.

Table 4: Summary of Infiltration Test Results

Test ID	Hole Depth (mbgs)	Hole Bottom Elevation (m)	Groundwater Depth (mbgs)	Infiltration Rate (mm/hr)	Percolation Time (min/cm)
TP1	2.4	466.3	<9.8 (MW1)	600	1
TP2	2.4	466.7	<6.2 (MW2)	120	5
TP3	1.85	460.5	<6.7 (MW4)	1200	0.5
TP4	2.2	452.8	4.8 (MW5)	300	2

4.4 Groundwater Use in the Study Area

A search of the MECP Water Well Information System (WWIS) database to identify active wells near the Site were conducted. The database search was requested for the area located within 500 m from the Site. The database search identified records for 90 wells.

Figure 5 presents the locations of the identified wells as well as the associated water use categories within 500 m around the Site. A detailed table showing water well record (WRR) information for these wells is provided in **Appendix C**. The classification of these wells is as follows:

- 4 monitoring/observation wells and test hole;
- 16 wells identified as abandoned; and
- 2 wells were not stated;
- 68 wells as water supply wells.

The monitoring wells/test holes identified in the database search are typically interpreted as geotechnical/geological boreholes and normally no water would be obtained or used from these boreholes. The search revealed the presence of 68 domestic water wells or other water supply wells potentially in use in the area of the Site. If groundwater use or dewatering is required for the Site, a door-to-door well survey is recommended.

5 GROUNDWATER DEWATERING ESTIMATES

Details of construction was not provided to HLV2K at the time of this investigation; however, it is our understanding that one level of basement is considered for the houses in this development. The water level monitored during the investigation shows that dewatering would not be required during the construction to control the groundwater. The monitoring well depths are 6.5 to 9.8 mbgs and no groundwater encountered within this depth except in MW5 at 4.8 mbgs or elevation of 449.3 m. Perch water may be present during the construction and the contractor should be ready to control that water, if encountered.

During the excavation for foundation or underground utilities, rainwater may need to be pumped from the trenches. According to MTO IDF Curve Lookup website[1], 24-hour rainfall with a 2-year return period in Erin area is 56.5 mm. The volume of the water depends on the area of excavation at the time.

6 WELLHEAD PROTECTION AREA

A small portion of the Site (approximately 0.6 ha) in the northeast is located within the Well Head Protection Area A (WHPA-A) which represents a 100 m circle around a municipality water supply well as shown in **Figure 7**. It is also located within the Significant Groundwater Recharge Area (SGRA). A water balance analysis was conducted to estimate the recharge rate in pre and post construction. The results are provided in the following section.

7 WATER BALANCE ANALYSIS

When precipitation (P) occurs, it can either run off (R) through the surface water system, infiltrate (I) to the water table, or evapotranspire (ET) from the earth's surface and vegetation. The sum of R and I is defined as the water surplus (S). When long-term averages of P, R, I, and ET are used, there is no net change in groundwater storage (ST). On a yearly basis, however, there is a potential for small changes in ST.

The annual water budget can be stated as,

$$P = ET + R + I + ST$$

The monthly averages of P and temperature (T) were collected from Environment Canada data. Based on the physiographic setting and proximity to weather stations, the Fergus Shand Dam Station (ID 6142400) located approximately 14 km west of the Site chosen as the most representative precipitation and temperature data

Climate Normals are arithmetic calculations of observed climate values over a specified time period and are used to describe the climatic characteristics of a location. Real-time values, such as daily temperature, may be compared to the "climate normal" to compare departures from the "average". The Canadian Climate Normals are calculated based on World Meteorological Organization (WMO) Standards. The WMO

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[1] http://www.mto.gov.on.ca/IDF_Curves

considers 30 years sufficient to eliminate year-to-year variations. The most recently published 30-year period from Environment Canada is January 1981 to December 2010.

In addition, the WMO established that normals should be arithmetic means calculated for each month of the year from daily data. To qualify, temperature data, soil temperatures and evaporation must fit the following rule: "If more than 3 consecutive daily values are missing or more than 5 daily values in total in a given month are missing, the monthly mean should not be computed and the year-month mean should be considered missing." This is referred to as the "3/5" rule. For total precipitation, degree-days, and "days with" calculations, no missing days are allowed.

7.1 Thornthwaite Monthly Water-Balance Model

The Thornthwaite water balance (Thornthwaite, 1948; Mather, 1978; 1979) uses an accounting type procedure to analyze the allocation of water among various components of the hydrologic cycle. Inputs to the model are monthly temperature, precipitation and the site latitude. Outputs include monthly potential and actual evapotranspiration, soil moisture storage, soil moisture storage change, surplus, and runoff. For ease of calculation, an Excel spreadsheet was developed. This water balance was prepared according to the “Hydrogeological Assessment Submissions: Conservation Authority Guidelines to Support Development Application (2013).

7.2 Pre-Construction Water Balance

To predict water balance elements the 30-year average weather data was used. The detailed calculations are presented in below sections.

Precipitation (P)

Based on the 30-year average (1981-2010) for the Fergus Shand Dam meteorological station, the average precipitation is about 945.9 mm/year. The monthly precipitation distribution is presented in **Table D.1** of **Appendix D**.

Storage (ST)

Long-term annual change in storage is 0, although there is some variation on a monthly basis. It should be noted that for the topography, soil conditions (silty sand till to sandy silt till) and vegetative cover (moderate to deep rooted crops), the maximum soil moisture storage was estimated at about 250 mm according to Table 3.1 of MECP Stormwater Management Planning and Design Manual (2003).

Evapotranspiration

Calculated potential evapotranspiration (PET) based on the Thornthwaite monthly water balance model is about 573 mm/year, or about 61% of the total precipitation. The actual evapotranspiration is calculated based on a potential evapotranspiration (PET) and soil-moisture-storage withdrawal (SMW). PET is estimated from monthly temperature and is defined as a water loss from a homogeneous, vegetation covered area that never lacks water (Thornthwaite, 1948; Mather, 1978). In Thornthwaite water balance, PET is calculated using Thornthwaite Method (Ponce, 1989). The method is based on an annual temperature efficiency index J, defined as the sum of 12 monthly values of heat index I. Each index I is a function of the mean monthly temperature T, in degrees Celsius, as follows:

$$I = \left(\frac{T}{5}\right)^{1.514}$$

Evapotranspiration is calculated by the following formula:

$$PET(0) = 1.6 \left(\frac{10T}{J}\right)^{c}$$

in which PET(0) is the potential evapotranspiration at 0° latitude in centimeters per month; and c is an exponent to be evaluated as follows:

$$c = 0.000000675J^{3} - 0.0000771J^{2} + 0.01792J + 0.49239$$

At the latitude other than 0° potential evapotranspiration is calculated by

$$PET = K\ PET(0)$$

in which K is a constant for each month of the year, varying as a function of latitude. The latitude for Fergus Shand Dam station is 43° 44’ and values of K are provided in **Table D.2** in **Appendix D**.

Water Surplus

The overall pre-construction water surplus for study area is estimated at 373 mm/year. Water surplus (S) has two components in Thornthwaite model: a runoff component, which is the overland flow component that occurs when soil moisture capacity is exceeded; and, an infiltration component. Using the MECP SWM manual (MECP, 2003) for guidance, it is estimated that about 50% of the water surplus (186.5 mm/year) infiltrates and the remaining 50% (186.5 mm/year) runs off either directly or as interflow. The details calculation is presented in **Table D.2** in **Appendix D**.

Annual Water Balance

The summary of annual water balance assessment for the pre-construction condition is provided in **Table D.3** in **Appendix D**.

7.3 Post-Construction Water Balance without LID

Based on the proposed Draft Plan provided by the Client (**Appendix E**), **Table 5** below shows a summary of post (proposed) construction land statistics.

Table 5: Post-Construction (Proposed) Land Statistics

Item	Area (m^2)
Total Area	404,000
Paved municipal roadways	101,700
Residentials (Impervious – 55% of lot area)	127,380
School (Impervious)	4,500
Park (Impervious – 20% of lot area)	4,060
Soft landscaped lot lawns, Boulevards, Park, Open space, and (excluding SWM Pond)	138,260
SWM Pond	28,100

It was estimated that 55% of the residential lots, 20% of the park, and 4,500 of the school to be covered with impervious surfaces. The future development (65,000 m^2) was not considered in this estimation, and it was considered to remain vacant, however, its contribution to recharge was not counted in water balance analysis.

To predict water balance elements, the 30-year average weather data was used. Based on the provided development information, it is our understanding that about 58% of the post construction surface will be considered impervious. Additionally, the Conservation Authority guidelines suggest infiltration will be lowered by 10% (a factor of 0.1) because of site grading and compaction of the soil due to construction work. However, the soil compaction issue might be resolved by increasing the topsoil depth to 300 mm. **Table D.4** in **Appendix D** presents the components of post construction water balance.

Precipitation (P)

Precipitation remains the same, the 30-year average (1981-2010) for the Fergus Shand Dam Station meteorological station (945.9 mm/year) was used.

Storage (ST)

Long-term change in storage is 0. It should be noted that compared to pre-construction, there is a change in the distribution and magnitude of monthly soil moisture storage. It is assumed that development of the land will result in reduced grades that, with the same soil conditions (clayey silt to sandy silt till) and changed vegetative cover (shallow rooted lawns and gardens), will reduce the maximum soil moisture storage to 125 mm.

Evapotranspiration

In post construction, it was assumed that the increased impervious area would result in an additional 20% in potential evaporation from the areas covered with hard surfaces. The total water lost to evaporation increases, but the PET for pervious areas, calculated at 573 mm/year, remains about the same.

Water Surplus

The post-construction water surplus for the entire Site is calculated to be about 1,130 mm/year. Of this, about 621 mm/year will be converted to runoff on impervious areas and 508 mm/year will be available for infiltration or runoff on pervious areas in post-development condition. This exceeds the infiltration potential for the surficial soils; thus a component of the available infiltration water will also run off.

The results of the post construction water balance calculation suggest that there is enough water to maintain recharge, as there is a positive surplus (S) in the post construction scenario.

Annual Water Balance without LID

The major change between the pre- and post-construction water balance is that in the pre-construction setting, most of the water surplus is carried off the site as interflow and infiltration, whereas in the post construction setting, there is more interflow and overland flow. **Table D.5** in **Appendix D** shows that the volume of runoff will be increased from 75,937 m^3/year in pre-development to 224,304 m^3/year. The post-development infiltration volume is approximately 28,372 m^3/year which is almost 38% of the pre-development, if no mitigation measure is implemented and 58% of the site surface is converted to impervious surface.

7.4 Post-Construction Water Balance with LID

To assess the potential impacts of the proposed development on groundwater resources, the draft development plan (**Appendix E**) was reviewed.

Table D.6 in **Appendix D** presents the overall post construction water balance with mitigation measures.

Post development infiltration and runoff rates will be affected by the presence of impervious surfaces (i.e. building/garage rooftops, asphalt driveways and road), which based on the proposed development plan will comprise approximately 58% of the development property. The results of the post-construction water balance assessment without LID measures (**Table D.5** in **Appendix D**) show that there will be enough water to infiltrate in the pervious areas to increase the infiltration rate and reduce the runoff in post-construction development. Techniques to maximize the water availability in pervious areas such as designing grades to direct roof runoff towards lawns, side and rear yard swales, and other pervious areas throughout the development where possible can considerably increase the volume of infiltration in developed areas. Increasing the topsoil thickness by about two times the normal thickness is also considered as beneficial to enhance storage of water in the topsoil and increase the potential for infiltration. Other mitigation techniques that can be considered to mitigate increases in runoff and reductions in infiltration include such measures as subsurface infiltration trenches, permeable pavements, rain gardens, bioswales, galleries and pervious pipe systems. Surface methods should only be considered in areas where there is sufficient depth to water table to accommodate the systems within the unsaturated zone and sufficient soil hydraulic conductivity to function effectively. The MECP manual recommends that subsurface galleries or trenches should be about 1 m above the high water table.

The proposed LID measures for the Site would be the disconnected roof leaders to convey the rainwater from roofs to the permeable areas around the residential houses and increase the chance of infiltration. In addition, infiltration gallery will be installed to increase the recharge rate. The infiltration trenches will be designed by others. According to the information provided by the Client, the followings were considered in water balance analysis in post-development conditions with LID

- 80% of the residential lots are contributing to the infiltration trenches (185,280 m^2).

- 50% of the park is contributing to the infiltration trenches (10,150 m^2).
- 4500 m^2 of the school area is contributing to the infiltration trenches.

It was considered that LID measures would be designed to infiltrate the 25 mm storm event or less which accounts for approximately 90% of precipitation. The estimated infiltration rate for the trenches, then, calculated based on the followings:

- 20% of the rainfall on impervious surface was assumed to be evaporated. It means there is 80% or 757 mm surplus.
- 90% of the rainfall event is 25 mm or less. Only 90% of the surplus was considered for infiltration (681 mm).
- The estimated infiltration rate on pervious areas is 45% in post-construction condition (MECP Guideline, 2003). The total infiltration rate from rains would be 307 mm or 32.4% of the precipitation.

Natural infiltration that occurs on pervious surfaces along with the proposed mitigative measures exceed the pre-development infiltration volume by approximately 1,334 m^3/year. The runoff volume also exceeds the pre-development runoff volume by approximately 124,772 m^3/year.

In this condition, the total infiltration volume will be 76,514 m^3/year and total runoff volume in the post-construction will be changed to 200,709 m^3/year. **Table 6** below summarizes the post-construction water balance for reducing the runoff and increasing infiltration using LID measures.

Table 6: Post -Construction Water Balance Summary

Parameter	Value
Average Annual Rainfall (mm)	946
Pre- Development Infiltration (m^3/year)	75,180
Post-Development Infiltration without Mitigation (m^3/year)	26,778
Post-Development Infiltration with Mitigation (m^3/year)	76,514
Pre- and Post-Development Infiltration Differential (%)	+2%

7.5 Impact Assessment

To assess the potential impacts of the proposed development on groundwater resources, the draft development plan was reviewed. From a hydrogeological perspective, the following changes will occur as a result of the proposed development.

- The subject site is characteristically homogeneous with respect to soil types at ground surface. It is mainly silty sand over sand and gravel.
- The development will create new hard surfaces over a portion of the site, increasing the impervious area. The amount of impervious areas is estimated to be about 58%.

