Hydrogeological Assessment Report – Part of Lot 19, Concession 19 – Township of Galway-Cavendish and Harvey, County of Peterborough

December 19, 2024

Prepared for:
Jeffery Homes

Revision 2

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1.0 Introduction

Cambium Inc. (Cambium) was retained by Jeffery Homes (Client) to complete a hydrogeological assessment in support of the proposed residential development at 168 County Road 49, Bobcaygeon, Ontario, legally known as Part of Lot 19, Concession 19, Township of Galway-Cavendish and Harvey, County of Peterborough (Site).

The purpose of the hydrogeological assessment was to characterize the soil and groundwater conditions at the Site, assess the pre- and post development water balance, discuss the need for groundwater control during the construction process, assess any impacts on the surrounding natural environment due to the proposed development, and evaluate and provide conclusions and recommendations for the proposed development. The proposed development will be privately serviced for water supply and wastewater disposal. It is understood that a detailed wastewater assessment and water supply assessment, per Guideline D-5-4 and D-5-5, respectively were completed by Jp2g Consultants Inc. in 2021 (see Section 1.3).

1.1 Scope of Work

This hydrogeological assessment was conducted to address the peer review comments on the previous hydrogeological investigation report (described below) with the following tasks:

- **Review of available background information**: a review of available geological and hydrogeological information for the Site and surrounding areas was conducted to provide background information to allow for characterization of the Site's soil and groundwater conditions.
- **Water level monitoring:** groundwater levels were measured in the existing monitoring wells to establish and/or confirm the general groundwater flow condition and to assess the fluctuations in groundwater elevations.
- **In-situ hydraulic conductivity tests:** single well response tests were conducted on the monitoring wells to estimate the hydraulic conductivity of underlying soils and/or bedrock, and to assess the potential dewatering requirements.

- **Instillation of drive-point piezometers:** drive-point piezometers were installed within the wetland to evaluate the relationship between the wetland and the shallow groundwater table.
- **Dewatering and impact assessment**: an assessment of short-term construction dewatering and long-term sub-drain drainage if applicable for the residential units as well as an assessment of the potential impacts on the surrounding groundwater system.
- **Water balance (preliminary):** a preliminary water balance assessment was completed for the proposed development using the Thornthwaite-Mather approach and Environment Canada climate data to determine the potential change in groundwater recharge between pre- and post-development conditions.
- **Nitrate mass balance:** based on the water balance assessment results, an assessment of nitrate dilution to occur under post development conditions was completed.
- **Source water impact assessment:** as the Site is situated within a Highly Vulnerable Aquifer (HVA) area, a Source Water Protection assessment was completed to detail threats to groundwater in terms of water quality and quantity.

1.2 Site Description and Site Development

The property consists of approximately 48.15 ha of undeveloped land, except for a dwelling and associated structures in the westernmost area bordering County Road 49. An unevaluated wetland and wetland buffer and an intermittent watercourse occupying about 9.80 ha, are present, leaving about 38.35 ha as the developable area.

The Site is bordered by existing houses on Ellwood Crescent to the south, mixed farmland and natural vegetation to the north, mixed natural vegetation and residential land to the east on Moon Line Road North, and County Road 49 to the west. There is Site access off County Road 49 and Moon Line North.

Cambium understands the proposed development includes the construction of 59 estate lots, with 25 lots planned for Phase 1 of development and 34 lots planned for Phase 2

(Appendix A). Although the Client is proposing a phased development, this report has been completed for the entire Site.

The regional location of the Site is outlined on Figure 1, the property and surrounding areas are outlined on Figure 2, and the proposed development plan is included in Appendix A.

1.3 Past Investigation and Peer Review Comments

There were several comments made by the Township's peer reviewer regarding the previous Hydrogeological Investigation and Terrain Analysis report for the Site prepared by Jp2g, dated October 2021. Cambium was retained to address the following comments made by Stantec Consulting Ltd and produce a supplemental hydrogeological assessment report.

1. The high groundwater table and shallow groundwater flow direction needs to be defined using a shallow groundwater monitoring well network assist with the following:
    a. setting basement elevations
    b. assessing the suitability of various infiltration deficit mitigation measures
    c. the placement of supply wells and sewage system envelopes on each lot (i.e., what direction(s) is groundwater flowing to assist with the placement of this infrastructure)
    d. assessing the relationship between the shallow groundwater table and the wetland (i.e., does the wetland depend on shallow groundwater inputs to maintain its form and function)
    e. septic system design (i.e., will the raised beds be required because of a shallow groundwater table or low permeability soils).
    f. assessing the need for construction dewatering
2. The function of the wetland needs to be evaluated to determine if the wetland is a groundwater recharge or discharge feature.
3. A pre- and post-development water balance must be completed to assess the infiltration deficit and identify appropriate mitigation measures to maintain pre-development infiltration rates.

4. The report needs to comment on whether the Site is situated within a Source Protection Vulnerable Area and if there are any Source Protection Policies that may impact the proposed development.

This supplemental hydrogeological report addresses the above comments, except the spring high water table conditions to define the spring high water table conditions at the Site.

A feature-based water balance is planned to be completed to evaluate the developmental impacts on the wetland feature concurrently with the Phase II detailed design and application. This approach was reviewed and agreed upon with the Kawartha Conservation Authority in a meeting held on December 2, 2024. Cambium will complete a long-term water level monitoring at the Site as part of feature-based water balance.

2.0 Environmental Features

To assess environmental features, databases maintained by the Ministry of Natural Resources and Forestry (MNRF), the Ministry of the Environment, Conservation and Parks (MECP), and Kawartha Region Conservation Authority (KRCA) were reviewed.

According to the data reviewed, the Site is situated within the Kawartha-Haliburton Source Protection Area and the majority of Site is located within the Pigeon Lake-Gannon Narrows watershed. A portion of the Site to the west is located within the Bobcaygeon River watershed (Ministry of the Environment, Conservation and Parks, 2024).

The Site is within KRCA regulated area per O.Reg. 41/24 and therefore development restriction do apply to the proposed development.

As per the MECP Source Water Protection Information Atlas, the Site is situated within a Highly Vulnerable Aquifer (HVA) area with a vulnerability score of 6.

As per the MNRF Natural Heritage System database, the Site does not have any Areas of Environmental Significance or Areas of Natural and Scientific Interests. The Site contains a mapped unevaluated wetland, woodland areas, as well as a Natural Heritage System area (Ministry of Natural Resources and Forestry, 2024). The type of natural heritage area is identified as Undifferentiated Enabling Plan Growth Plan for the Greater Golden Horseshoe.

3.0 Physical Setting

3.1 Topography and Drainage

Based on the topographic contours provided in the topographic map (Appendix A) created using the MNRF database, the Site has a topographic high in the north-west corner of the property at approximately 305 metres above sea level (masl). From this high, land slopes to the southeast to an elevation of just above 284 masl near the south-east property boundary. There are many rolling hills with low lying areas around the existing residence in southwest corner of Site, a wetland in the centre of the Site, and overland drainage / an intermittent watercourse in the northeast corner.

The local drainage for the Site is assumed to follow the topography, discharging southeast off-site and ultimately discharging into Pigeon Lake approximately 1.3 km east of Site.

3.2 Physiography

According to the Miscellaneous Release – Data 228 from the Ontario Geological Survey (Chapman & Putnam, 1984), the Site is located within the Dummer Moraines physiographic region.

The Dummer Moraine consists of rough stony land with an area of approximately 1550 square kilometres. The bedrock of the Dummer Moraines consists of limestone thinly covered in till and slopes gently southward. Moraines are scattered throughout the region.

3.3 Overburden Geology

According to Data Set 126 – Revised from the Ontario Geological Survey (2010), the Site overburden is characterized as stoney, sandy silt to silty sand-textured till. A bedrock-drift complex with till cover is in the eastern portion of the Site.

3.4 Bedrock Geology

According to Miscellaneous Release – Data 219 from the Ontario Geological Survey (2007), the bedrock of the Site consists of Middle Ordovician rocks from the Simcoe Group. The

Simcoe Group consists of four formations that dip gently towards the southwest from oldest to youngest and consist of the Gull River, Bobcaygeon, Verulam, and the Lindsay Formations. The bedrock of the Site consists of two Simcoe Group formations. Western portion of the Site consists of the Verulam Formation, which is described as limestone and shale. The eastern portion of the Site consists of the Bobcaygeon Formation described as limestone, with minor shales in the upper part of the formation.

4.0 Borehole Drilling and Monitoring Well Instillation

4.1 Borehole Investigation

Cambium completed a borehole investigation and test pit investigation on October 25 to October 27, 2023, to assess subsurface conditions at the Site. A total of 14 boreholes, designated as BH101-23 to BH114-23, were advanced to a termination depth ranging from 2.44 to 4.98 mbgs for geotechnical and hydrogeological purposes. Four boreholes, BH101-23, BH108-23, BH109-23, and BH113-23 were equipped as monitoring wells to allow for the assessment of groundwater levels and elevations over time. Borehole and monitoring well locations are included in Figure 2, and borehole logs are included in Appendix B.

A summary of general lithological details is presented below.

Topsoil

Brown silt and sand topsoil was encountered in all boreholes, ranging from 0.075 to 0.250 m in thickness, with an average thickness of approximately 0.150 m.

Clayey Silt

Brown clayey silt, with some sand and trace gravel, and occasional cobbles, was encountered immediately below the topsoil in boreholes BH101-23 and BH102-23. Trace amounts of organics were found within the clayey silt soil in BH102-23. The clayey silt material extended to depths 0.70 and 1.45 mbgs, respectively. The clayey silt soil was generally found to be drier than the plastic limit at the time of investigation. Standard penetration test (SPT) blow counts within the clayey silt provide evidence of generally soft to stiff relative consistencies.