- As a result of the increase in impervious area, the overall infiltration will decrease and the amount of overland flow runoff will increase, particularly during storm events. Runoff will be managed using conventional storm water management techniques or Low Impact Development (LID) that include storm water management (SWM) facilities.
- With the inevitable changes in impervious areas and potential changes to groundwater quality and quantity, best management practices (BMPs) that promote groundwater infiltration/recharge for the purpose of trying to establish post-development infiltration at pre-development levels makes a significant contribution to mitigate the effects of development. Some of the recommended practices includes:
    - Disconnected roof leaders to convey the rainwater from roofs to the permeable areas and infiltration trenches around the residential houses and increase the chance of infiltration. Using the roof-tops rainwater can also preserve the groundwater quality. The location of these facilities and the function/operation are addressed by others.
- Although, the increase in impervious area can potentially result in a slight lowering of shallow groundwater levels, maintaining infiltration at levels similar to existing conditions will result water levels within the current range of seasonal fluctuations. No change in the overall flow direction is expected.
- The contribution of groundwater can be an important factor in the overall health of aquatic systems. Implementing mitigation measures to reduce the infiltration deficit will assist in maintaining the current level of groundwater contribution to the surface water features. As such, no negative impact is expected if LID measures are implemented to maintain the groundwater recharge similar to the existing conditions.

8 PREDICTED EFFECTS

Based on the hydrogeological information and data analysis in this report, the potential impacts to surface water and groundwater resources in the vicinity of the Site due to excavation dewatering for construction of the proposed houses at the Site are described below.

8.1 Groundwater Use

As indicated in Section 4.3, the search of the MECP water well records indicated 68 water supply wells within approximately 500 m of the Site. The area of the Site is currently serviced with a municipal water supply. The groundwater depth at the site is expected to be below basement floor and foundation. However, if groundwater dewatering and/or use is considered for this development, a door-to-door survey is recommended.

8.2 Surface Water Resources

The only surface water feature in the vicinity of the Site is the wetland at the southwest side of the Site (**Figure 8**). Since no groundwater use/dewatering is expected for this development, the impact on surface water is not anticipated. The change in the infiltration rate or runoff due to the development is considered in the water balance analysis.

8.3 Potential for Dewatering-Related Consolidation Settlement

Based on the investigation completed, temporary dewatering (i.e. during construction) is not expected. No settlement due to dewatering is expected for this Site.

9 SUMMARY AND CONCLUSION

Based on the results of the subsurface investigation, hydrogeological assessment, and analysis of hydraulic conductivity testing and groundwater level monitoring data, the following summary of conclusions and recommendations is provided:

- The groundwater was not encountered in any of the monitoring wells within the depth of expected excavation and PTTW/EASR is not required for dewatering during construction. Perched water and rainfall might be present during excavation and the contractor should be ready to deal with the water, if encountered.

- The Site is located within the Significant Groundwater Recharge Area (SGRA). Based on water balance analysis, implementing mitigation measures to reduce the infiltration deficit will assist in maintaining the current level of groundwater contribution to the surface water features. As such, no negative impact is expected if LID measures are implemented to maintain the groundwater recharge similar to the existing conditions.

- A small portion of Site (approximately 0.6 ha) is within the Wellhead Protection Area A (WHPA-A), which represent a 100 m distance from one municipal supply well. The sanitary sewer and stormwater management facility should be designed as per policy SWG-13 and SWG-14 to protect the groundwater quality.

- HLV2K recommends the decommissioning of existing groundwater monitoring wells after completion of the construction of the project. In conformance with Ontario's Wells Regulation (O.Reg.903) of the Ontario Water Resources Act, the installation and eventual decommissioning of groundwater wells must be carried out by a licensed well contractor. If a well is damaged/destroyed during the construction activities, then the well should be properly decommissioned in advance of that work.

10 STATEMENT OF LIMITATIONS

The contents of this report are subject to the attached 'Statement of Limitation' sheet. The reader's attention is specifically drawn to these conditions as it is considered essential that they be followed for proper use and interpretation of this report. The Statement of Limitations is not intended to reduce the level of responsibility accepted by HLV2K, but rather to ensure that all parties who have been given reliance for this report are aware of the responsibilities each assumes in so doing.

This report was prepared by HLV2K exclusively for the account of Hillsburgh Heights Inc. (the CLIENT). Other than by the CLIENT, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted without the express written permission of HLV2K. Any use, reliance on or decision made by any person other than CLIENT based on this report is the sole responsibility of such other person. The CLIENT and HLV2K make no representation or warranty to any other person with regard to this report and the work referred to in this report and the CLIENT and HLV2K accept no duty of care to any other person or any liability or responsibility whatsoever for any losses, expenses, damages, fines, penalties or other harm that may be suffered or incurred by any other person as a result of the use of, reliance on, any decision made or any action taken based on this report or the work referred to in this report.

11 CLOSURE

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

For and Behalf of HLV2K Engineering Limited

K. Mohamadi

Kourosh Mohammadi, PhD, P.Eng.

Principal Hydrogeological Engineer

LICENSED PROFESSIONAL ENGINEER
K. Mohammadi
100172155
Nov. 17, 2021
PROVINCE OF ONTARIO

REFERENCES

Chapman, L.J., and Putnam, D.F. (2007). The Physiography of Southern Ontario, Ontario Geological Survey, Miscellaneous Release—Data 228.

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Environment Canada (2021). Canadian National Climate Archive, Canadian Climate Norms and Averages (1981 – 2010), Fergus Shand Dam – Station ID 6142400– Website: https://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?searchType=stnName&txtStationName=fergus+shand+dam&searchMethod=contains&txtCentralLatMin=0&txtCentralLatSec=0&txtCentralLongMin=0&txtCentralLongSec=0&stnID=4760&dispBack=1

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OGS (2011). 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release---Data 126-Revision 1.

HLV2K Engineering Limited

STATEMENT OF LIMITATIONS

Your report has been developed based on your unique project specific requirements as understood by HLV2K Engineering Limited (HLV2K) and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking HLV2K to assess how factors that changed subsequent to the date of the report affect the report's recommendations. HLV2K cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions, which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult HLV2K to be advised how time may have impacted on the project.

The findings derived from this investigation were based on information collected and/or provided by the Client. It may become apparent that soil and groundwater conditions differ between and beyond the testing locations examined during future investigations or other work that could not be detected or anticipated at the time of this study. As such, HLV2K cannot be held liable for environmental conditions that were not apparent from the available information. The conclusions presented represent the best judgment of the assessors based on limited investigations.

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature, external data source review, sampling, and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions, which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of HLV2K through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report is based on the assumption that he site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only HLV2K, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and HLV2K cannot be held responsible for such misinterpretation.

To avoid misuse of the information contained in your report it is recommended that you confer with HLV2K before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain HLV2K to work with other project design professionals who are affected by the report. Have HLV2K explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment.

Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact HLV2K for information relating to geoenvironmental issues.

HLV2K is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with HLV2K to develop alternative approaches to problems that may be of genuine benefit both in time and in cost.

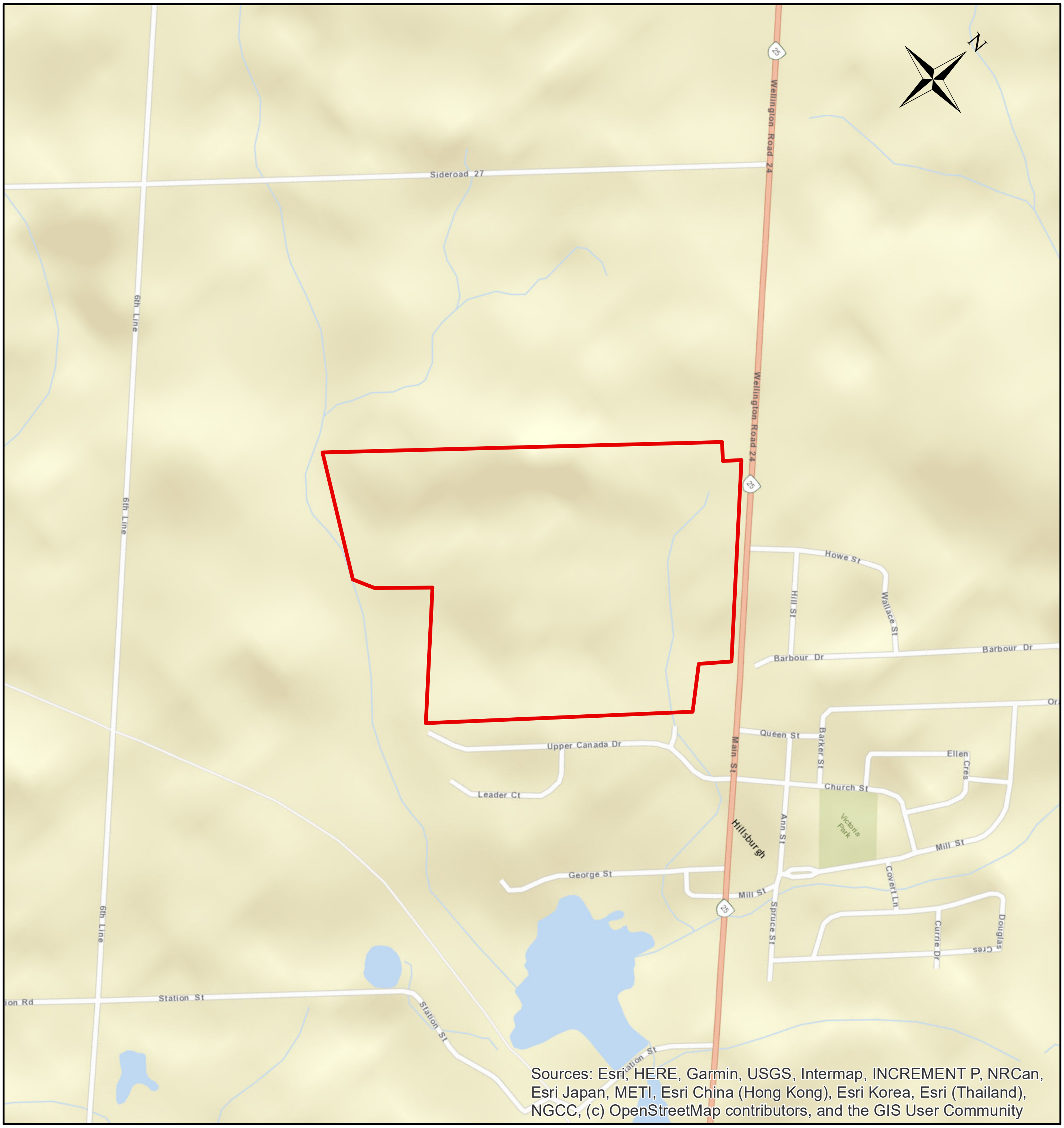
Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from HLV2K to other parties but are included to identify where HLV2K's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from HLV2K closely and do not hesitate to ask any questions you may have.

Third party information reviewed and used to formulate this report is assumed to be complete and correct. HLV2K used this information in good faith and will not accept any responsibility for deficiencies, misinterpretation or incompleteness of the information contained in documents prepared by third parties.

Nothing in this report is intended to constitute or provide a legal opinion.

Should additional information become available, HLV2K requests that this information be brought to our attention so that we may re-assess the conclusions presented herein.

FIGURES



Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Legend

🟥 Site Boundary

Drawn: MM	Title SITE LOCATION PLAN	
Approved: KM Date: SEP. 2021 Project No.: 2100428AH	Project HYDROGEOLOGICAL INVESTIGATION 5916 Trafalgar Road North, Town of Erin, Ontario	
	Client Hillsburgh Heights Inc.	
HLV2K ENGINEERING LIMITED	0 105 210 420 Meters	FIGURE 1

Legend

⌖ Monitoring Wells/Boreholes

◎ Piezometer Percolation Test

⊕ Site Boundary

▭

Drawn: MM

Approved: KM

Date: SEP. 2021

Project No.: 2100428AH

Title BOREHOLES LOCATION PLAN

Project

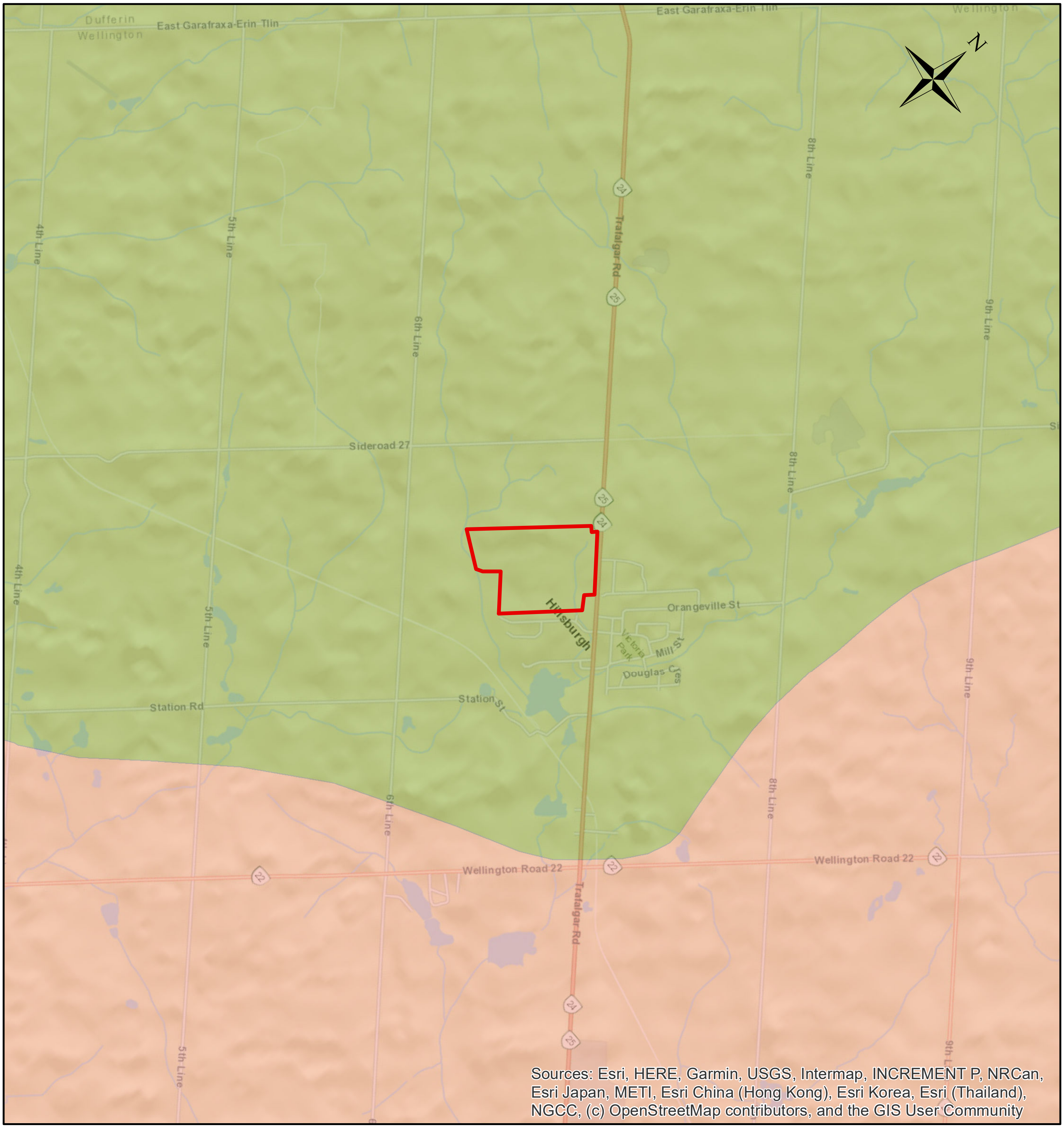
HYDROGEOLOGICAL INVESTIGATION
5916 Trafalgar Road North, Town of Erin, Ontario

Client Hillsburgh Heights Inc.

HLV2K ENGINEERING LIMITED

0 40 80 160 Meters

FIGURE 2



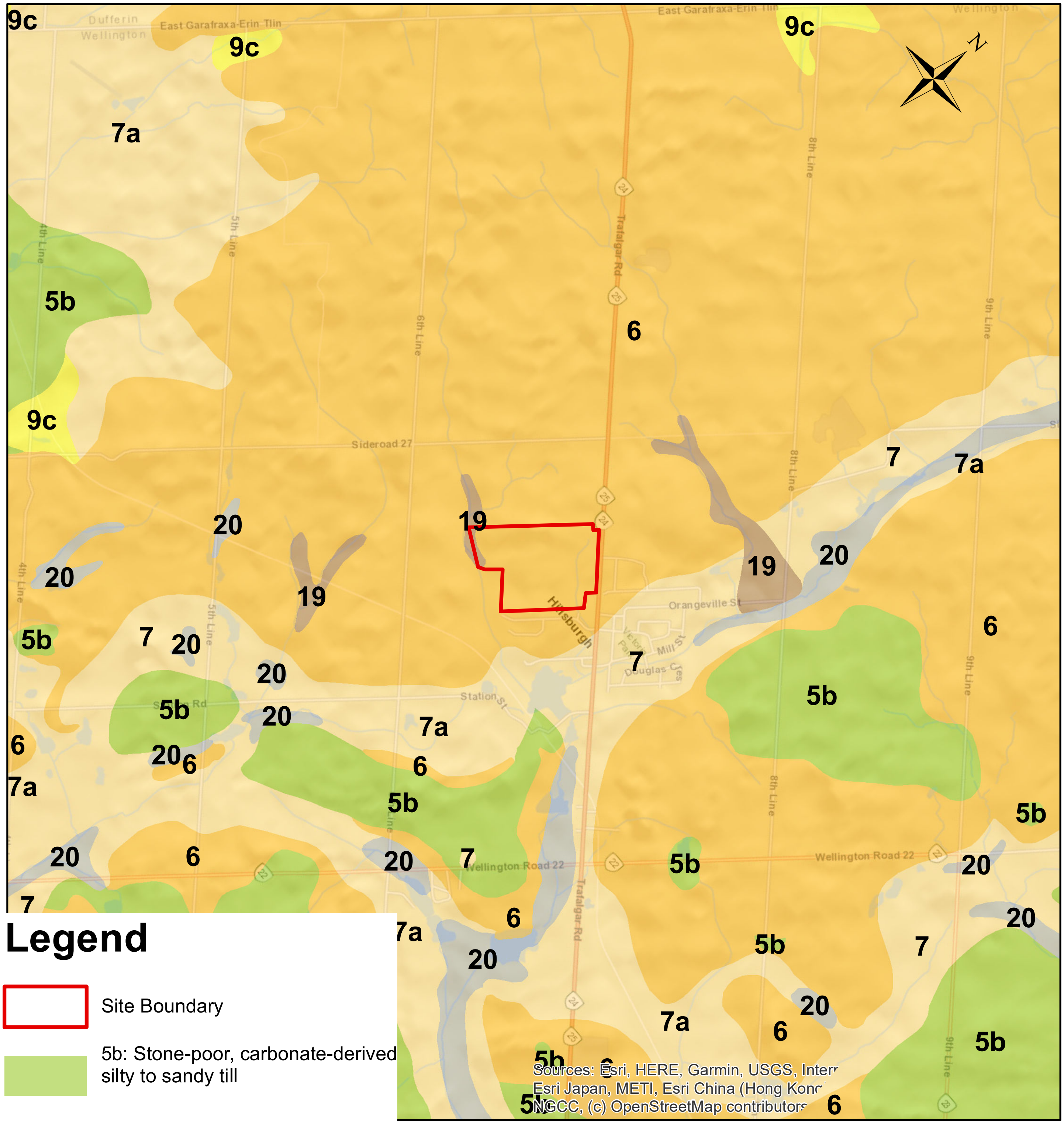
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Legend

- ☐ Site Boundary
- 🟩 9, Hillsburgh Sandhills
- 🟧 11, Guelph Drumlin Field

Drawn: MM	Title PHYSIOGRAPHIC MAP
Approved: KM	Project HYDROGEOLOGICAL INVESTIGATION 5916 Trafalgar Road North, Town of Erin, Ontario
Date: SEP. 2021	
Project No.: 2100428AH	
	Client Hillsburgh Heights Inc.
HLV2K ENGINEERING LIMITED	0 337.5 675 1,350 Meters

FIGURE 3



Sources: Esri, HERE, Garmin, USGS, Interr
Esri Japan, METI, Esri China (Hong Konc
NGCC, (c) OpenStreetMap contributors

Legend

- 🟥 Site Boundary
- 🟩 5b: Stone-poor, carbonate-derived silty to sandy till
- 🟧 6: Ice-contact stratified deposits
- ▨ 7: Glaciofluvial deposits
- ▨ 7a: Sandy deposits
- 🟨 9c: Foreshore-basinal deposits
- 🟫 19: Modern alluvial deposits
- ⬜ 20: Organic deposits

Drawn: MM

Approved: KM

Date: SEP. 2021

Project No.: 2100428AH

Title SURFICIAL GEOLOGY

Project

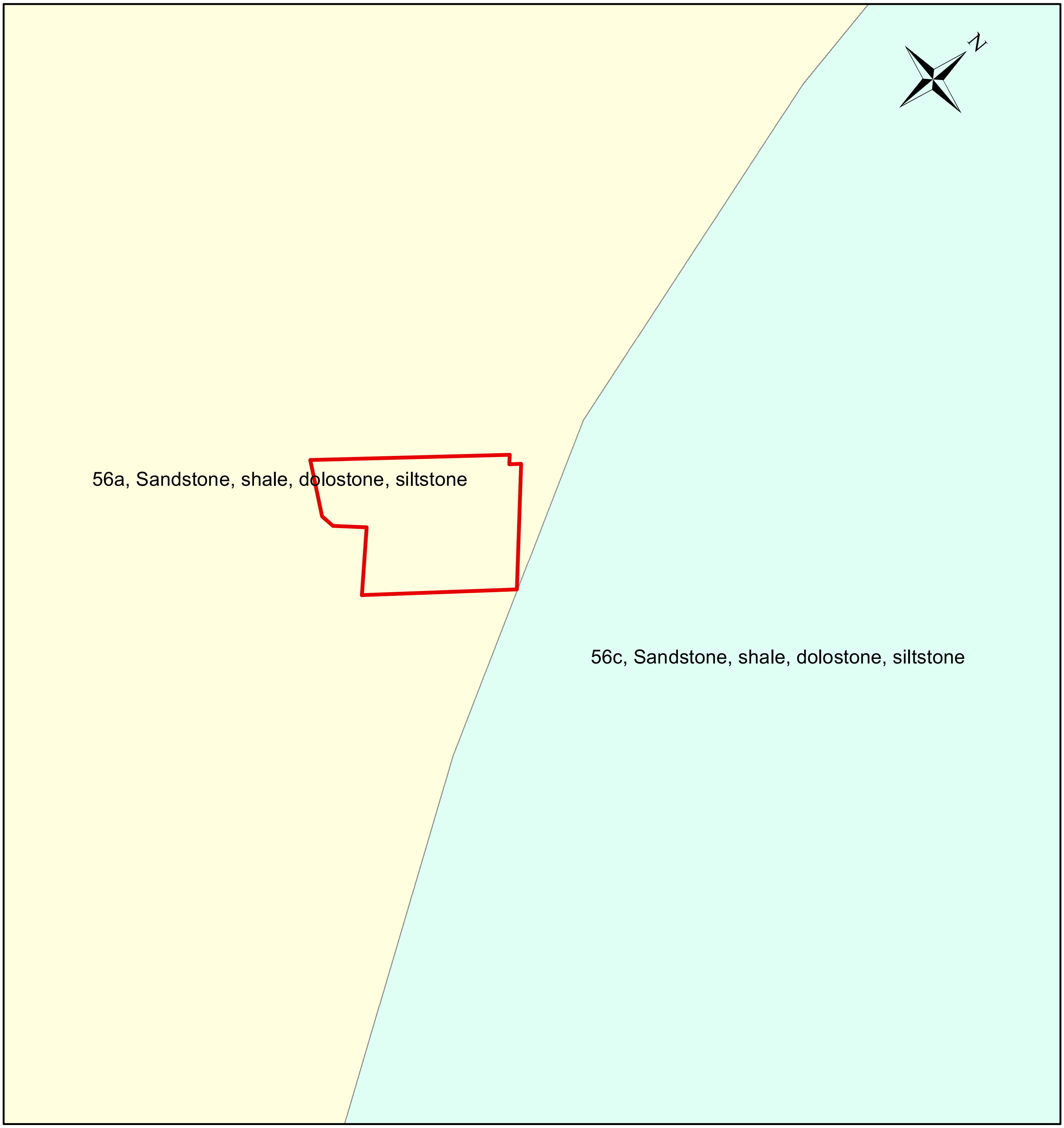
HYDROGEOLOGICAL INVESTIGATION
5916 Trafalgar Road North, Town of Erin, Ontario

Client Hillsburgh Heights Inc.

HLV2K ENGINEERING LIMITED

0 337.5 675 1,350 Meters

FIGURE 4



Legend

🟥 Site Boundary

Bedrock Formation

🟨 56a, Guelph Formation

🟦 56c, Armabel Formation

Drawn: MM

Approved: KM

Date: SEP. 2021

Project No.: 2100428AH

Title BEDROCK GEOLOGY

Project

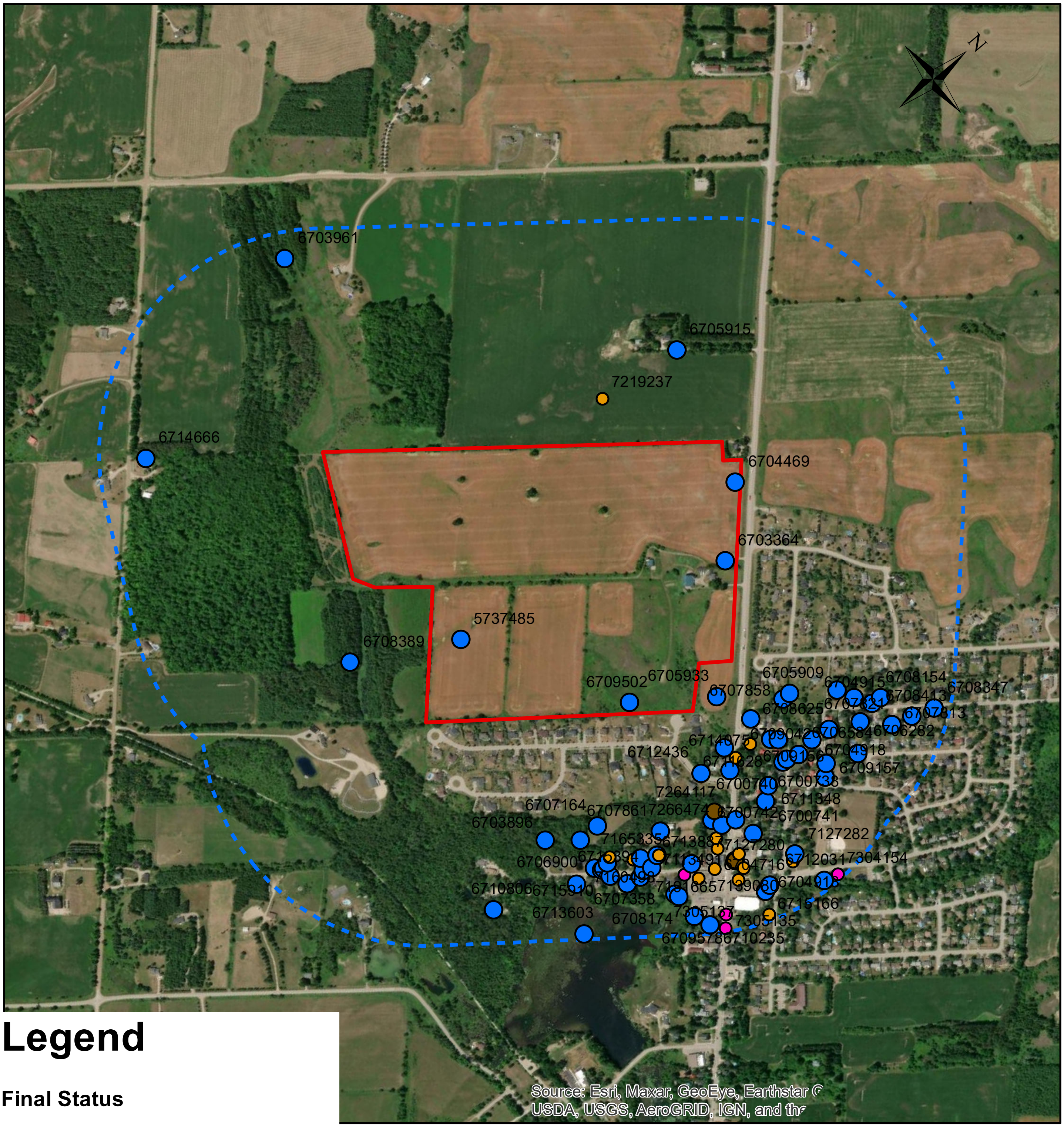
HYDROGEOLOGICAL INVESTIGATION
5916 Trafalgar Road North, Town of Erin, Ontario

Client Hillsburgh Heights Inc.