Till

Brown to light brown to grey till soil with a relatively even mixture of sand, gravel, and silt, and some cobbles, was encountered immediately below the topsoil in all boreholes, except BH101 -23 and BH102-23, where it was encountered immediately below the clayey silt soils. The till extended to termination depth in all boreholes. The till was generally found to be moist at the time of investigation, with BH101-23 exhibiting moist-to-wet to wet soils and BH104-23

exhibiting moist-to-wet soils beginning at 2.3 mbgs. SPT blow counts within the till provide evidence of generally compact to very dense relative densities throughout the entire soil column.

Bedrock

Presumed bedrock was encountered at depths of 3.12, 2.44, 3.35, and 3.66 mbgs, in BH101-23, BH102-23, BH111-23, and BH114-23, respectively. All other boreholes were terminated in native soils at depths from 4.60 to 4.98 mbgs.

Monitoring wells construction details including screen elevations are presented in the Table 1.

Table 1 Well Construction Details

Monitoring Well	Borehole Termination Depth (mbgs)	Monitoring Well Installation Depth (mbgs)	Ground Elevation (masl)	Screen Top (masl)	Screen Bottom (masl)
BH101-23	3.12	3.1	292.72	291.2	289.6
BH108-23	4.72	4.6	287.88	284.8	283.3
BH109-23	4.85	4.6	290.31	287.3	285.7
BH113-23	4.60	4.6	301.62	298.6	297.0

4.2 Physical Laboratory Testing

Physical laboratory testing was completed for a total of seven selected soil samples to confirm textural classification and to estimate percolation rates of the native soils. Results are presented in Appendix C and details of the grain-size analysis are presented in Table 2 below.

Table 2 Particle Size Distribution

Borehole	Depth (mbgs)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	T-Time (min/cm)
BH101-23 SS4	2.3 – 2.9	Silty Gravel and Sand	34	34	25	7	20
BH102-23 SS2	0.8 – 1.4	Clayey Silt, some Sand	7	16	50	27	45
BH105-23 SS3	1.5 – 2.1	Sandy Silty Gravel some Clay	39	28	23	10	30
BH108-23 SS3	1.5 – 2.1	Gravelly Silty Sand	32	41	20	7	20
BH109-23 SS4	2.3 – 2.9	Gravelly Silty Sand	33	35	23	9	25
BH112-23 SS3	1.5 – 2.1	Sandy Silty Gravel some Clay	34	29	26	11	30

As per the data above, the percolation (T) times ranged from 45 to 20 min/cm for the soils ranging in depth from as shallow as 0.8 mbgs to as deep as 2.9 mbgs. The geometric average percolation time was about 27.2 min/cm. This indicates a moderate drainage and infiltration potential for the overburden soils at the Site.

4.3 Piezometer Installation

Cambium staff installed one drive point piezometer (DP101-23) within the wetland feature at the Site on November 10, 2023. Piezometer construction details, including screen elevations, are presented in Table 3. Location of the piezometer DP101-23 is depicted on Figure 3. The elevation of DP101-23 is approximate and is based on Lidar topographic data at the location.

Table 3 Piezometer Construction Details

Piezometer	Piezometer Installation Depth (mbgs)	Approximate Ground Elevation (masl)	Approximate Screen Top (masl)	Approximate Screen Bottom (masl)
DP101-23	1.61	289.72	288.41	288.11

4.4 Groundwater Level Monitoring

On November 10, 2023, Cambium staff measured the depths to groundwater in the four new monitoring wells. A summary of groundwater elevations is presented in Table 4.

Table 4 Measured Groundwater Details – November 10, 2023

Well	BH101-23	BH108-23	BH109-23	BH113-23
Top of Pipe Elevation (masl)	293.63	288.79	291.15	302.51
Ground Surface Elevation (masl)	292.72	287.88	290.31	301.62
Stick-up (m)	0.91	0.91	0.84	0.89
Water Level (mbgs)	0.33	dry	dry	3.85
Groundwater Elevation (masl)	292.39	<283.3	<285.7	297.77

As presented above, the manual measured groundwater levels in the monitoring wells ranged in depth from 0.33 to 3.85 mbgs, while the elevations ranged from 292.39 to 297.77 masl. Accordingly, the highest fall groundwater level and elevation could be 0.33 mbgs and 292.39 masl, respectively. Of note, monitoring wells BH108-23 and BH109-23, both were installed to a depth of 4.6 mbgs were dry on November 10, 2023.

4.5 Piezometer Water Level

The measured water level in piezometer DP101-23 is included in Table 5. Piezometer was installed to a depth of 1.61 m below the bottom of the wetland. The surface water level at DP101-23 was 0.23 metres above the bottom of the wetland, with an approximate surface water elevation of 289.95 masl. The height of stick-up above the water surface was 0.60 m. The manual measured groundwater level in the piezometer was 2.11 metres below top of pipe (mbtop) at an elevation of 288.44 masl.

Table 5 Measured Piezometer Water Level – November 10, 2023

Well	DP101-23
Top of Pipe Elevation (masl)	290.55
Wetland Bottom Elevation (masl)	289.72
Stick-up (m above wetland bottom)	0.83
Water Level (mbtop)	2.11
Groundwater Elevation (masl)	288.44

Note. Elevations are approximate and based off mapped Lidar topographic contours at the location of DP101-23

4.6 Groundwater Flow Direction

4.6.1 Horizontal Gradient

Based on the groundwater elevation data obtained from the November 10, 2023, monitoring event, a site-specific groundwater elevation contour map was prepared to present the groundwater flow direction across the Site (Figure 4). This map was prepared using water level elevations obtained from the western monitoring wells and the drive-point piezometer from the centre of the Site. As the eastern monitoring wells are dry to the installed depth of 4.6 mbgs, groundwater contours are interpreted to be at lower elevations in this area.

As shown in Figure 4, the groundwater flow direction was found to be to the east-southeast, where it is interpreted to ultimately discharge into Pigeon Lake located 1.3 km east of the Site.

4.6.2 Vertical Gradient

Wetland surface water elevation noted by Cambium staff on November 10, 2023, was 291.23 masl, while the groundwater level in the drivepoint piezometer was measured at an elevation of 288.44 masl. As the depth to the water table at the wetland feature (288.44 masl) is lower than the groundwater elevation (292.39 masl), there is a downward vertical gradient between the surface water and the shallow groundwater localized around DP101-23.

A feature-based water balance is planned to be completed which will include detailed monitoring of the wetland over a duration of a minimum of 1 year. The wetland's status as a discharge or recharge feature, including any seasonal trends, will be determined through the study.

4.7 In-Situ Hydraulic Conductivity Tests

The hydraulic conductivities (K-value) of the native soils were estimated based on the results obtained from the single well hydraulic tests (SWHT) conducted on November 10, 2023. Rising head tests were performed in the monitoring wells BH103-23, and BH113-23, which had

sufficient water for SWHTs. Results of hydraulic conductivity tests are presented below in Table 6 and analytical data is included in Appendix D.

Table 6 Results of Estimated Hydraulic Conductivity as per SWHT

Monitoring Well	Estimated Hydraulic Conductivity (m/sec)		Tested Soil Type
BH101-23	Test 1	8.38×10^{-6}	Gravelly silty sand to silty gravel and sand
	Test 2	8.00×10^{-6}	
	Test 3	8.64×10^{-6}	
BH113-23	Test 1	4.51×10^{-8}	Sandy to silty gravel, some clay
	Test 2	2.45×10^{-8}	

The hydraulic conductivity was estimated utilizing Aquifer Test Pro software using the Hvorslev interpretation method. The estimated hydraulic conductivities ranged between 2.45×10^{-8} and 8.64×10^{-6} m/sec, geometric mean of 9.15×10^{-7} m/sec. The results were consistent with published values for the native till soils encountered at the respective boreholes.

5.0 Construction Dewatering Requirements

Construction dewatering is intended to lower the groundwater levels in the excavation area to ensure a dry and safe working condition.

The requirements for construction dewatering generally depend on the Site's soil and groundwater conditions including soil type, soil permeability or hydraulic conductivity, local groundwater levels, and the design of the proposed development, such as the foundation and/or basement elevation, as well as the size of proposed structure.

5.1 Proposed Development, Anticipated Excavation and Dewatering

The proposed development will include the construction of 59 estate lots, with 25 estate lots planned for Phase 1 of development. At the time of writing this report, the actual finished floor elevations (FFE) for the structures were not provided. Due to the localized high points, it is assumed that some cut and fill will be completed at the Site. The geotechnical investigation report indicated exterior footings to be placed at a minimum of 1.5 metres below final grade to protect from frost penetration (Cambium, 2023). At the southwest portion of Site, dewatering may be required due to shallow measured water level of 0.33 mbgs. Assuming the excavations for building foundations will go at a minimum to the frost penetration depth of 1.5 mbgs, any seepage within the excavation depths should be controllable with filtered sumps and pumps.

The rest of the Site has water levels deeper than 3.85 mbgs and therefore is feasible to go for conventional basements without requiring a potential dewatering either for short-term or long-term basis. Accordingly, a Permit to Take Water (PTTW) or registry in the Environmental Activity and Sector Registry (EASR) for the MECP will not be required.

The design invert elevations for the Sites linear infrastructure were not available at the time the document was prepared. The open cut excavations for installation of linear infrastructure in the southwestern parts of the Site will likely intercept the groundwater table since the services/utilities are to be placed below the frost penetration depth of 1.5 mbgs (Cambium, 2023). The linear infrastructure installation will require construction dewatering. Preliminary dewatering estimates were not able to be calculated for linear infrastructure, because

proposed detailed design of services location and invert depths were not available at this time. Construction dewatering requirements should be revisited once a detailed design for the linear infrastructure and building basements is available.

6.0 Water Balance Assessment

According to methodology developed by Thornthwaite and Mather (Thornthwaite & Mather, 1957), a water balance is an accounting of water in the hydrologic cycle. Precipitation (P) falls as rain and snow. It can run off towards lakes and streams (R), infiltrate to the groundwater table (I), or evaporate from ground or be transpired by vegetation (ET). When long-term average values of P, R, I, and ET are used, there is minimal or no net change to groundwater storage (ΔS) in a steady-state system.

The annual water budget of a Site can be expressed as:

$$P = R + I + ET + \Delta S$$

Where:

P = Precipitation (mm/year)

R = Run-off (mm/year)

I = Infiltration (mm/year)

ET = Evapotranspiration (mm/year)

ΔS = Change in groundwater storage (taken as zero) (mm/year)

The calculations presented here compare the pre- and post-development water balance changes within the Site boundaries because of the proposed development. It is noted that the water balance described herein does not account for catchment areas that extend off-site.

Based on the available design information, the pre- and post-development Site coverage can be generally categorized into three types: paved areas, roof areas, and landscaped areas.

A summary of the surface areas of the development is listed in Table 8. The pre-development Site area is underlain by a mixture of silt, sand, and gravel till. Detailed design layouts for residential lots were not available for review at the time this document was prepared; therefore, some assumptions had to be made regarding pervious and impervious surfaces.

The impermeable paved area for the residential lot driveways were assumed to be 10% of the lot area, the roofed area for the structures on the lots were assumed to be 250 m^2 and the rest of the lot was assumed to be pervious landscaped area. The wetland, open space, firefighting/ stormwater management pond blocks were considered to be landscaped area in the calculations.

The development of the Site is proposed to happen in two phases: Phase 1 and Phase 2. The water balance calculations consider each phase individually, as well as a summary of the whole Site. The pre-development land coverage area is depicted on Figure 5 and the Site statistics in Table 7 below.

Table 7 Pre-Development Site Statistics

Type of Land Coverage	Phase 1 Pre-Development Areas (ha)	Phase 2 Pre-Development Areas (ha)	Entire Site Pre-Development Areas (ha)
Paved Area	0.07	0.00	0.07
Roof Area	0.03	0.00	0.03
Landscaped Area	21.71	26.34	48.05
Total	**21.81**	**26.34**	**48.15**

The table below (Table 8) shows the post-development Site statistics and while the areas were depicted schematically on Figure 6.

Table 8 Post-Development Site Statistics

Type of Land Coverage		Phase 1 Post-Development Areas (ha)	Phase 2 Post-Development Areas (ha)	Entire Site Post-Development Areas (ha)
Lot Areas	Paved Area	1.39	1.98	3.37
	Roof Area	0.63	0.85	1.48
	Landscaped Area	11.89	16.93	28.82
Paved Area – Roadways		1.94	2.11	4.05
Landscaped (Wetland, SWM Pond & Open Space)		5.97	4.48	10.45
Total		**21.81**	**26.34**	**48.15**

Supporting information referenced herein (including detailed water balance calculations) is attached in Appendix E.

6.1 Water Surplus

Water surplus is calculated by determining the difference between precipitation and evapotranspiration over the course of a year (changes in soil water storage were assumed to be negligible). The volume of water surplus is further sub-divided into portions that infiltrate the on-site soils and that are directed off-site as runoff.

The 30-year climate normal data, including monthly average temperature and precipitation, was obtained from Environment Canada, for Peterborough Trent U (Climate ID: 6166455) located about 29.11 km distance from the Site. The average annual precipitation was recorded to be 882 mm/year and the average annual evapotranspiration was estimated to be about 540 mm/year using the USGS Thornthwaite Monthly Water Balance methodology (Thornthwaite & Mather, 1957). Accordingly, the water surplus of the Site was calculated to be 342 mm/year.

Transpiration does not occur from structures and paved areas. It was assumed that 10% of precipitation falling on such surfaces is lost directly to evaporation. The remaining depth (i.e., 90% of precipitation) was considered surplus and converted either to infiltration and/or runoff.

6.2 Infiltration Rates

The volume of surplus water that infiltrates through pervious surfaces on-site was determined by applying an infiltration factor to the surplus depth. The surplus water that does not infiltrate into pervious surfaces will leave the Site as surface water runoff. The infiltration factor varies from 0 to 1 and is estimated based on topography, soils, and vegetation cover as per the *Stormwater Management Planning and Design Manual* (Ministry of the Environment, 2003).

The rate of infiltration at a Site is expected to vary, based on several factors to be considered in any infiltration model. To partition the available water surpluses into infiltration and surface run-off, the MECP infiltration factors were used. The MECP Storm Water Management

Planning and Design Manual (2003) methodology for calculating total infiltration based on topography, soil type and land cover was used, and a corresponding run-off component was calculated for the soil moisture storage conditions.

The Site has a slight rolling topography and, based on the results of the borehole investigation and the grain size analysis, the subsurface conditions at the Site are combinations of silty sand and gravelly till dominant soils.

Therefore, an infiltration factor of 0.65 was calculated for the Site using the MECP method.

6.3 Phase 1 Water Balance Assessment

This section outlines the pre- and post-development water balance calculations for Phase 1 of the development.

6.3.1 Phase 1 Pre-Development Water Balance

The water balance for the existing conditions in Phase 1 of the Site is summarized in Table 9. The pre-development infiltration rate was calculated to be about 48,300 m^3/year and the runoff rate was about 26,800 m^3/year.

Table 9 Phase 1 Pre-Development Water Balance

Land Use		Area (m^2)	Precipitation (m^3)	Evapo-transpiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Impervious Areas	Paved Area	700	617	62	-	556
	Roof Area	300	265	26	-	238
Pervious Areas	Landscape Area	217,080	191,465	117,223	48,257	25,984
Total		**218,080**	**192,347**	**117,311**	**48,257**	**26,778**

Assuming no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

6.3.2 Phase 1 Post-Development Water Balance

The Phase 1 post-development water balance is summarized in Table 10. The Phase 1 post-development infiltration rate was calculated to be approximately 39,700m^3/year and the runoff volume was about 52,700 m^3/year.

Table 10 Phase 1 Post-Development Water Balance

Land Use		Area (m^2)	Precipitation (m^3)	Evapo-transpiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Impervious Areas	Paved Area	33,254	29,330	2,933	-	26,397
	Roof Area	6,250	5,513	551	-	4,961
Pervious Areas	Landscape Area	178,576	157,504	96,431	39,697	21,376
Total		**218,080**	**192,347**	**99,915**	**39,697**	**52,734**

Assuming no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

6.4 Phase 2 Water Balance Assessment

This section outlines the pre- and post-development water balance calculations for Phase 2 of the development.

6.4.1 Phase 2 Pre-Development Water Balance

The Phase 2 water balance for the existing conditions of the Site, is summarized in Table 11. The pre-development infiltration rate was calculated to be about 58,600 m^3/year and the runoff rate was about 31,500 m^3/year.

Table 11 Phase 2 Pre-Development Water Balance

Land Use		Area (m^2)	Precipitation (m^3)	Evapo-transpiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Impervious Areas	Paved Area	-	-	-	-	-
	Roof Area	-	-	-	-	-
Pervious Areas	Landscape Area	263,420	232,336	142,247	58,558	31,531
Total		**263,420**	**232,336**	**142,247**	**58,558**	**31,531**

Assuming no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

6.4.2 Phase 2 Post-Development Water Balance

The Phase 2 post-development water balance is summarized in Table 12. The post-development infiltration rate for Phase 2 was calculated to be approximately 47,600 m^3/year and the runoff volume was about 64,800 m^3/year.

Table 12 Phase 2 Post-Development Water Balance

Land Use		Area (m^2)	Precipitation (m^3)	Evapo-transpiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Impervious Areas	Paved Area	40,847	36,027	3,603	-	32,424
	Roof Area	8,500	7,497	750	-	6,747
Pervious Areas	Landscape Area	214,073	188,812	115,599	47,588	25,625
Total		**263,420**	**232,336**	**119,952**	**47,588**	**64,796**

Assuming no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

6.5 Water Balance Comparison

The water balances of the Phase 1 and Phase 2 pre-development and post-development scenarios are summarized below in Table 13.

Table 13 Water Balance Comparison

		Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Phase 1	**Pre-Development**	192,347	117,311	48,257	26,778
	Post-Development	192,347	99,915	39,697	52,734
	Change in Volume	**-**	**-17,396**	**-8,559**	**25,956**
	Change in %	**-**	**-15**	**-18**	**97**
Phase 2	**Pre-Development**	232,336	142,247	58,558	31,531
	Post-Development	232,336	119,952	47,588	64,796
	Change in Volume	**-**	**-22,295**	**-10,970**	**33,265**
	Change in %	**-**	**-16**	**-19**	**105**

Based on the above, there is a net infiltration deficit of about 8,600 and 11,000 m^3/year for Phase 1 and Phase 2, respectively, compared to the pre-development infiltration. Therefore the overall infiltration deficit over the entire Site would be 19,600 m^3/year The runoff rate upon development of the Site will increase by about 26,000 m^3/year for Phase 1 and about 33,300 m^3/year for Phase 2. The net runoff rate over the entire Site upon development would thus increase by about 59,300 m^3/year.

The roof surfaces Phase 1 and Phase 2 of the proposed development are projected to generate about 5,000 and 6,700 m^3/year totalling approximately 11,700 m^3/year of runoff

(Table 10 and Table 12). Reinfiltrating all the roof runoff at the Site could account for approximately 60% of the overall infiltration deficit.

6.6 Water Balance Summary

A summary of the water balance could be provided as below:

- There is a net increase in run-off for the entire Site of about 58,300 m^3/year. This increase is a result of the development of the Site with more impervious areas such as roof and paved areas and a decrease in pervious areas.
- Post-development landscape area was decreased by about 87,900 m^2 when compared to pre-development conditions, which would result in less infiltration across the Site.
- Without implementing any mitigation measures the projected infiltration deficit over the entire Site is 19,600 m^3/year.
- Re-infiltrating almost 100% of the roof runoff will account for approximately 60% of the projected infiltration deficit.
- Low impact development (LID) practices should be investigated to help offset the infiltration deficit.