HLV2K ENGINEERING LIMITED

0 210 420 840 Meters

FIGURE 5



Source: Esri, Maxar, GeoEye, Earthstar G
USDA, USGS, AeroGRID, IGN, and the

Legend

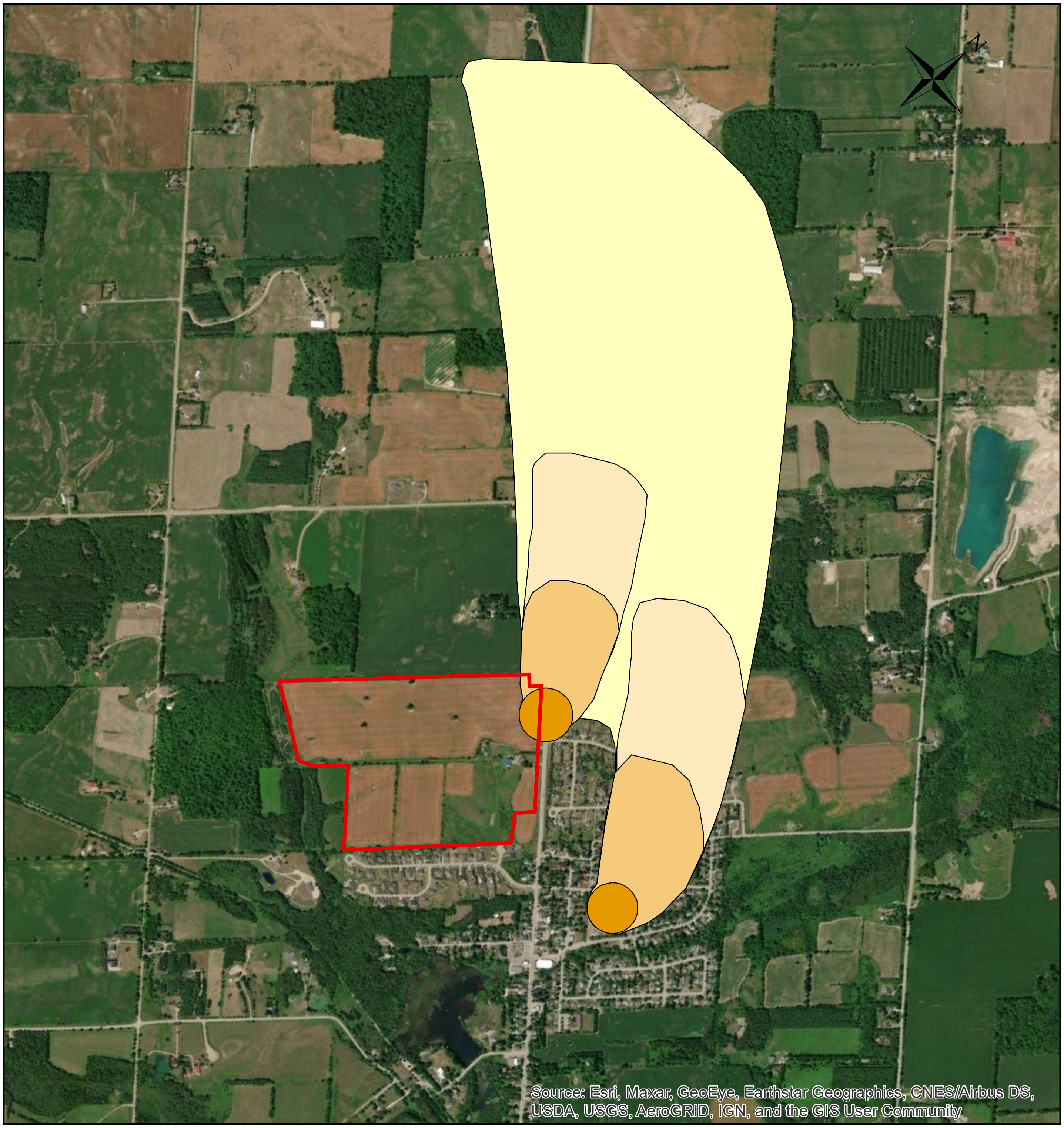
Final Status

●	Abandoned
●	Monitoring and Test Hole
●	Not Stated
●	Water Supply
▭	500m Buffer
▭	Site Boundary

Drawn: MM	Title WATER WELL USE MAP
Approved: KM	Project HYDROGEOLOGICAL INVESTIGATION 5916 Trafalgar Road North, Town of Erin, Ontario
Date: SEP. 2021	
Project No.: 2100428AH	
HLV2K ENGINEERING LIMITED	Client Hillsburgh Heights Inc.

0 105 210 420 Meters

FIGURE 6



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- 🟥 Site Boundary
- 🟧 WHPA-A
- 🟧 WHPA-B
- 🟨 WHPA-C
- 🟨 WHPA-D

Drawn: MM

Approved: KM

Date: NOV. 2021

Project No.: 2100428AH

Title WELLHEAD PROTECTION AREA CLOSE TO SITE

Project

HYDROGEOLOGICAL INVESTIGATION
5916 Trafalgar Road North, Town of Erin, Ontario

Client Hillsburgh Heights Inc.

HLV2K ENGINEERING LIMITED

0 170 340 680 Meters

FIGURE 7

APPENDIX A

BOREHOLE LOGS AND GRAIN SIZE ANALYSIS

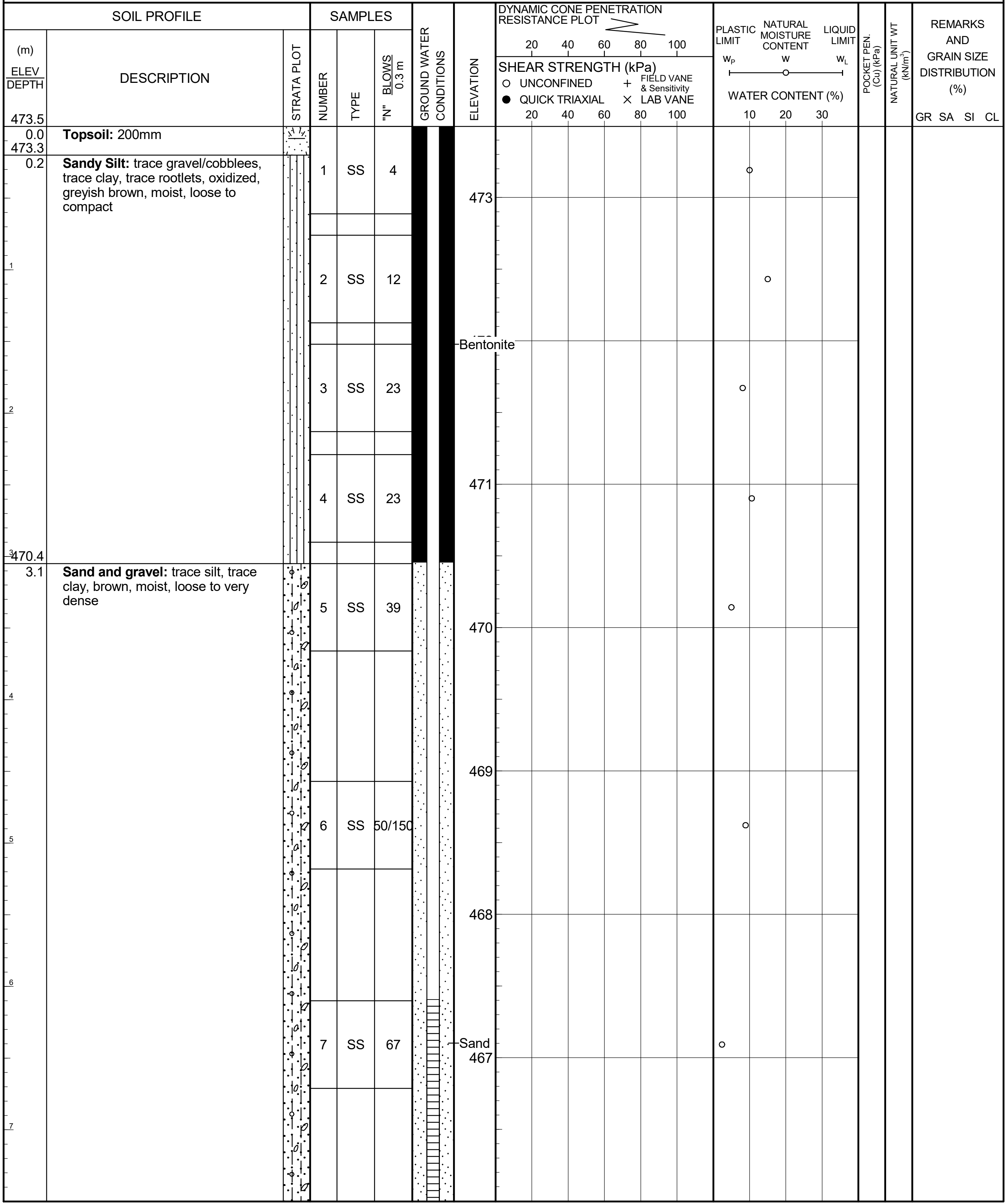
HLV2K ENGINEERING LIMITED

LOG OF BOREHOLE BH1

PROJECT: Briarwood Hillsburgh Development
CLIENT: Briarwood Homes
PROJECT LOCATION: 5916 Trafalgar Road North, Town of Erin, Ontario
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan N 4849474.973 E 568214.5891

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150mm
Date: Sep-07-2021

REF. NO.: 2100428AH
DRAWING NO.: 2



(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS 0.3 m
473.5				
0.0	**Topsoil:** 200mm			
473.3 0.2	**Sandy Silt:** trace gravel/cobblees, trace clay, trace rootlets, oxidized, greyish brown, moist, loose to compact	1	SS	4
		2	SS	12
		3	SS	23
		4	SS	23
470.4 3.1	**Sand and gravel:** trace silt, trace clay, brown, moist, loose to very dense	5	SS	39
		6	SS	50/150
		7	SS	67

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES + 3 , × 3 : Numbers refer to Sensitivity ○ ε=3% Strain at Failure

HLV2K ENGINEERING LIMITED

LOG OF BOREHOLE BH1

PROJECT: Briarwood Hillsburgh Development
CLIENT: Briarwood Homes
PROJECT LOCATION: 5916 Trafalgar Road North, Town of Erin, Ontario
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan N 4849474.973 E 568214.5891

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150mm
Date: Sep-07-2021

REF. NO.: 2100428AH
DRAWING NO.: 2

SOIL PROFILE			SAMPLES									
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Sand and gravel: trace silt, trace clay, brown, moist, loose to very dense(Continued)											
8			8	SS	13	Screen			○			
							465					
9												
			9	SS	6		464		○			
463.7 9.8	**End of Borehole:** borehole terminated at 9.8m 1) 50 mm diameter monitoring well installed upon completion. Upon completion: open & dry											

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

HLV2K ENGINEERING LIMITED

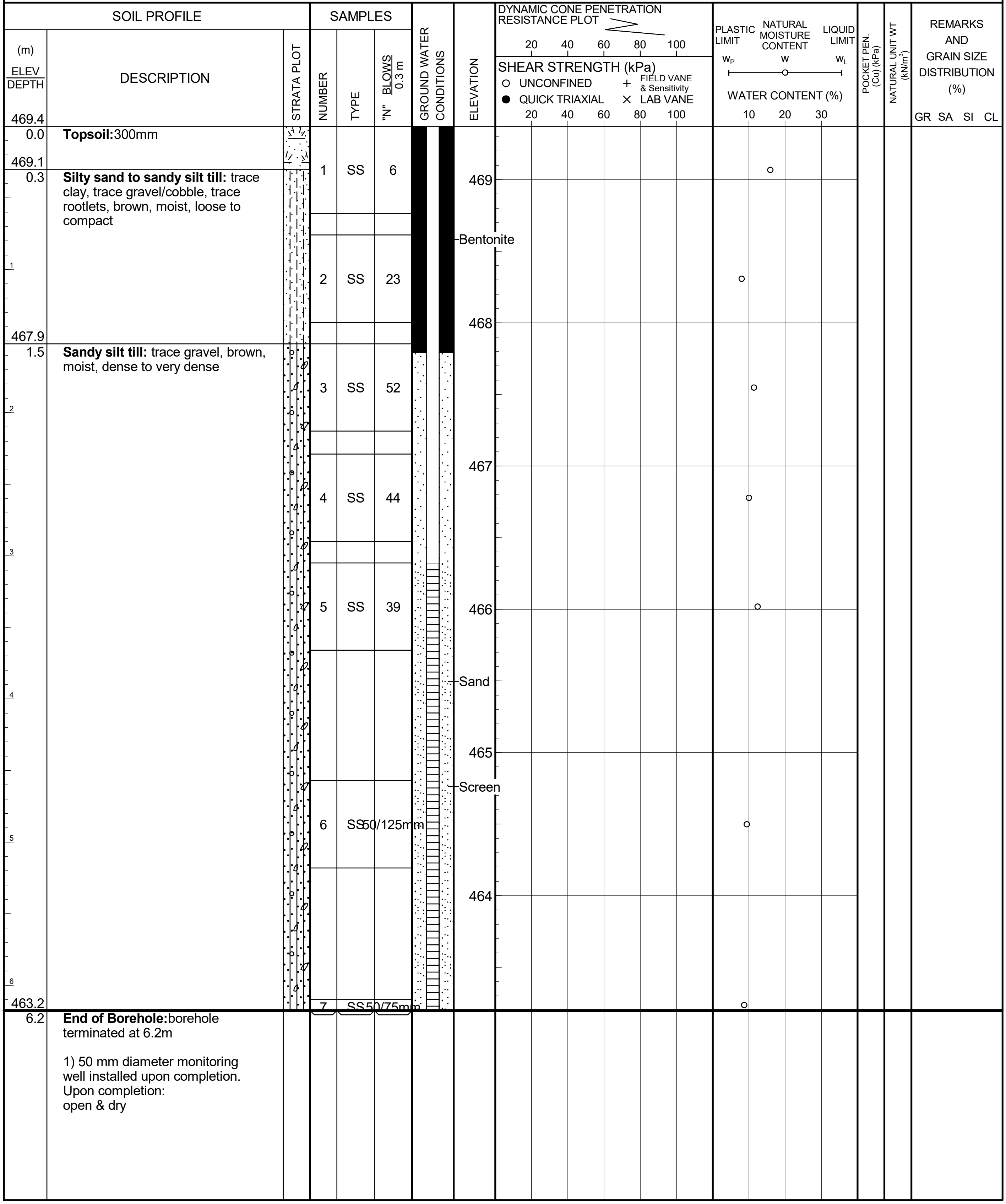
LOG OF BOREHOLE BH2

1 OF 1

PROJECT: Briarwood Hillsburgh Development
CLIENT: Briarwood Homes
PROJECT LOCATION: 5916 Trafalgar Road North, Town of Erin, Ontario
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan N 4849079.566 E 567864.1193