6.7 Discussions on LID Measures

Low impact development practices attempt to capture runoff and mimic the natural hydrologic cycle. It is important to maintain the natural hydrologic cycle as much as possible as reduction in infiltration reduces groundwater recharge and soil moisture replenishment and can also lead to reductions in stream baseflows which are needed to sustain aquatic life.

In general, there are two primary types of LIDs. The first promotes the infiltration of stormwater run-off close to the source. These infiltration type LIDs are preferred when hydrogeological and physical conditions are optimal and allow for their emplacement. The second type of LID captures and slowly releases stormwater to the groundwater water system through a process of storage and filtration by infiltration LIDs.

The conceptual water balance indicates that there will be an infiltration deficit of about 19,600 m³/year in the post-development infiltration upon development of both Phase 1 and Phase 2, compared to the pre-development condition.

Infiltration targets at the Site may be achieved through LIDs and incorporation of a variety of stormwater management techniques including reduced lot grading, roof downspout disconnection, roof leaders discharging to ponding areas or soak away pits, infiltration trenches, and grassed swales. Re-infiltrating roof runoff is a common solution to addressing the infiltration deficit, especially when there is a good extent of landscape area available. However, the calculated roof runoff generated will only account for 60% of the infiltration deficit. A stormwater engineer should be retained to design the LID infrastructure and to address runoff flow generated from roof surfaces, as well as roadways if allowed. If runoff from roadways is accepted, the entire infiltration deficit can be accounted for.

It is noted that groundwater levels were measured between 0.33 and 3.85 mbgs in the western part of the Site on November 10, 2023, with the highest levels to groundwater recorded on the southwestern well BH101-23. LID features require one metre of vertical separation between the invert of a LID and high groundwater level; therefore, LID implementation should be considered for the eastern portion of the Site where dry conditions were noted at a depth of >4.6 mbgs (elevations between <283.3 and <285.7masl). Consideration should be given to the thickness and percolation rates of unsaturated soils when finalizing the stormwater management plan and LID measures for the Site.

It should be noted that water levels will vary based on seasonal events and therefore, should be measured regularly to confirm high water conditions prior to construction.

In-situ infiltration testing is proposed as a supplementary investigation to determine infiltration rates expected in specific areas of the Site and to aid the detailed design process of the LID measures. Once infiltration testing locations and their design are provided from the storm water management consultant to Cambium will be able to complete the infiltration testing. Also, it should be noted that the infiltration tests cannot be completed in frozen ground conditions.

7.0 Wastewater Assessment (Nitrate Mass Balance)

As per Guideline D-5-4 Technical Guideline for Individual On-Site Sewage Systems: Water Quality Risk Assessment (Ministry of the Environment, 1996) an assessment was completed to determine the feasibility of utilizing on-site sewage disposal for the development.

Guideline D-5-4 requires the septic effluent plume at the Site boundary to be less than the Ontario Drinking Water Quality Standards (ODWQS) limit of 10 mg/L for nitrate to prevent contamination of groundwater on adjacent properties. Although natural processes and soil interaction can result in nitrate being attenuated in the receiving aquifer system, Guideline D-5-4 states that only dilution can be used as the attenuation mechanism to predict future nitrate concentrations. As such, a mass balance calculation is used to predict the impact of developing residential lots on the Site.

7.1 Available Dilution

The total available dilution for the Site is estimated by the following equation:

$$Qi = A \times S \times I$$

Where: Qi – Volume of Available dilution water

A – Area of the Site

S – Water surplus

I – Infiltration factor

To calculate the water surplus, the thirty-year climate normal data collected between 1981 and 2010 at the Peterborough Trent U (ID 6166455) weather station was used. The data was accessed through the Environment Canada website (Environment Canada, 2024).The total yearly precipitation, on average, was 882 mm.

The Thornthwaite method was used to determine the amount of evapotranspiration that will occur at the Site (Dingman, 2008). The calculated depth of evapotranspiration was 540 mm/year, and the water surplus was calculated to be 342 mm per year. The evapotranspiration calculations are attached in Appendix E.

To determine the fraction of surplus water that infiltrates into the soils at the Site, the volume of surplus water is multiplied by an infiltration factor. As described the infiltration factor was determined to be 0.65 using the Stormwater Management Planning and Design Manual (Ministry of the Environment, 2003).

The volume of dilution water was calculated based on the post-development permeable area. The areas of the roads, roofs, and standing surface water were assumed to be impermeable. For road areas, water was assumed to run-off towards the permeable areas of the Site, therefore road surfaces were included in the dilution calculations. The proposed roofed area was included in the permeable area as it is assumed that roof leaders will direct any roof runoff to landscaped areas as is typical in rural subdivisions and therefore will not contribute to a post-development recharge deficit. Therefore, the only land that isn't being used within the dilution calculations is the wetland area with standing water and the intermittent water course with their associated buffer areas (9.80 ha). The area available for dilution is the developable area at 38.35 ha.

The calculations of the available dilution water for the Site are outlined below Table 14.

Table 14 Available Dilution Calculations

Infiltration Factor			
Topography		Rolling Land = 0.2	
Soil		Combination of silt, sand, and gravel till = 0.3	
Cover		Cultivated and woodland mix =0.15	
Infiltration Factor (I)		0.65	
Volume of Precipitation Water			
Parameter	**Symbol**	**Units**	
Dilution Area	A	m^2	383,500
Surplus	S	m/day	0.000937
Volume of Surplus Water (Per Day)	A * S	m^3	359.50
Volume of Available Dilution Water (Per Day)	A * S * I	m^3	233.67
Volume of Runoff Water (Per Day)	A * S * (1-I)	m^3	125.82

7.2 Predictive Assessment

As per the procedure in Guideline D-5-4, a nitrate loading of 40 grams/lot/day is required to simulate the effluent loading from conventional septic systems on the receiving groundwater system. Total nitrogen (all species) ultimately converts to nitrate through the wastewater treatment process, so nitrate is the critical contaminant in sewage effluent. Each proposed lot is anticipated to generate an average discharge of 1,000 L/day of sewage effluent which contributes to the dilution of the total nitrate load.

To determine if the proposed lot density is adequate for nitrate dilution, a mass balance calculation is used to determine the sewage loading for nitrate on the property boundary. The mass balance calculations are outlined below as:

$$Q_tC_t = Q_eC_e + Q_iC_i$$

Where: Q_t = Total volume ($Q_e + Q_i$)

C_t = Total concentration of nitrate at the property boundary

Q_e = Volume of septic effluent

C_e = Concentration of nitrate in effluent (40 mg/L)

Q_i = Volume of available dilution water

C_i = Concentration of nitrate in dilution water (0.1 mg/L)

To determine the concentration of nitrate at the property boundary (C_t), the above mass balance equation can be arranged as follows:

$$C_t = \frac{Q_eC_e + Q_iC_i}{Q_t}$$

This equation was used to determine the dilution of wastewater by including infiltration on both the developable and non-developable portions of the Site. The results of the equation have been outlined in Table 15 below. Detailed calculations are included in Appendix F.

Table 15 Predictive Assessment of Nitrate Concentration

Variable	Value
Number of Lots	59
Q_e (L)	59,000
C_e (mg/L)	40
Q_i (L)	233,674
C_i (mg/L)	0.1
Q_t (L)	292,675
C_t (mg/L)	**8.14**

At the time of the assessment, the proposed development includes the construction of 59 new residential dwellings. The development of Site is proposed to happen in two phases, with Phase 1 being developed with 25 lots and Phase 2 with 34 lots. The nitrate calculations considered the whole Site for both phases and did not consider the two phases independently.

The predicted nitrate concentration at the Site boundary based on this 59-lot density using the calculated dilution volume is 8.14 mg/L, which is less than the maximum allowable limit of 10 mg/L. Therefore, the Site can accommodate the proposed 59 new lots according to Guideline D-5-4.

The actual nitrate concentration is anticipated to be even lower due to the natural attenuation that will occur within the soil since this calculation only assumes dilution. In addition, conservative estimates were used for infiltration factors for the non development area with the limited information on soil characteristics in the area.

8.0 Source Water Protection and Risk Management

As per the Trent Source Protection Plan, the Site is located within a Highly Vulnerable Aquifer (HVA) area (Appendix A).

8.1 HVA

An HVA is an aquifer that can be easily changed or affected by contamination from both human activities and natural processes. This is a result of preferential pathways to the aquifer or the areas intrinsic susceptibility as a function of the thickness and permeability of the overlying soils. In Ontario, a HVA is defined as having an Intrinsic Susceptibility Index of less than 30. In general, an HVA will consist of granular materials (e.g., sand and/or gravel) or fractured rock that has a high permeability and is near the surface of the ground. It is important to protect highly vulnerable areas to prevent drinking water contamination.

The land use practices at the proposed development Site are not expected to cause any contamination to the water resources as it is assumed that there are no chemicals, fertilizers, or petroleum hydrocarbons proposed to be stored at or handled on Site.

9.0 Assessment of Potential Impacts

Based on the information available, the proposed development consists of a 59 estate lots with 25 estate lots planned for Phase 1 of development. The potential impacts due to the Site development were assessed as below.

9.1 Natural Features

As discussed, an unevaluated wetland occupies much of the central portion and northeast of the Site and therefore, there could be some impacts on the local natural features due to the Site development. Therefore, as per Ont. Reg. 41/24set-back distances or buffer zones as prescribed by KRCA should be followed to protect the natural features.

9.2 Water Supply Wells near the Site

Based on the Site-specific conditions and the nature of the proposed development, it is highly unlikely that large scale dewatering activity will take place and additionally, water well records from the surrounding area indicate that the depth to water in the bedrock aquifer (which provides local water supply) has a geometric mean depth of 18.3 mbgs. It is therefore not expected that the water present in the shallow subsurface at the Site is connected to the water supply aquifer. Thus, no groundwater quantity impacts on local water wells (private or public), are anticipated due to the proposed development.

9.3 Considerations on Drinking Water Vulnerability

The entire area of the Site is identified as a HVA with moderate vulnerability. The proposed development therefore has potential to be affected by contamination from both human activities and natural processes, which can then in turn impact local drinking water supplies. The risk to drinking water quality can be minimized by preventing the infiltration of poor-quality runoff from paved surfaces such as driveways and roadways. As discussed in Section 8.1 The land use practices at Site are not expected to cause contamination to the water resources as it is assumed that there are no chemicals, fertilizers, or petroleum hydrocarbons proposed to be stored at or handled on Site. A multi-pronged approach is advised to reduce the impact of

winter salt application and promote best practices for residential outdoor use of chemicals and pesticides.

10.0 Conclusion and Recommendations

Cambium was retained by Jeffery Homes to complete a hydrogeological assessment of the property with a legal description of Part of Lot 19, Concession 19, Township of Galway-Cavendish and Harvey, County of Peterborough.

The Site is situated in a KRCA regulated area. The Site has an unevaluated wetland, woodlands, as well as a Natural Heritage System Area mapped on the Site. The type of natural heritage area is identified as Undifferentiated Enabling Plan Growth Plan for the Greater Golden Horseshoe. The unevaluated wetland occupies much of the central and northeast portions of the Site and therefore, there could be some impacts on the local natural features due to the Site development. Set-back distances or buffer zones as prescribed by the KRCA should be followed to protect the natural features.

The measured groundwater levels in the monitoring wells and piezometer during November 2023 ranged in depths from 0.33 mbgs to 3.85 mbgs, and the elevations ranged from 292.39 to 297.77 masl. Dry conditions on the east portion of Site were noted to the explored depths of approximately 4.6 mbgs in BH108-23 and BH109-23 (bottom of well elevations ranging from 283.3 to 285.7 masl). Groundwater flow was determined to be to the east-southeast where is it interpreted to discharge into Pigeon Lake, located about 1.3 km east of the Site.

A feature-based water balance is planned to be completed to evaluate the developmental impacts on the wetland feature concurrently with the Phase II detailed design and application. Cambium will complete a long-term water level monitoring at the Site as part of feature-based water balance.

The estimated hydraulic conductivities ranged between 2.45 x 10^{-8} and 8.64 x 10^{-6} m/sec, geometric mean of 9.15 x 10^{-7} m/sec.

The open cut excavations for installation of linear infrastructure in the southwestern parts of the Site will likely intercept the groundwater table since the services/utilities are to be placed below the frost penetration depth of 1.5 mbgs (Cambium, 2023). The linear infrastructure installation will likely require construction dewatering. Preliminary dewatering estimates were

not able to be calculated for linear infrastructure, as detailed design of services and invert depths were not available at this time.

Proposed development will include the construction of 59 estate lots, with 25 planned for Phase 1 of development. Construction excavation dewatering may be required for linear infrastructure. At the time of writing this report, the actual FFEs for the structures and services were not provided. Detailed design for Site servicing including locations and invert elevations were unavailable, so dewatering estimates were not provided. When Site plan drawings are made available, the dewatering estimates for linear infrastructure as well as building basements should be revisited.

The conceptual water balance indicates that there will be an infiltration deficit upon development of the Site in the order of about 19,600 m^3/year (8,600 and 11,600 m^3/year for Phase 1 and Phase 2 respectively) based off the current proposed Site plan. To compensate the infiltration deficit, roof downspout disconnection discharge to the sloped areas away from the building footprint should be implemented. Based on the estimation, a diversion of 100% of general roof water for infiltration would allow for 60% offset of the infiltration deficit of proposed Phase 1 and Phase 2 development to maintain an enhanced infiltration after the development.

Additional LID measures (ex. soak away pits, infiltration trenches, and grassed swales) should be explored to offset the remainder of the infiltration deficit. LIDs should not be incorporated in the southwestern portion of Site due to the high-water table conditions. LIDs should be designed by a competent stormwater engineer and were not incorporated into this assessment.

In-situ infiltration testing is proposed as a supplementary investigation to determine infiltration rates expected in specific areas of the Site and to aid the detailed design process of the LID measures.

The wastewater assessment indicates that the proposed development of 59 lot estate homes with private, on-site wastewater disposal, would result in a nitrate concentration of 8.14 mg/L at the property boundary, which is less than the Ontario Drinking Water Quality Standard of

10 mg/L. The proposed development is therefore expected to maintain acceptable nitrate concentrations at property boundaries.

Since the Site is situated within an HVA, Cambium recommends using the BMPs to avoid overland flow of any contaminants to the natural environment. There are no significant chemical or pathogen threats identified for the proposed land uses at the development.

10.1 Recommendations

Construction dewatering requirements should be revisited once a detailed design for the linear infrastructure and building basements is available.

Once infiltration testing locations and their design are provided from the storm water management consultant, Cambium can complete the infiltration testing if authorized by the Client. Also, it should be noted that the infiltration tests cannot be completed in frozen ground conditions.

As per Stantec's peer review of the hydrogeological assessment report, a feature-based water balance is recommended to be completed for the Site. Cambium can complete this work in conjunction with spring water level monitoring as the feature-based water balance requires a minimum of 12 months of groundwater monitoring. The purpose of the feature-based water balance is for the wetland to demonstrate that its form and function will be maintained post-development. Cambium can complete the feature-based water balance if authorized by the Client.

11.0 Closing

We trust that the information in this submission meets your current requirements. If you have any questions regarding the contents of this report, please contact the undersigned.

Respectfully submitted,

Cambium Inc.

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13.0 Standard Limitations

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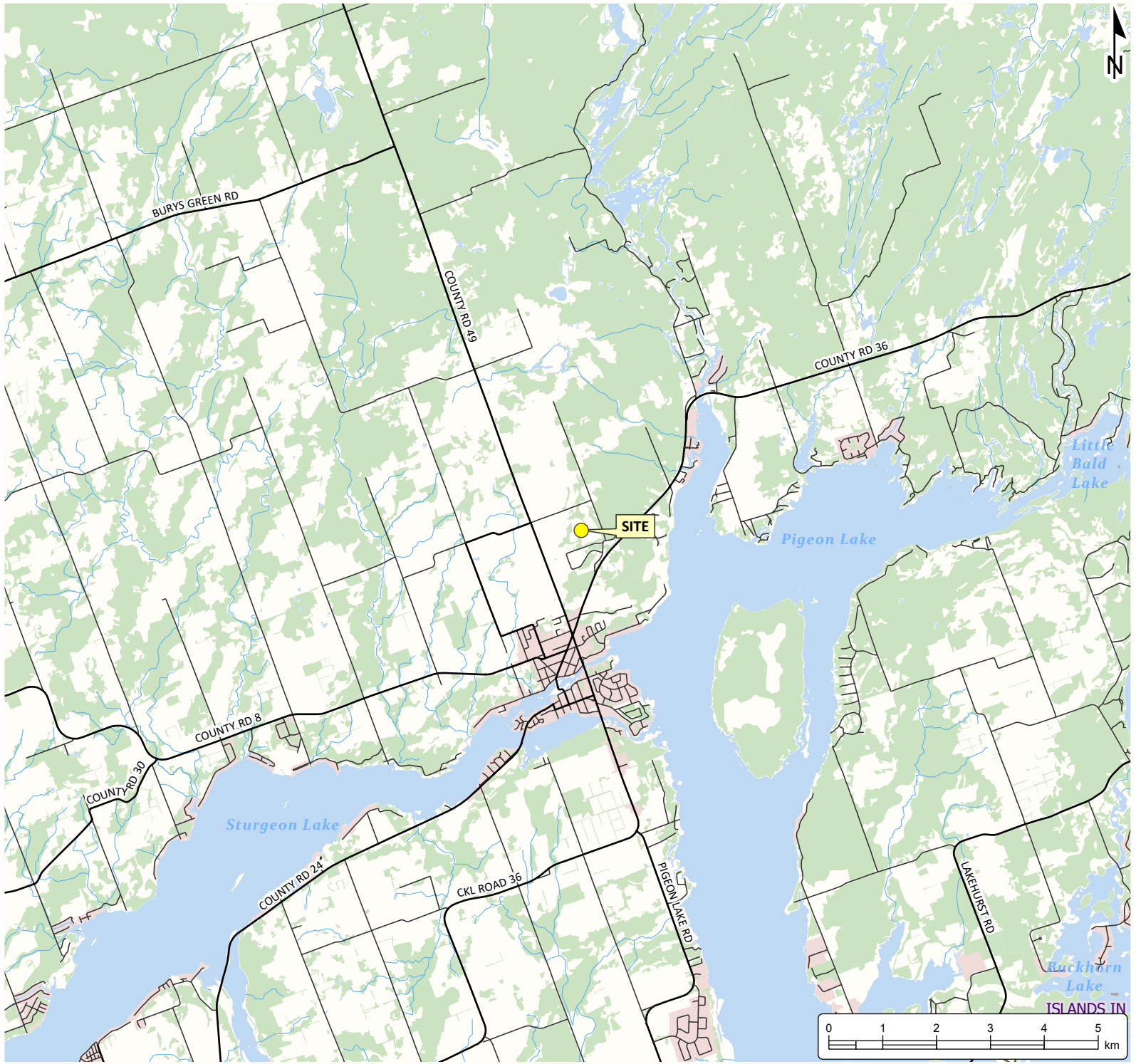
Appended Figures



HYDROGEOLOGICAL ASSESSMENT

JEFFERY HOMES
Pt. Lot 19, Conc. 19 - 168 County Road 49
Bobcaygeon, Ontario

LEGEND

- Highway
- Major Road
- Minor Road
- Railway
- Water Area
- Watercourse
- First Nations Reserve
- Provincial Park
- Wooded Area
- Built Up Area

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SITE LOCATION PLAN

Project No.: 17986-001		Date: December 2024	
		Rev.:	
Scale: 1:100,000		Projection: NAD 1983 UTM Zone 17N	
Created by: DBB	Checked by: SK	Figure:	1