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150mm
Date: Sep-07-2021

REF. NO.: 2100428AH
DRAWING NO.: 3



(m) ELEV DEPTH	DESCRIPTION
469.4	
0.0	**Topsoil:**300mm
469.1 0.3	**Silty sand to sandy silt till:** trace clay, trace gravel/cobble, trace rootlets, brown, moist, loose to compact
467.9 1.5	**Sandy silt till:** trace gravel, brown, moist, dense to very dense
463.2 6.2	**End of Borehole:**borehole terminated at 6.2m 1) 50 mm diameter monitoring well installed upon completion. Upon completion: open & dry

NUMBER	TYPE	"N" BLOWS 0.3 m
1	SS	6
2	SS	23
3	SS	52
4	SS	44
5	SS	39
6	SS	50/125mm
7	SS	50/75mm

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

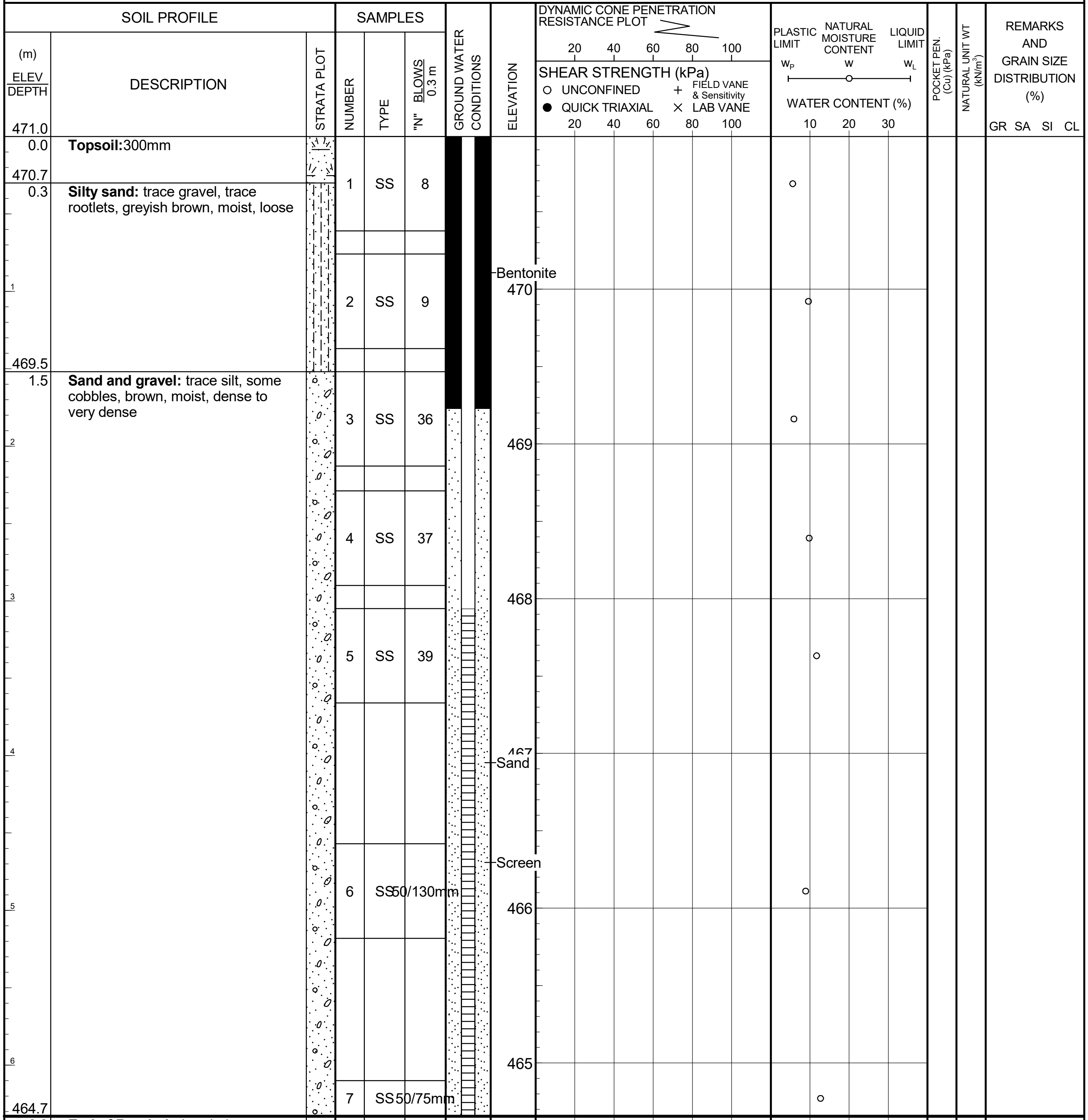
GRAPH NOTES + 3 , × 3 : Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE BH3

PROJECT: Briarwood Hillsburgh Development
CLIENT: Briarwood Homes
PROJECT LOCATION: 5916 Trafalgar Road North, Town of Erin, Ontario
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan N 4849170.944 E 568075.1217

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150mm
Date: Sep-07-2021

REF. NO.: 2100428AH
DRAWING NO.: 4



(m) ELEV DEPTH	DESCRIPTION
471.0	
0.0	**Topsoil:**300mm
470.7 0.3	**Silty sand:** trace gravel, trace rootlets, greyish brown, moist, loose
469.5 1.5	**Sand and gravel:** trace silt, some cobbles, brown, moist, dense to very dense
464.7 6.3	**End of Borehole:**borehole terminated at 6.3m 1) 50 mm diameter monitoring well installed upon completion. Upon completion: open & dry

NUMBER	TYPE	"N" BLOWS / 0.3 m
1	SS	8
2	SS	9
3	SS	36
4	SS	37
5	SS	39
6	SS	50/130mm
7	SS	50/75mm

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3$, $\times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

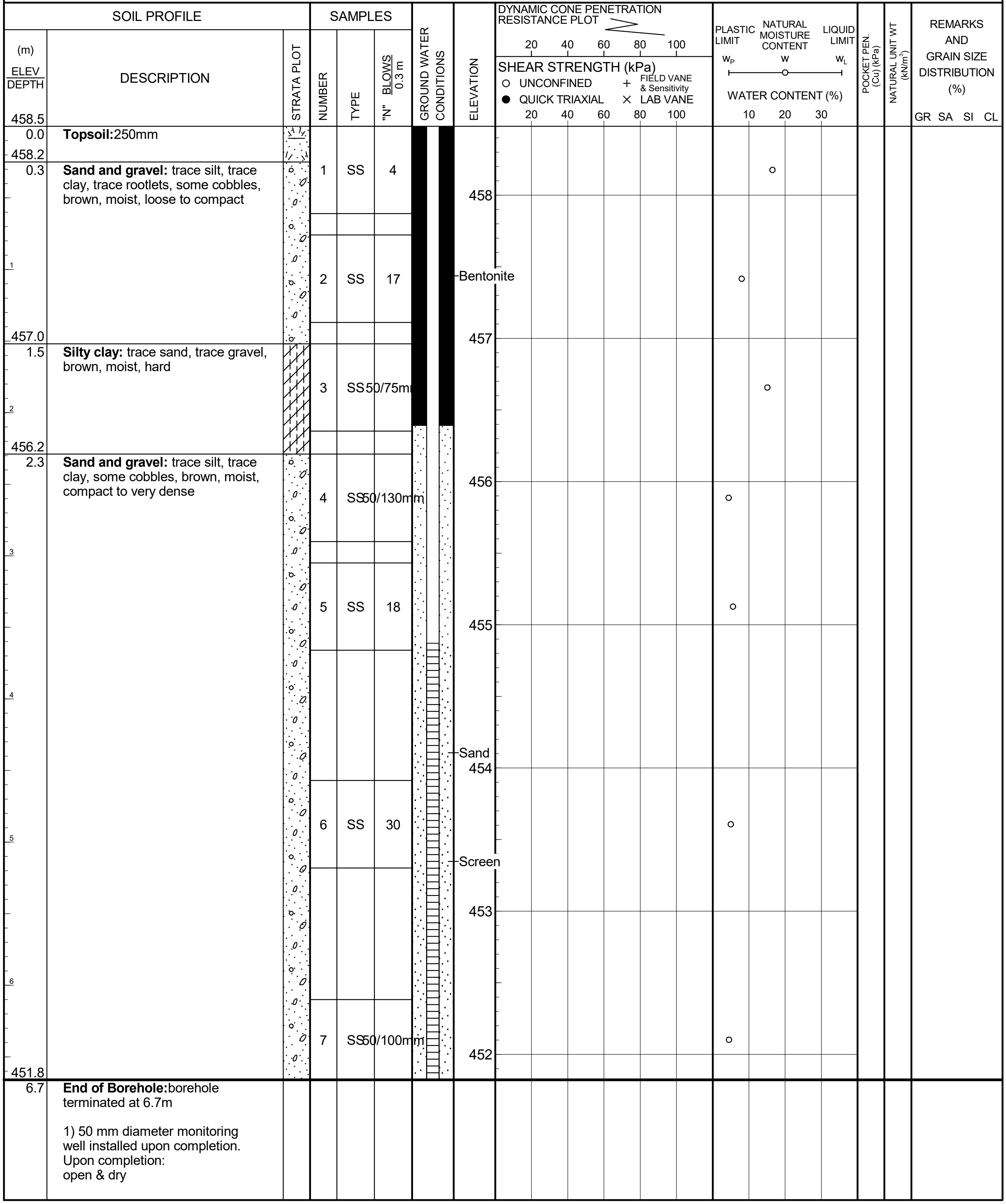
HLV2K ENGINEERING LIMITED

LOG OF BOREHOLE BH4

PROJECT: Briarwood Hillsburgh Development
CLIENT: Briarwood Homes
PROJECT LOCATION: 5916 Trafalgar Road North, Town of Erin, Ontario
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan N 4848881.638 E 568028.4108

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150mm
Date: Sep-07-2021

REF. NO.: 2100428AH
DRAWING NO.: 5



(m) ELEV DEPTH	DESCRIPTION
458.5	
0.0	**Topsoil:**250mm
458.2 0.3	**Sand and gravel:** trace silt, trace clay, trace rootlets, some cobbles, brown, moist, loose to compact
457.0 1.5	**Silty clay:** trace sand, trace gravel, brown, moist, hard
456.2 2.3	**Sand and gravel:** trace silt, trace clay, some cobbles, brown, moist, compact to very dense
451.8 6.7	**End of Borehole:**borehole terminated at 6.7m 1) 50 mm diameter monitoring well installed upon completion. Upon completion: open & dry

NUMBER	TYPE	"N" BLOWS / 0.3 m
1	SS	4
2	SS	17
3	SS	50/75mm
4	SS	50/130mm
5	SS	18
6	SS	30
7	SS	50/100mm

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

HLV2K ENGINEERING LIMITED

LOG OF BOREHOLE BH5

PROJECT: Briarwood Hillsburgh Development
CLIENT: Briarwood Homes
PROJECT LOCATION: 5916 Trafalgar Road North, Town of Erin, Ontario
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan N 4849136.503 E 568418.3089

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150mm
Date: Sep-07-2021

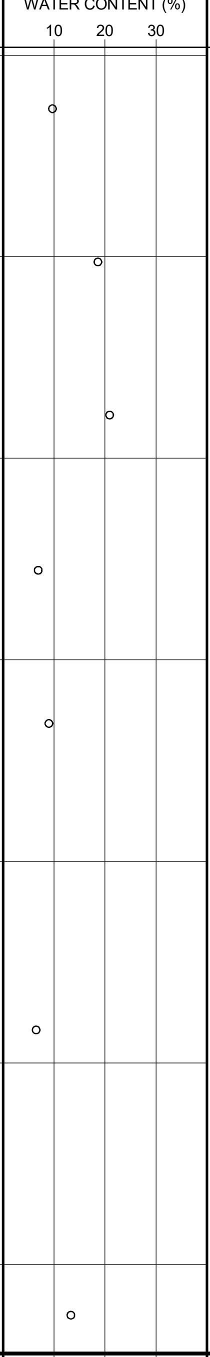
REF. NO.: 2100428AH
DRAWING NO.: 6

(m) ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS 0.3 m	ELEVATION	GROUND WATER CONDITIONS	GR	SA	SI	CL
454.0					454					
0.0	**Topsoil:**250mm									
453.8 0.3	**Silty sand:** trace clay, trace gravel. trace rootlets, brown, moist, loose	1	SS	5						
		2	SS	5	453	Bentonite				
		3	SS	7			7	47	39	7
					452					
451.7 2.3	**Sand:** some gravel, some silt, trace clay, brown, moist, compact to very dense	4	SS	12			15	64	17	4
					451					
		5	SS	50/130mm						
					450	Sand				
		6	SS	69	449	Screen				
					448					
447.6		7	SS	50/75mm						
6.5	**End of Borehole:**borehole terminated at 6.5m 1) 50 mm diameter monitoring well installed upon completion. 2) Water Level Readings: Date: Water Level(mbgl): Sept 07, 2021 4.8									

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH (kPa): ○ UNCONFINED; + FIELD VANE & Sensitivity; ● QUICK TRIAXIAL; × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L