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HYDROGEOLOGICAL ASSESSMENT

JEFFERY HOMES
Pt. Lot 19, Conc. 19 - 168 County Road 49
Bobcaygeon, Ontario

LEGEND

Site (approximate)

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SITE PLAN

Project No.: 17986-001		Date: December 2024	Rev.:
Scale: 1:6,000		Projection: NAD 1983 UTM Zone 17N	
Created by: DBB	Checked by: SK	Figure: 2	

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HYDROGEOLOGICAL ASSESSMENT

JEFFERY HOMES
Pt. Lot 19, Conc. 19 - 168 County Road 49
Bobcaygeon, Ontario

LEGEND

- Borehole
- Monitoring Well
- Piezometer
- Site (approximate)

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BOREHOLE LOCATION PLAN

Project No.: 17986-001		Date: December 2023	
		Rev.:	
Scale: 1:6,000		Projection: NAD 1983 UTM Zone 17N	
Created by: DBB	Checked by: SK	Figure: 3	

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HYDROGEOLOGICAL ASSESSMENT

JEFFERY HOMES
Pt. Lot 19, Conc. 19 - 168 County Road 49
Bobcaygeon, Ontario

LEGEND

- Benchmark
- Borehole
- Monitoring Well
- Piezometer
- Watercourse, Permanent
- Watercourse, Intermittent
- Groundwater Contour (1m interval)
- Site (approximate)
- **(288.44)** Groundwater Elevation
- Groundwater Flow Direction

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GROUNDWATER ELEVATION PLAN

Project No.: 17986-001		Date: December 2024	Rev.:
Scale: 1:8,000		Projection: NAD 1983 UTM Zone 17N	
Created by: DBB	Checked by: SK	Figure: 4	

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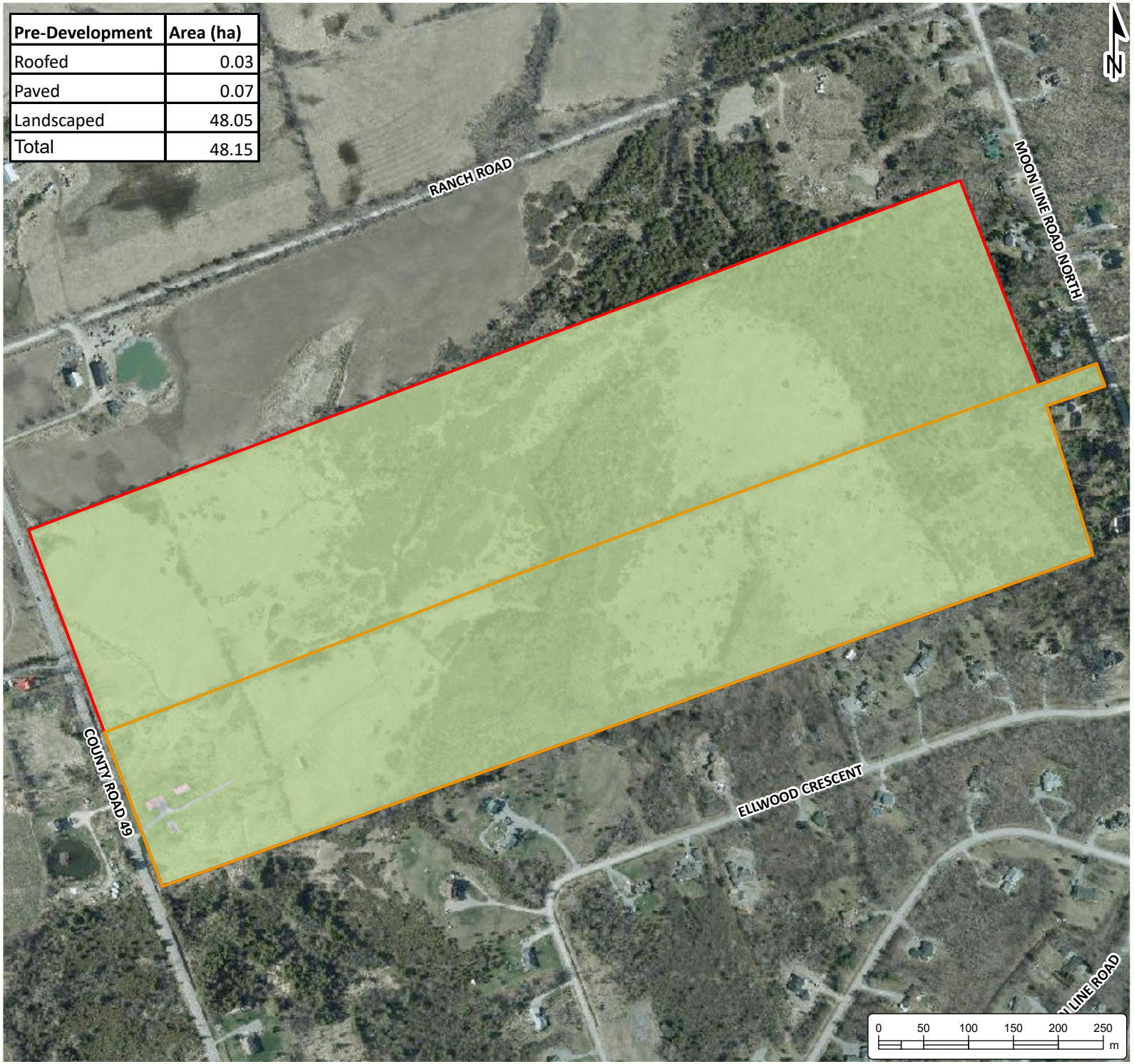
Pre-Development	Area (ha)
Roofed	0.03
Paved	0.07
Landscaped	48.05
Total	48.15



HYDROGEOLOGICAL ASSESSMENT

JEFFERY HOMES
Pt. Lot 19, Conc. 19 - 168 County Road 49
Bobcaygeon, Ontario

LEGEND

- Roofed
- Paved
- Landscaped
- Phase 2
- Phase 1

Notes:
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- Distances on this plan are in metres and can be converted to feet by dividing by 0.3048.
- Cambium Inc. makes every effort to ensure this map is free from errors but cannot be held responsible for any damages due to error or omissions. This map should not be used for navigation or legal purposes. It is intended for general reference use only.

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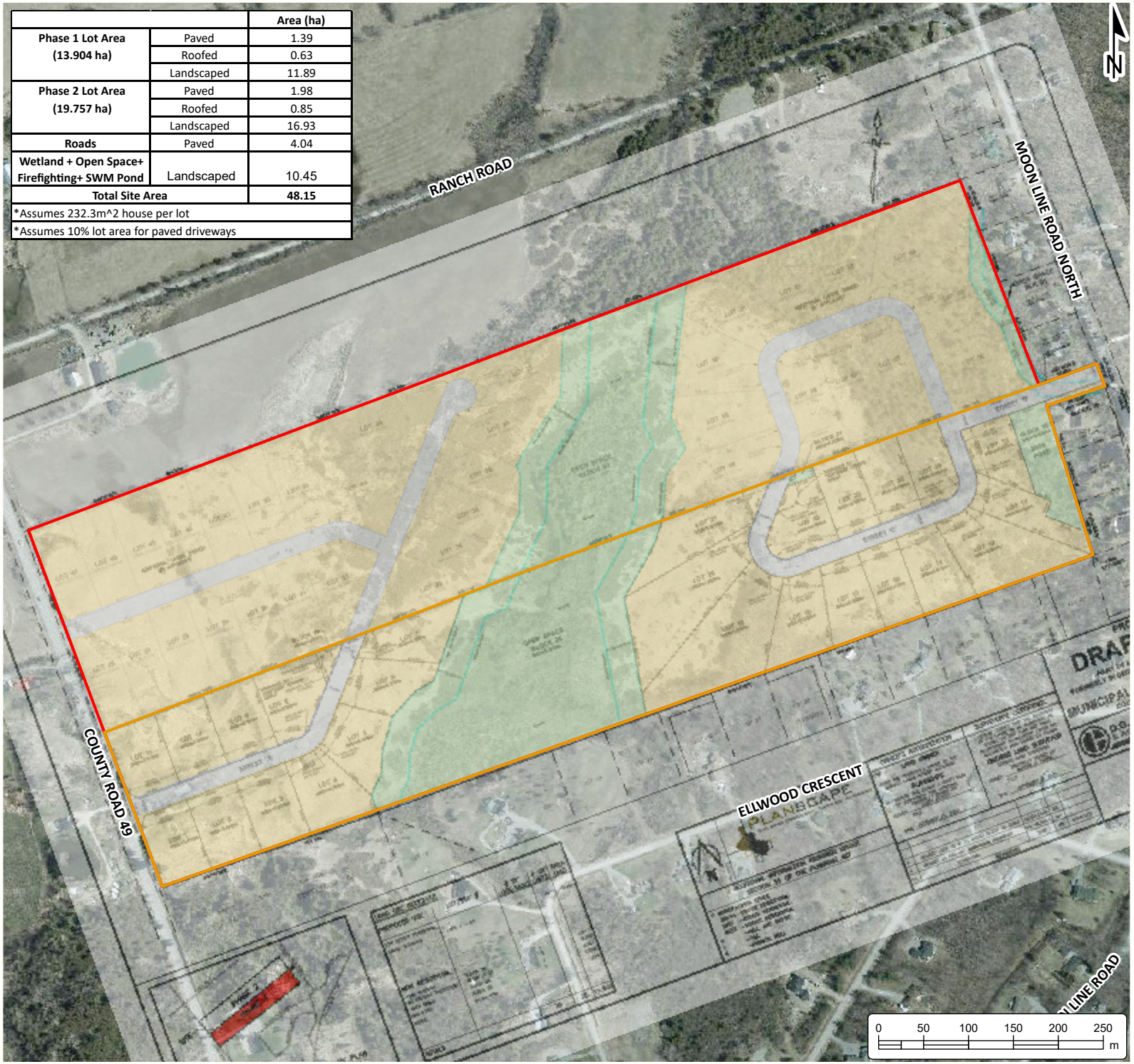
194 Sophia Street
Peterborough, Ontario, K9H 1E5
Tel: (705) 742.7900 Fax: (705) 742.7907
www.cambium-inc.com