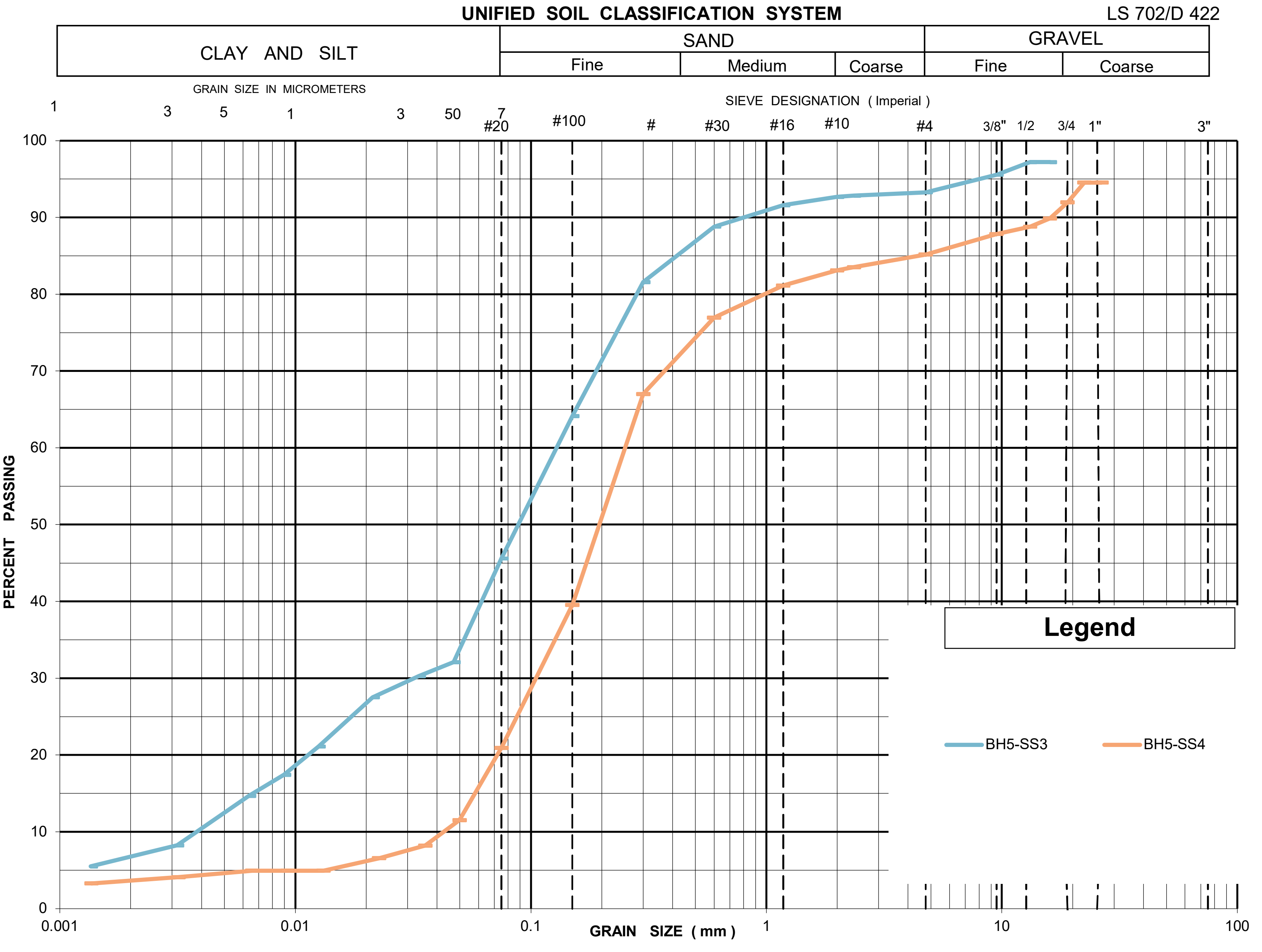
POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m^3)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure



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GRAIN SIZE DISTRIBUTION

Drawing No : 2

PROJECT # : 2100428AH

DATE : Sept 23, 2021

APPENDIX B

INFILTRATION TESTS
FIELD MEASUREMENTS AND CALCULATIONS

Test Hole:	TP4
Tested By:	Bruce Kashani

Date:	07-Sep-21
Weather:	Cloud & windy
Depth to Water (m):	>6.5
Diameter (cm):	15

Project No.:	2100428AH
Depth to bedrock (m): N/A	
Depth (cm):	220

Horizon (m)	Soil Texture	Soil color	Comments
0.0 - 0.25	Topsoil	Brown, black	
0.25 - 2.20	Sandy silt	Brown	

Time (min)	Water Depth (cm)
0	15.00
2	30.00
5	38.00
12	42.00
20	53.00
30	58.00
40	63.00
50	68.00

Δt (min)	Δh (cm)		Inf. Rate (cm/min)	Inf. Rate (mm/hr)	Percolation time (min/cm)	Average (min/cm)
2	15.00		7.5	4500.0		
3	8.00		2.7	1600.0	0.38	
7	4.00		0.6	342.9	1.75	
8	11.00		1.4	825.0	0.73	
10	5.00		0.5	300.0	2.00	
10	5.00		0.5	300.0	2.00	
10	5.00		0.5	300.0	2.00	**2.0**

Test Hole:	TP1
Tested By:	Bruce Kashani

Date:	01-Sep-21
Weather:	Sunny
Depth to Water (m):	>6.5
Diameter (cm):	15

Project No.:	2100428AH
Depth to bedrock (m): N/A	
Depth (cm):	240

Horizon (m)	Soil Texture	Soil color	Comments
0.0 - 0.20	Topsoil	Brown, black	
0.20 - 2.40	Sandy silt to silty sand with gravel and cobbles	Brown	

Time (min)	Water Depth (cm)
0	30.00
2	60.00
5	75.00
10	83.00
20	105.00
30	115.00
40	125.00
50	135.00

Δt (min)	Δh (cm)		Inf. Rate (cm/min)	Inf. Rate (mm/hr)	Percolation time (min/cm)	Average (min/cm)
2	30.00		15.0	9000.0		
3	15.00		5.0	3000.0	0.20	
5	8.00		1.6	960.0	0.63	
10	22.00		2.2	1320.0	0.45	
10	10.00		1.0	600.0	1.00	
10	10.00		1.0	600.0	1.00	
10	10.00		1.0	600.0	1.00	**1.0**

Test Hole:	TP2
Tested By:	Bruce Kashani

Date:	07-Sep-21
Weather:	Cloud & windy
Depth to Water (m):	>6.5
Diameter (cm):	15

Project No.:	2100428AH
Depth to bedrock (m): N/A	
Depth (cm):	240

Horizon (m)	Soil Texture	Soil color	Comments
0.0 - 0.30	Topsoil	Brown, black	
0.30 - 1.50	Silty sand to sandy silt with gravel and cobbles	Brown	
1.50 - 2.40	Sandy silt till	Brown	

Time (min)	Water Depth (cm)
0	30
2	33
6	39
11	45
16	48
21	49
26	50
31	51
36	52

Δt (min)	Δh (cm)		Inf. Rate (cm/min)	Inf. Rate (mm/hr)	Percolation time (min/cm)	Average (min/cm)
2	3.00		1.5	900.0		
4	6.00		1.5	900.0	0.67	
5	6.00		1.2	720.0	0.83	
5	3.00		0.6	360.0	1.67	
5	1.00		0.2	120.0	5.00	
5	1.00		0.2	120.0	5.00	
5	1.00		0.2	120.0	5.00	
5	1.00		0.2	120.0	5.00	**5.0**

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Test Hole:	TP3
Tested By:	Bruce Kashani

Date:	07-Sep-21
Weather:	Cloud & windy
Depth to Water (m):	>6.5
Diameter (cm):	15

Project No.:	2100428AH
Depth to bedrock (m): N/A	
Depth (cm):	185

Horizon (m)	Soil Texture	Soil color	Comments
0.0 - 0.25	Topsoil	Brown, black	
0.25 - 1.50	Sand and gravel	Brown	
1.50 - 2.30	Silty caly	Brown	
1.50 - 1.85	Sand and gravel	Brown	

Time (min)	Water Depth (cm)
0	18
2	36
6	55
9	62
12	68
15	74
18	80
21	86

Δt (min)	Δh (cm)		Inf. Rate (cm/min)	Inf. Rate (mm/hr)	Percolation time (min/cm)	Average (min/cm)
2	18.00		9.0	5400.0		
4	19.00		4.8	2850.0	0.21	
3	7.00		2.3	1400.0	0.43	
3	6.00		2.0	1200.0	0.50	
3	6.00		2.0	1200.0	0.50	
3	6.00		2.0	1200.0	0.50	
3	6.00		2.0	1200.0	0.50	**0.5**

APPENDIX C

INFORMATION ON WATER WELL RECORDS RECEIVED FROM MECP

Water Well Record

WELL_ID	BOREHOLE ID	Easting	Northing	Well Depth (m)	Water Table Depth (m)	Date Completed	Final Status
5737485	10541210	568049	4848857	47.2	31.4	10-Dec-02	Water Supply
6700714	10464860	568613	4849152	33.5	19.8	19-Oct-57	Water Supply
6700738	10464884	568722	4849243	45.7	10.4	16-Feb-65	Water Supply
6700740	10464886	568722	4849233	42.7	12.2	04-Aug-58	Water Supply
6700741	10464887	568764	4849146	25.9	4.3	20-May-60	Water Supply
6700742	10464888	568801	4849079	29.9	6.1	21-Mar-61	Water Supply
6703364	10467506	568294	4849423	68.6	25.9	05-Feb-69	Water Supply
6703528	10467665	568634	4848703	54.9	7.6	05-Aug-69	Water Supply
6703896	10468025	568514	4848713	50.3	8.5	01-Apr-71	Water Supply
6703961	10468086	567144	4849103	41.8	15.2	14-Jun-71	Water Supply
6704469	10468577	568174	4849553	88.4	42.1	22-Sep-72	Water Supply
6704716	10468823	568914	4849033	45.7	2.4	11-May-73	Water Supply
6704913	10469017	568918	4849017	74.7	4.6	25-Oct-73	Water Supply
6704915	10469019	568749	4849470	47.2	13.7	20-Sep-73	Water Supply
6704918	10469022	568725	4849314	27.7	9.8	18-Sep-73	Water Supply
6705909	10469993	568614	4849343	46.6	9.8	08-Jul-75	Water Supply
6705915	10469999	567864	4849643	68.0	35.1	05-Jun-75	Water Supply
6705933	10470017	568514	4849213	35.1	12.5	30-May-75	Water Supply
6706282	10470362	568764	4849423	27.4	12.8	16-Oct-76	Water Supply
6706584	10470660	568814	4849373	53.0	0.9	20-May-77	Water Supply
6706900	10470970	568564	4848773	60.0	7.6	29-Apr-78	Water Supply
6707164	10471227	568564	4848823	29.0	6.4	09-Jan-79	Water Supply
6707358	10471410	568714	4848823	32.9	3.7	18-Apr-80	Water Supply
6707813	10471818	568814	4849473	32.0	12.2	29-Apr-83	Water Supply
6707821	10471826	568814	4849473	20.4	12.8	08-Jun-83	Water Supply
6707858	10471859	568614	4849323	36.6	14.9	06-Jul-83	Water Supply
6707861	10471862	568664	4848923	36.6	2.4	12-May-83	Water Supply
6708154	10472069	568752	4849492	19.2	12.2	29-Jun-84	Water Supply
6708174	10472089	568803	4848861	22.9	2.1	18-Apr-84	Water Supply
6708346	10472255	568642	4848787	35.4	4.3	24-Jul-85	Water Supply
6708347	10472256	568847	4849569	33.5	12.2	04-Dec-85	Water Supply
6708360	10472268	568714	4849447	33.5	14.3	18-Dec-85	Water Supply
6708365	10472273	568793	4848858	34.1	3.0	24-Dec-85	Water Supply
6708389	10472295	567929	4848635	41.1	6.4	09-May-85	Water Supply
6708413	10472319	568828	4849519	33.5	10.7	07-Apr-86	Water Supply
6708616	10472508	568719	4849027	29.6	8.8	01-Dec-86	Water Supply
6708625	10472517	568732	4849358	23.5	10.7	11-Aug-86	Water Supply
6708826	10472716	568676	4849428	15.2	6.7	13-Apr-87	Water Supply
6709042	10472915	568731	4849270	48.2	12.2	10-Dec-87	Water Supply
6709050	10472923	568646	4848767	57.0	5.5	30-Nov-87	Water Supply
6709156	10473026	568808	4849283	51.8	7.6	12-Jan-88	Water Supply
6709157	10473027	568786	4849305	30.2	7.6	09-Dec-87	Water Supply
6709502	10473351	568399	4849055	15.2	5.5	20-Dec-88	Water Supply
6709578	10473427	568859	4848859	49.7	7.0	15-Dec-88	Water Supply
6710235	10474082	568896	4848874	32.0	2.7	27-Jul-89	Water Supply
6710806	10474647	568559	4848525	25.6	3.0	24-Jul-91	Water Supply
6710809	10474650	568682	4848850	34.1	6.7	24-May-91	Water Supply
6711075	10474916	568765	4848930	57.0	4.3	30-Oct-92	Water Supply
6711348	10475182	568741	4849173	48.8	12.2	19-Oct-93	Water Supply
6711628	10475461	568665	4849244	44.2	16.8	27-Oct-94	Water Supply
6712031	10475864	568983	4849133	57.9	1.8	01-May-96	Water Supply
6712436	10476269	568623	4849076	39.6	9.8	30-Jul-97	Water Supply
6713318	10477151	568660	4849130	49.4	8.5	26-Jan-00	Water Supply
6713603	10477436	568730	4848645	29.6	3.0	22-Nov-00	Water Supply
6713631	10477464	568677	4849256	51.8	15.2	09-Jan-01	Water Supply
6713887	10523019	568753	4849068	29.0	8.5	04-Oct-01	Water Supply
6713900	10523032	568707	4848838	38.1	4.3	25-Oct-01	Water Supply
6714075	10528610	568602	4849240	38.4	17.4	18-Jun-02	Water Supply
6714666	10548217	567286	4848578	72.5	34.1	09-Oct-03	Water Supply
6715166	11179802	568963	4848990			10-Dec-04	Abandoned
6715250	11327036	568800	4848921	4.3		10-Feb-05	Abandoned
6715394	11327180	568714	4848856	30.5	5.2	04-Jul-05	Water Supply
6715503	11327289	568674	4848836			02-Sep-05	Abandoned
6715772	11558293	568669	4848773	30.5	6.1	15-Jun-06	Water Supply
6715910	11695692	568647	4848772	30.5	7.0	06-Sep-06	Water Supply
7050905	23050905	568707	4848791	30.5	5.2	01-Oct-07	Water Supply
7105350	1001599370	568636	4848799			05-May-08	Abandoned
7113491	1001839380	568822	4849009	27.7	3.4	07-May-08	Water Supply
7118031	1001955780	568633	4848757	44.8	7.0	25-Sep-08	Water Supply
7127280	1002637730	568907	4849107			02-Jun-09	Abandoned
7127282	1002637730	568897	4849121	25.0	2.7	09-Jun-09	Water Supply