PRE-DEVELOPMENT PLAN

Project No.: 17986-001		Date: December 2024 Rev.:	
Scale: 1:6,000		Projection: NAD 1983 UTM Zone 17N	
Created by: DBB	Checked by: SK	Figure:	5

O:\GIS\MXDs\17900-17999\17986-002 Jeffery Homes - GEO & HydroG - Pt. Lot 19, Conc. 19 - Bobcaygeon Development\2023-11-27 Hydro G.aprx

		Area (ha)
Phase 1 Lot Area (13.904 ha)	Paved	1.39
	Roofed	0.63
	Landscaped	11.89
Phase 2 Lot Area (19.757 ha)	Paved	1.98
	Roofed	0.85
	Landscaped	16.93
Roads	Paved	4.04
Wetland + Open Space+ Firefighting+ SWM Pond	Landscaped	10.45
Total Site Area		**48.15**
*Assumes 232.3m^2 house per lot		
*Assumes 10% lot area for paved driveways		



HYDROGEOLOGICAL ASSESSMENT

JEFFERY HOMES
Pt. Lot 19, Conc. 19 - 168 County Road 49
Bobcaygeon, Ontario

LEGEND

- Developable Lot
- Paved
- Landscaped
- Phase 2
- Phase 1

***Note there are not any houses proposed on the plan, so the areas for paved and roofed in the residential lots are assumed values for the houses and the driveways.**

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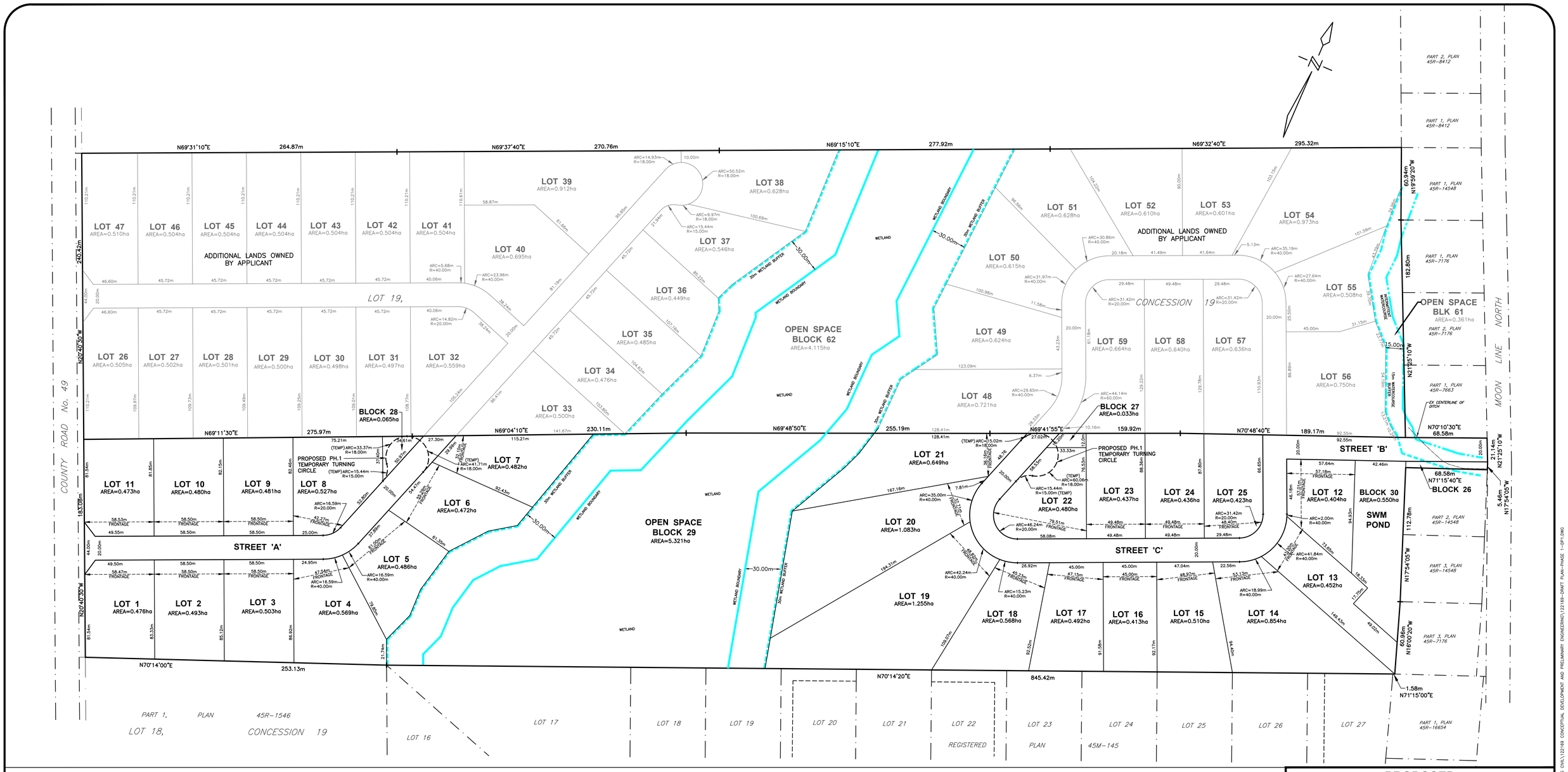
POST-DEVELOPMENT PLAN

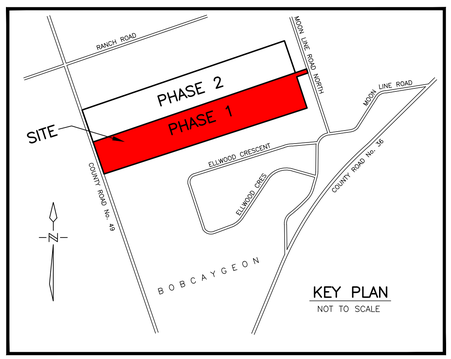
Project No.: 17986-001		Date: December 2024 Rev.:	
Scale: 1:6,000		Projection: NAD 1983 UTM Zone 17N	
Created by: DBB	Checked by: SK	Figure:	6

O:\GIS\MXDs\17900-17999\17986-002 Jeffery Homes - GEO & HydroG - Pt. Lot 19, Conc. 19 - Bobcaygeon Development\2023-11-27 Hydro G.aprx

Appendix A

Proposed Development Plan and Land Information





LAND USE SCHEDULE

PROPOSED USE	LOT/BLK #	# OF LOTS/BLKS	# OF UNITS	AREA (ha)
LOW DENSITY RESIDENTIAL				
SINGLE DETACHED	LOTS 1 – 25	25	25	13.904
NON RESIDENTIAL				
ROAD WIDENING	BLOCK 26	1		0.041
FIRE FIGHTING PROTECTION	BLOCK 27,28	2		0.098
OPEN SPACE	BLOCK 29	1		5.321
SWM POND	BLOCK 30	1		0.550
ROADS	20.0m ROW			1.894
TOTALS		30	25	21.808

PLANSCAPE
BUILDING COMMUNITY THROUGH PLANNING

ADDITIONAL INFORMATION REQUIRED UNDER SECTION 51 OF THE PLANNING ACT

F NORTH – OPEN SPACE
SOUTH – ESTATE RESIDENTIAL
EAST – ESTATE RESIDENTIAL
WEST – ESTATE RESIDENTIAL
H – WELL AND SEPTIC
I – TILL
K – PRIVATE WELL

OWNER'S AUTHORIZATION

I/WE LAND OWNER

BEING THE REGISTERED OWNER OF THE SUBJECT LANDS HEREBY AUTHORIZE PLANSCAPE TO PREPARE AND SUBMIT A DRAFT PLAN OF SUBDIVISION FOR APPROVAL

SIGNED *ORIGINALLY SIGNED BY: SCOTT JEFFERY*
TITLE

DATE *DECEMBER 21, 2022*

SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARY OF THE LANDS TO BE SUBDIVIDED AS SHOWN ON THIS PLAN AND THEIR RELATIONSHIP TO ADJACENT LANDS ARE ACCURATELY AND CORRECTLY SHOWN

ONTARIO LAND SURVEYOR
ONTARIO LAND SURVEYORS

ORIGINALLY SIGNED BY: MARYNA A. HANNA
SIGNED
O.L.S

DATE *SEPTEMBER 2, 2022*

No.	REVISION	DATE	BY	APPROVED
2.	REVISED LOTS 12 & 13, ADDED BLOCK 30 (SWM)	12/03/2024	BB	
1.	REVISED AS PER 1ST SUBMISSION COMMENTS	03/18/2024	MH	

REVISIONS

PROPOSED

DRAFT PLAN

PART OF LOT 19, CONCESSION 19
FORMERLY IN GEOGRAPHIC TOWNSHIP OF HARVEY
NOW IN THE
MUNICIPALITY OF TRENT LAKES
COUNTY OF PETERBOROUGH

D.G. BIDDLE & ASSOCIATES
CONSULTING ENGINEERS & PLANNERS
96 King Street East
Oshawa, Ontario, L1H 1B6
Phone: 905-576-8500
info@dgbiddle.com
dgbiddle.com

SCALE:	1:1500
DRAWN BY:	B.B.
DESIGN BY:	M.J.H.
CHECKED BY:	M.B.C.
PLOT DATE:	06/12/2024

122169

DP-1

A:\DRAFT\JOB FILES\122000\122169 JEFFERY – BOBCAYGEON\122169 DRAWINGS\122169 DRAWINGS CIVIL\122169 CONCEPTUAL DEVELOPMENT AND PRELIMINARY ENGINEERING\122169-DRAFT PLAN-PHASE 1-DP1.DWG