Water Well Record

WELL_ID	BOREHOLE ID	Easting	Northing	Well Depth (m)	Water Table Depth (m)	Date Completed	Final Status
7139080	1002932280	568847	4849013			14-Aug-08	Abandoned
7139081	1002932280	568822	4849009			14-Aug-09	Not Stated
7160498	1003486390	568701	4848883	18.3	3.7	23-Feb-11	Water Supply
7165335	1003534010	568704	4848886			13-Jun-11	Abandoned
7174984	1003633140	568777	4848996			12-Nov-11	Abandoned
7191665	1004205580	568807	4848962			25-Sep-12	Abandoned
7194971	1004232460	568816	4849025			06-Nov-12	Abandoned
7197600	1004256250	568757	4849009			20-Dec-12	Abandoned
7201338	1004288380	568860	4848987			25-Apr-13	Abandoned
7201342	1004288390	568787	4848856			25-Apr-13	Abandoned
7219237	1004731810	567841	4849446			15-Sep-13	Abandoned
7249486	1005717520	568647	4849158			02-Sep-15	Abandoned
7264117	1006030530	568708	4849044			29-May-16	Not Stated
7266474	1006141900	568742	4849038	23.5	6.4	11-Apr-16	Water Supply
7278147	1006322440	568644	4849203			21-Dec-16	Abandoned
7304154	1006975720	568993	4849166	7.6		03-Nov-17	Monitoring and Test Hole
7305135	1006981980	568902	4848916	4.6		29-Nov-17	Monitoring and Test Hole
7305136	1006981980	568773	4848902	5.5		24-Nov-17	Monitoring and Test Hole
7305137	1006981980	568924	4848896	4.6		24-Nov-17	Monitoring and Test Hole

APPENDIX D

WATER BALANCE TABLES

TABLE B.1 - Climate Data

Fergus Shand Dam Station, Ontario

Latitude: 43°44' N Longitude: 80°19' W Elevation: 417.6 m

Temperature: Temperature:	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Daily Average (°C)	-7.4	-6.3	-1.9	5.7	12.2	17.5	20.0	19.0	14.9	8.3	2.1	-3.9	6.7
Rainfall (mm)	27.8	25.3	36.7	67.9	86.8	83.8	89.2	96.6	93.1	75.6	80.5	34.7	798
Snowfall (mm)	40.1	30.6	22.9	6.2	0.1	0.0	0.0	0.0	0.0	1.6	12.5	33.9	147.9
Precipitation (mm)	67.9	55.9	59.6	74.1	86.9	83.8	89.2	96.6	93.1	77.2	93.0	68.6	945.9

TABLE B.2

Pre- and Post-Development Water Balance Components
Based on Thornthwaite's Soil Moisture Balance Approach

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Davily Average Temperature (^{o}C)	-7	-6	-2	6	12	18	20	19	15	8	2	-4	7
Heat index: i = $(t/5)^{1.514}$	0.00	0.00	0.00	1.22	3.86	6.66	8.16	7.55	5.22	2.15	0.27	0.00	**35.1**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	26.65	59.36	86.76	99.85	94.61	73.26	39.58	9.32	0.00	**489**
Adjusting Factor K for U (Latitude 43^{o} 44' N)	0.77	0.87	0.99	1.11	1.23	1.29	1.27	1.17	1.05	0.92	0.80	0.74	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	30	73	112	127	111	77	36	7	0	**573**
PRE-DEVELOPMENT WATER BALANCE	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	68	56	60	74	87	84	89	97	93	77	93	69	946
Potential Evapotranspiration (PET)	0	0	0	30	73	112	127	111	77	36	7	0	573
P - PET	68	56	60	44	14	-28	-37	-14	16	41	86	69	373
Change in Soil Moisture Storage	0	0	0	0	0	-28	-37	-14	16	41	23	0	**0**
Soil Moisture Storage (Assume January Soil Moisture Storage = 100% SMS)	250	250	250	250	250	222	184	170	186	227	250	250	
Actual Evapotranspiration (AET)	0	0	0	30	73	112	127	111	77	36	7	0	573
Soil Moisture Deficit (in mm)	0	0	0	0	0	28	66	80	64	23	0	0	
Surplus - available for infiltration or runoff	68	56	60	44	14	0	0	0	0	0	63	69	**373**
Potential Infiltration (based on MOE metholodogy*; independent of temperature)	34.0	28.0	29.8	22.2	6.9	0.0	0.0	0.0	0.0	0.0	31.4	34.3	187
Potential Surface Water Runoff (independent of temperature)	34.0	28.0	29.8	22.2	6.9	0.0	0.0	0.0	0.0	0.0	31.4	34.3	187
POST- DEVELOPMENT WATER BALANCE ON IMPERVIOUS AREAS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	68	56	60	74	87	84	89	97	93	77	93	69	946
Potential Evaporation (PE) from impervious areas (assume 20%)	13.6	11.2	11.9	14.8	17.4	16.8	17.8	19.3	18.6	15.4	18.6	13.7	189
P-PE (surplus available from impervious areas)	54	45	48	59	70	67	71	77	74	62	74	55	757
Water surplus change compared to pre-condition (for areas that change from vegetated open areas to impervious areas)	-14	-11	-12	15	56	67	71	77	74	62	12	-14	384

Soil Moisture Storage	250
PE from impervious areas %	20

*MOE SWM infiltration factor calculation	
topography - Rolling land (approximately 2.8 to 3.8m/km)	0.2
soils - relatively tight silty clay till materials	0.2
cover - predominantly cultivated land	0.1
Infiltration Factor	0.5

TABLE B.3 - Annual Pre-Construction Water Balance

	Pre-Construction		
	Unpaved Areas	Impervious Areas (building)	Totals
Area	403000	1000	404000
Pervious Area	403000	0	403000
Impervious Area	0	1000	1000
Infiltration Factors			
Topography Infiltration Factor	0.2	0.15	
Soil Infiltration Factor	0.2	0.1	
Land Cover Infiltration Factor	0.1	0	
MOE Infiltration Factor	0.5	0.25	
Actual Infiltration Factor	0.5	0	
Runoff Coefficient Pervious Surfaces	0.5	1	
Runoff from Impervious Surfaces*	0	0.8	
Inputs (per Unit Area)			
Precipitation (mm/yr)	946	946	946
Run-On (mm/yr)	0	0	0
Other Inputs (mm/yr)	0	0	0
Total Inputs (mm/yr)	946	946	946
Outputs (per Unit Area)			
Precipitation Surplus (mm/yr)	373	757	374
Net Surplus (mm/yr)	373	757	374
Evapotranspiration (mm/yr)	573	189	572
Infiltration (mm/yr)	187	0	186
Rooftop Infiltration (mm/yr)	0	0	0
Total Infiltration (mm/yr)	187	0	186
Runoff Pervious Areas	187	0	186
Runoff Impervious Areas	0	757	2
Total Runoff (mm/yr)	187	757	188
Total Outputs (mm/yr)	946	946	946
Difference (Inputs - Outputs)	0	0	
Inputs (Volumes)			
Precipitation (m3/yr)	381198	946	382144
Run-On (m3/yr)	0	0	0
Other Inputs (m3/yr)	0	0	0
Total Inputs (m3/yr)	381198	945.9	382144
Outputs (Volumes)			
Precipitation Surplus (m3/yr)	150360	757	151117
Net Surplus (m3/yr)	150360	757	151117
Evapotranspiration (m3/yr)	230838	189	231027
Infiltration (m3/yr)	75180	0	75180
Rooftop Infiltration (m3/yr)	0	0	0
Total Infiltration (m3/yr)	75180	0	**75180**
Runoff Pervious Area (m3/yr)	75180	0	75180
Runoff Impervious Areas (m3/yr)	0	757	757
Total Runoff (m3/yr)	75180	757	**75937**
Total Outputs (m3/yr)	381198	946	382144
Difference (Inputs - Outputs)	0	0	0

* Evaporation from impervious areas was assumed to be 20% of precipitation

TABLE B.4 - WATER BALANCE COMPONENTS FOR CASE WHERE RUNOFF IS DIRECTED TO PERVIOUS AREAS

POTENTIAL EVAPOTRANSPIRATION CALCULATION	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (° C)	-7.4	-6.3	-1.9	5.7	12.2	17.5	20.0	19.0	14.9	8.3	2.1	-3.9	6.7
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.22	3.86	6.66	8.16	7.55	5.22	2.15	0.27	0.00	**35.1**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	26.65	59.36	86.76	99.85	94.61	73.26	39.58	9.32	0.00	**489**
Adjusting Factor K for U (Latitude 43° 44' N)	0.77	0.87	0.99	1.11	1.23	1.29	1.27	1.17	1.05	0.92	0.80	0.74	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	30	73	112	127	111	77	36	7	0	**573**
POST-DEVELOPMENT WATER BALANCE	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Pervious areas will receive rainfall plus some runoff from impervious areas, so the following balance calculations use this total water supply to assess potential infiltration.													
Precipitation (P)	68	56	60	74	87	84	89	97	93	77	93	69	946
Potential Evaporation (PE) from impervious areas (assume 20% of P)	14	11	12	15	17	17	18	19	19	15	19	14	189
P-PE (surplus available for runoff from impervious areas)	54	45	48	59	70	67	71	77	74	62	74	55	**757**
WAT (Total water supply to pervious areas = rain plus impervious area runoff)	122	101	107	133	156	151	161	174	168	139	167	123	**1703**
Potential Evapotranspiration from pervious areas (PET)	0	0	0	30	73	112	127	111	77	36	7	0	**573**
WAT - PET	122	101	107	104	83	39	34	63	91	103	160	123	**1130**
Change in Soil Moisture (mm)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Soil Moisture Storage (mm)*	125	125	125	125	125	125	125	125	125	125	125	125	
Actual Evapotranspiration (AET)	0	0	0	30	73	112	127	111	77	36	7	0	**573**
Total surplus - available for infiltration or runoff on pervious areas	122	101	107	104	83	39	34	63	91	103	160	123	**1130**
Estimate of I and R (based on MOE infiltration factor)*													
Potential Infiltration* (based on soil conditions; independent of temperature)	55.0	45.3	48.3	46.6	37.5	17.5	15.3	28.3	40.9	46.2	72.0	55.6	**508**
Potential Surface Water Runoff (independent of temperature)	67.2	55.3	59.0	57.0	45.9	21.4	18.7	34.6	50.0	56.4	87.9	67.9	**621**
Estimate of I and R (based on MOE Factors and CA Guideline assumption of a 10% reduction in infiltration reduction related to soil compaction)													
Potential Infiltration (based on soil conditions; independent of temperature)	49.5	40.8	43.4	42.0	33.8	15.7	13.8	25.5	36.8	41.6	64.8	50.0	**458**
Potential Surface Water Runoff (independent of temperature)	72.7	59.9	63.8	61.7	49.6	23.1	20.2	37.5	54.1	61.0	95.1	73.5	**672**

Max SMS	125
PE from impervious areas %	20

*MOE SWM infiltration factor calculation	
topography - flat to rolling	0.2
soils - tight sandy to clayey silt till	0.2
cover - predominantly impervious paved surface	0.05
Infiltration Factor	0.45

TABLE B.5 - Annual Post-Construction Water Balance without LID

	Unpaved Areas	Impervious Areas (Paved/Buildings)	Water (Pond)	Totals
Area	138260	237640	28100	404000
Pervious Area	138260	0	0	138260
Impervious Area	0	237640	28100	265740
Infiltration Factors				
Topography Infiltration Factor	0.2	0	0	
Soil Infiltration Factor	0.2	0	0	
Land Cover Infiltration Factor	0.05	0	0	
MOE Infiltration Factor	0.45	0	0	
Actual Infiltration Factor	0.55	0	0	
Runoff Coefficient Pervious Surfaces	0.45	1	1	
Runoff from Impervious Surfaces*	0	0.8	0.8	
Inputs (per Unit Area)				
Precipitation (mm/yr)	946	946	946	946
Run-On (mm/yr)	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0
Total Inputs (mm/yr)	946	946	946	946
Outputs (per Unit Area)				
Precipitation Surplus (mm/yr)	373	757	757	625
Net Surplus (mm/yr)	373	757	757	625
Evapotranspiration (mm/yr)	573	189	189	320
Infiltration (mm/yr)	205	0	0	70
Rooftop Infiltration (mm/yr)	0	0	0	0
Total Infiltration (mm/yr)	205	0	0	70
Runoff Pervious Areas	168	0	0	57
Runoff Impervious Areas	0	757	757	498
Total Runoff (mm/yr)	168	757	757	555
Total Outputs (mm/yr)	946	946	946	946
Difference (Inputs - Outputs)	0	0	0	
Inputs (Volumes)				
Precipitation (m3/yr)	130780	224784	26580	382144
Run-On (m3/yr)	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0
Total Inputs (m3/yr)	130780	224784	26580	382144
Outputs (Volumes)				
Precipitation Surplus (m3/yr)	51585	179827	21264	252676
Net Surplus (m3/yr)	51585	179827	21264	252676
Evapotranspiration (m3/yr)	79195	44957	5316	129468
Infiltration (m3/yr)	28372	0	0	28372
Rooftop Infiltration (m3/yr)	0	0	0	0
Total Infiltration (m3/yr)	28372	0	0	**28372**
Runoff Pervious Area (m3/yr)	23213	0	0	23213
Runoff Impervious Areas (m3/yr)	0	179827	21264	201091
Total Runoff (m3/yr)	23213	179827	21264	**224304**
Total Outputs (m3/yr)	130780	224784	26580	382144
Difference (Inputs - Outputs)	0	0	0	0

* Evaporation from impervious areas was assumed to be 20% of precipitation

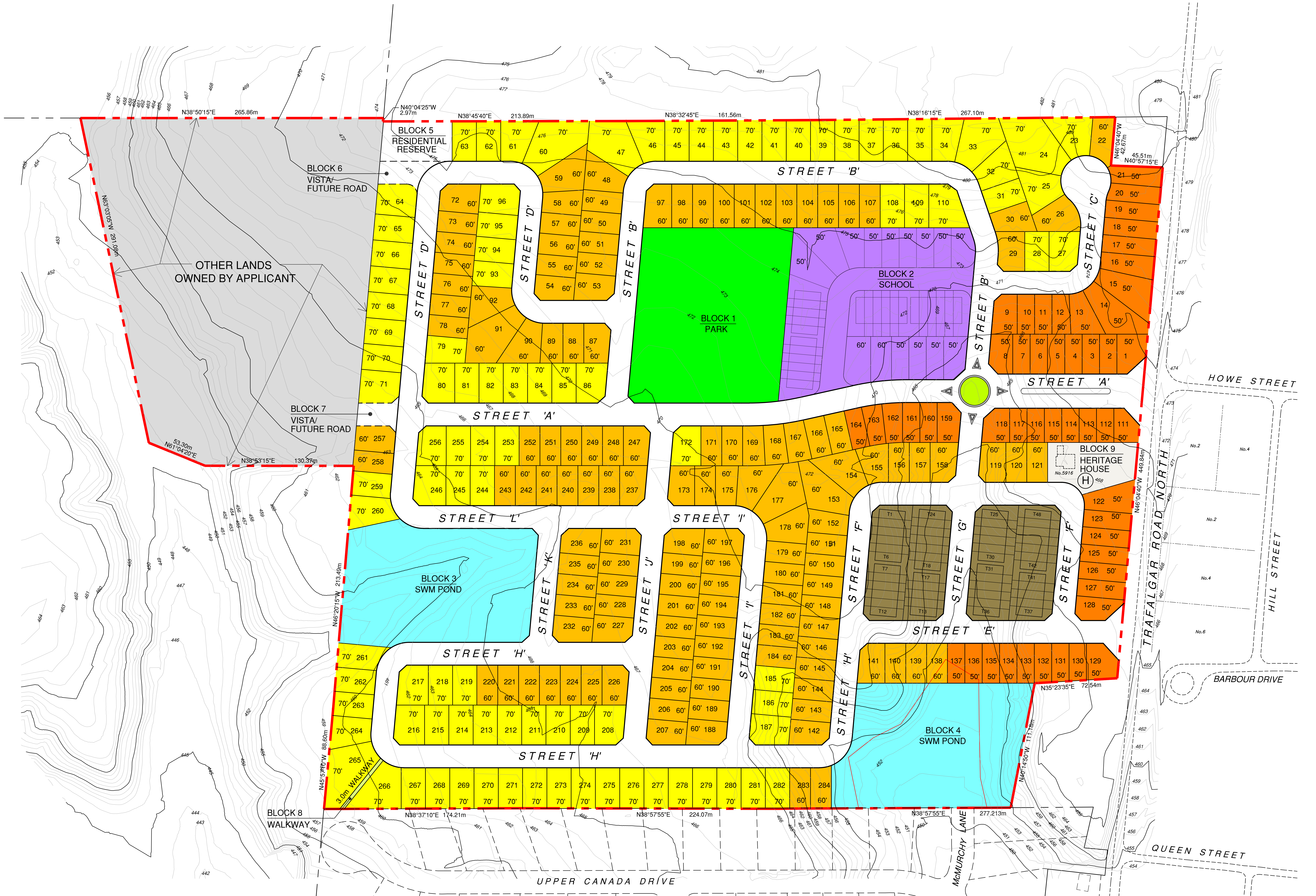
TABLE B.6 - Annual Post-Construction Water Balance with LID

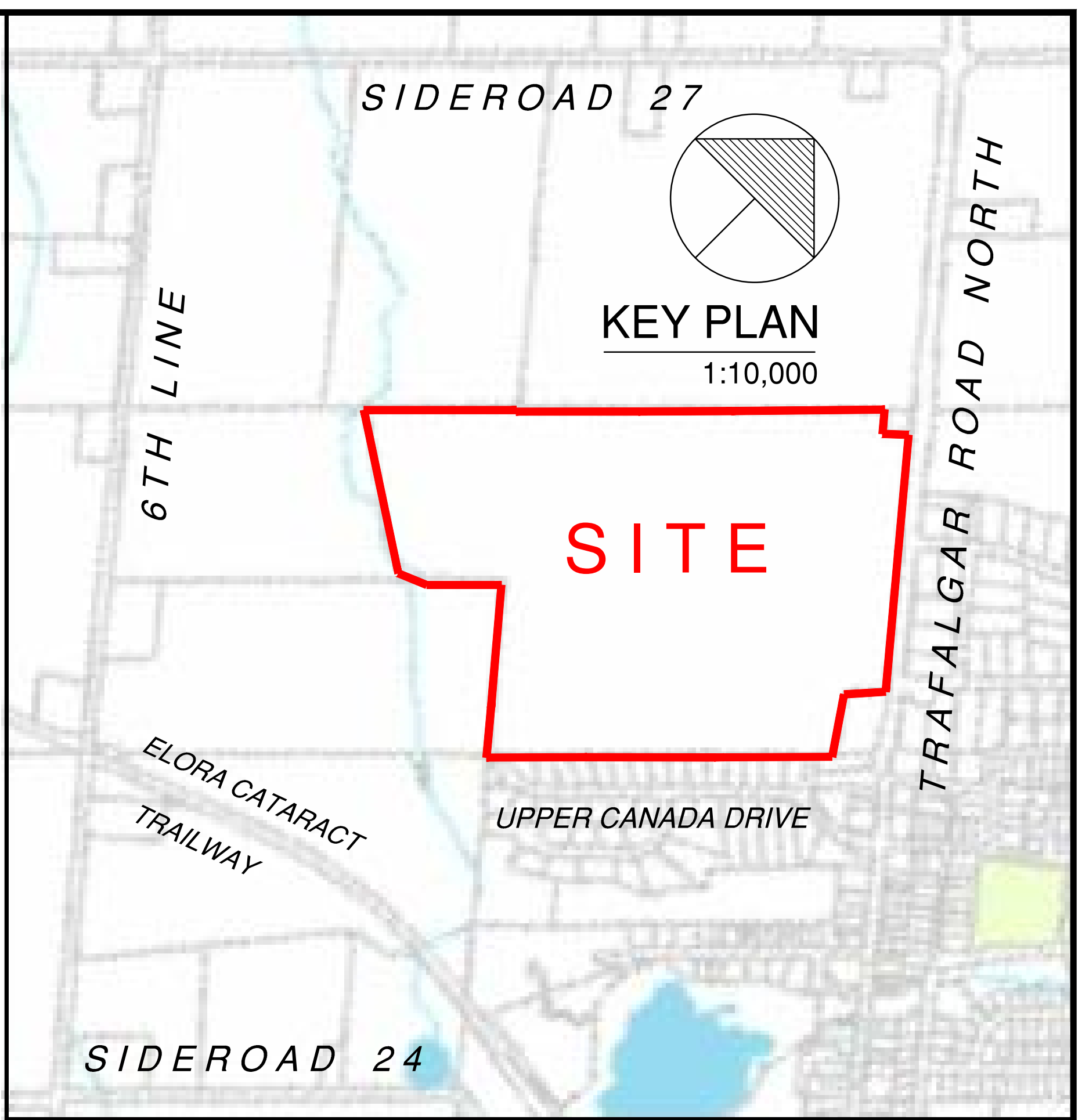
	Unpaved Areas (Landscape)	Impervious Areas (Roads/Buildings)	LID (Infiltration Trenches)	Water	Totals
Area	74270	101700	199930	28100	404000
Pervious Area	74270	0	0	0	74270
Impervious Area	0	101700	199930	28100	329730
Infiltration Factors					
Topography Infiltration Factor	0.2	0	0	0	
Soil Infiltration Factor	0.2	0	0	0	
Land Cover Infiltration Factor	0.05	0	0	0	
MOE Infiltration Factor	0.45	0	0	0	
Actual Infiltration Factor	0.55	0	0	0	
Runoff Coeffcient Pervious Surfaces	0.45	1	1	1	
Runoff from Impervious Surfaces*	0	0.8	0.8	0.8	
Inputs (per Unit Area)					
Perecipitation (mm/yr)	946	946	946	946	946
Run-On (mm/yr)	0	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0	0
Total Inputs (mm/yr)	946	946	946	946	946
Outputs (per Unit Area)					
Precipitation Surplus (mm/yr)	373	757	757	757	686
Net Surplus (mm/yr)	373	757	757	757	686
Evapotranspiration (mm/yr)	573	189	189	189	260
Infiltration (mm/yr)	205	0	0	0	38
LID (mm/yr)	0	0	306	0	152
Total Infiltration (mm/yr)	205	0	306	0	189
Runoff Pervious Areas	168	0	0	0	31
Runoff Impervious Areas	0	757	450	757	466
Total Runoff (mm/yr)	168	757	450	757	497
Total Outputs (mm/yr)	946	946	946	946	946
Difference (Inputs - Outputs)	0	0	0		
Inputs (Volumes)					
Precipitation (m3/yr)	70252	96198	189114	26580	382144
Run-On (m3/yr)	0	0	0	0	0
Other Inputs (m3/yr)	0	0	0	0	0
Total Inputs (m3/yr)	70252	96198	189114	26580	382144
Outputs (Volumes)					
Precipitation Surplus (m3/yr)	27710	76958	151291	21264	277224
Net Surplus (m3/yr)	27710	76958	151291	21264	277224
Evapotranspiration (m3/yr)	42542	19240	37823	5316	104920
Infiltration (m3/yr)	15241	0	0	0	15241
Rooftop Infiltration/Other LID (m3/yr)	0	0	61273	0	61273
Total Infiltration (m3/yr)	15241	0	61273	0	**76514**
Runoff Pervious Area (m3/yr)	12470	0	0	0	12470
Runoff Impervious Areas (m3/yr)	0	76958	90018	21264	188240
Total Runoff (m3/yr)	12470	76958	90018	21264	**200709**
Total Outputs (m3/yr)	70252	96198	189113	26579	382143
Difference (Inputs - Outputs)	0	0	0	0	1

* Evaporation from impervious areas was assumed to be 20% of precipitation

APPENDIX E

DRAWINGS PROVIDED BY THE CLIENT





LOT SCHEDULE

DESCRIPTION	TYPE	MINIMUM FRONTAGE	MINIMUM DEPTH	NUMBER OF LOTS	NUMBER OF UNITS
SINGLE DETACHED	50'	15.2m (50.0')	35.0m (114.8')	51	51
SINGLE DETACHED	60'	18.3m (60.0')	35.0m (114.8')	137	137
SINGLE DETACHED	70'	21.3m (70.0')	35.0m (114.8')	96	96
TOWNHOUSE	T	7.5m (24.6')	35.0m (114.8')	-	48
TOTAL				284	332

LAND USE	BLOCK / LOT	AREA
RESIDENTIAL	LOTS 1-284	22.25 ha. (54.99 Ac.)
PARK	BLOCK 1	2.03 ha. (5.01 Ac.)
SCHOOL	BLOCK 2	2.23 ha. (5.51 Ac.)
SWM POND	BLOCKS 3-4	3.41 ha. (8.43 Ac.)
RESIDENTIAL RESERVE	BLOCK 5	0.22 ha. (0.55 Ac.)
VISTA / FUTURE ROAD	STREETS 6-7	0.16 ha. (0.40 Ac.)
ROADS	STREETS A-L	9.79 ha. (24.18 Ac.)
WALKWAY	BLOCK 8	0.01 ha. (0.02 Ac.)
HERITAGE HOUSE	BLOCK 9	0.30 ha. (0.74 Ac.)
TOTAL		40.40 ha. (99.83Ac.)

NOTE:

1. R.O.W. RADII AT INTERSECTIONS:
17.0m TO 17.0m = 5.0m
17.0m TO 20.0m = 5.0m
20.0m TO 20.0m = 5.0m
20.0m TO 23.0m = 10.0m
23.0m TO 23.0m = 10.0m
23.0m TO 26.0m = 15.0m (DAYLIGHT TRIANGLE)
26.0m TO 36.0m = 15.0m (DAYLIGHT TRIANGLE)

2. MINIMUM RADII AT CENTRELINES:
17.0m R.O.W. R = 14.0m
20.0m R.O.W. R = 74.0m
23.0m R.O.W. R = 145.0m

REVISIONS

NO.	DESCRIPTION	DATE	BY
△			
△			
△			
△			

ADDITIONAL INFORMATION

AS REQUIRED UNDER SECTION 51(17) OF THE PLANNING ACT (R.S.O. 1990 C.P. 13)

A) AS SHOWN ON DRAFT PLAN.
B) AS SHOWN ON DRAFT AND KEY PLAN.
C) AS SHOWN ON KEY PLANS.
D) AS SHOWN IN LAND USE SCHEDULE.
E) AS SHOWN ON DRAFT PLAN.
F) AS SHOWN ON DRAFT PLAN.
G) AS SHOWN ON DRAFT AND KEY PLANS.
H) MUNICIPAL SERVICES TO BE PROVIDED.
I) SOIL IS CLAYEY SILT.
J) AS SHOWN ON DRAFT PLAN.
K) MUNICIPAL SERVICES TO BE PROVIDED.
L) NONE.

OWNER'S AUTHORIZATION:

THE UNDERSIGNED, BEING THE OWNER OF THE SUBJECT LANDS HEREBY AUTHORIZE CANDEVCON LIMITED TO ACT ON OUR BEHALF AS AGENTS AND TO PREPARE AND SUBMIT A DRAFT PLAN OF SUBDIVISION FOR APPROVAL.

DATE

HILLSBURGH HEIGHTS INC.
(BRIARWOOD DEVELOPMENTS GROUP)

SURVEYOR'S CERTIFICATE:

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LAND TO BE SUBDIVIDED AND THEIR RELATIONSHIP TO THE ADJOINING PROPERTIES ARE CORRECTLY SHOWN ON THIS PLAN

DATE

SIGNATORY
ONTARIO LAND SURVEYORS
COMAPNY
ADDRESS
WEBSITE TELEPHONE

DRAFT PLAN OF SUBDIVISION

5916 TRAFALGAR ROAD NORTH
(PLAN 61R-9590)
PART OF LOT 26, CONCESSION 7
TOWN OF ERIN
COUNTY OF WELLINGTON

CANDEVCON LIMITED
CONSULTING ENGINEERS AND PLANNERS

TEL. (905) 794-0600
FAX (905) 794-0611

SCALE: 1:1500
0m 15 30 45 60

DWG. No. PL-1

DATE: NOV., 12th 2021

PROJECT No. W21051