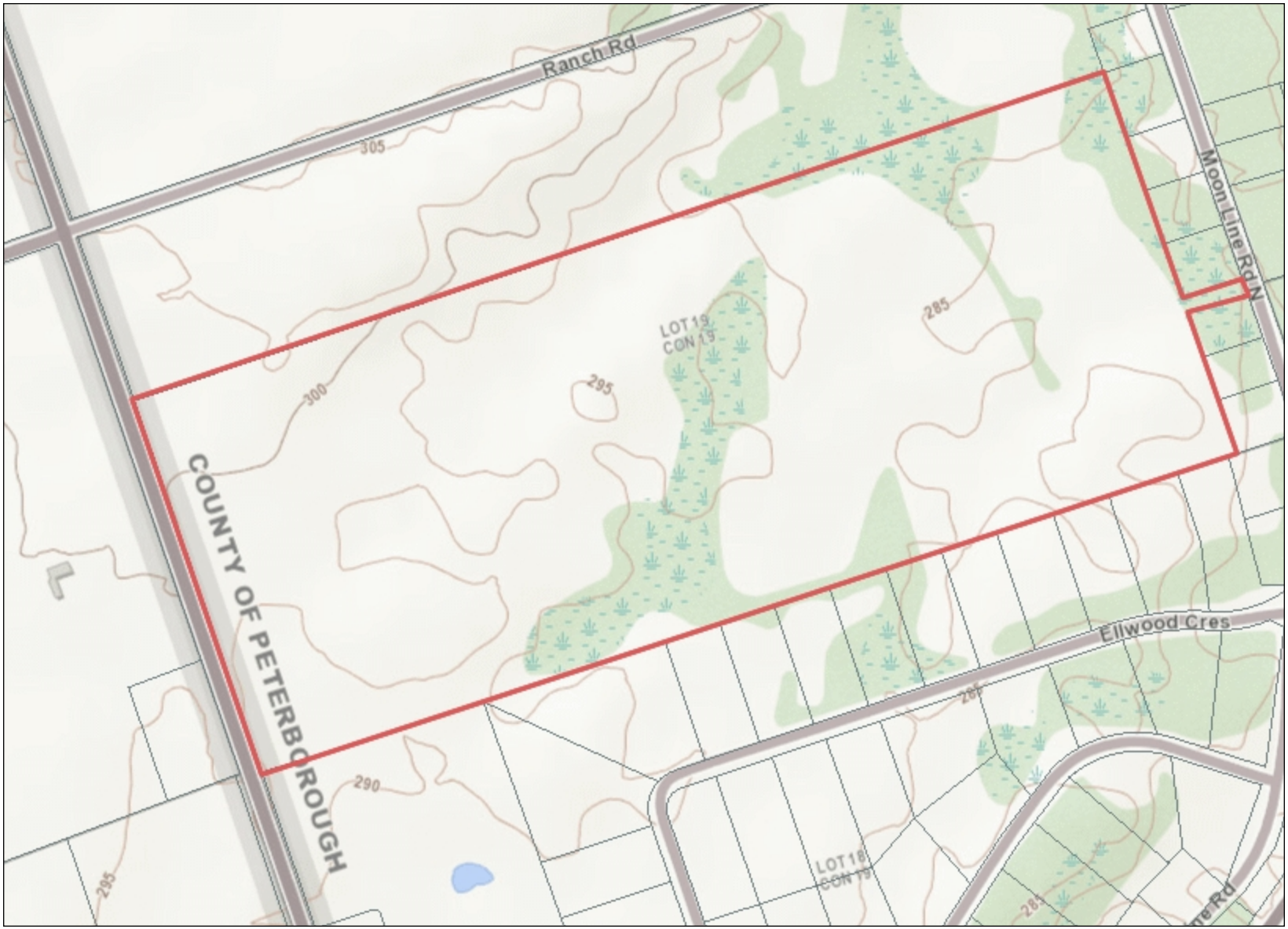
Ontario

MINISTRY OF NATURAL RESOURCES AND FORESTRY

Make a Topographic Map

Topo map

Notes:



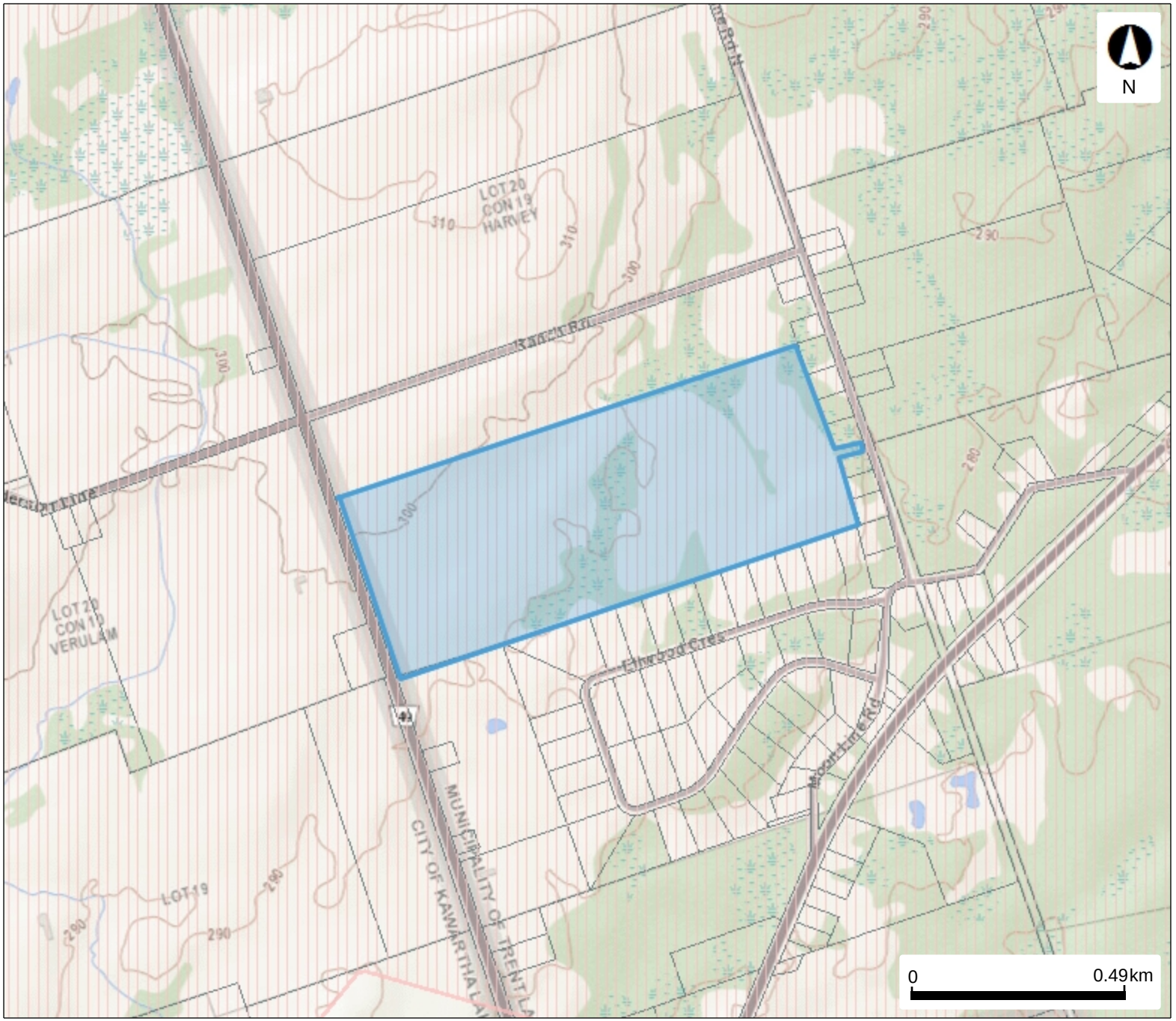
Legend

- Building as Symbol
- Building to Scale
- Airport
- Heliport \ Hospital Heliport
- Seaplane Base
- Ferry Route
- Trail
- Bruce Trail
- Greenbelt Route
- Rideau Trail
- Trans Canada Trail
- Voyageur Trail
- Waterfront Trail
- Railway \ Train Station
- Railway with Bridge
- Railway with Tunnel
- Road (Major → Minor)
- Winter Road
- Road with Bridge
- Road with Tunnel
- Primary, Kings or 400 Series Highway
- Secondary Highway
- Tertiary Highway
- District, County, Regional or Municipal Road
- Toll Highway
- One Way Road
- Road with Permanent Blocked Passage
- Road with Address Ranges
- Hydro Line, Communication Line or Unknown Transmission Line
- Natural Gas Pipeline, Water Pipeline or Unknown Pipeline
- Spot Height
- Index Contour
- Contour
- Wooded Area
- Wetland
- Waterbody
- Waterbody Elevation
- Watercourse
- Falls
- Rapids
- Rapids \ Falls
- Rapids
- Rocks
- Lock Gate
- Dam \ Hydro Wall
- Dam \ Hydro Wall
- Provincial \ State Boundary
- International Boundary
- Upper Tier \ District Municipal Boundary
- Lower Tier \ Single Tier Municipal Boundary
- Lot Line
- Indian Reserve
- Provincial Park
- National Park
- Conservation Reserve
- Military Lands

0 0.3 km

Projection: Web Mercator

Source Protection Information Atlas Map



Legend

- Highly Vulnerable Aquifers
- Assessment Parcel

This map should not be relied on as a precise indicator of routes or locations, nor as a guide to navigation. The Ontario Ministry of Environment, Conservation and Parks (MECP) shall not be liable in any way for the use or any information on this map. of, or reliance upon, this map.

Ontario

Map Created: 11/10/2023
Map Center: 44.56425 N, -78.54321 W

Kawartha Conservation Public Property Mapping Tool

KAWARTHA CONSERVATION

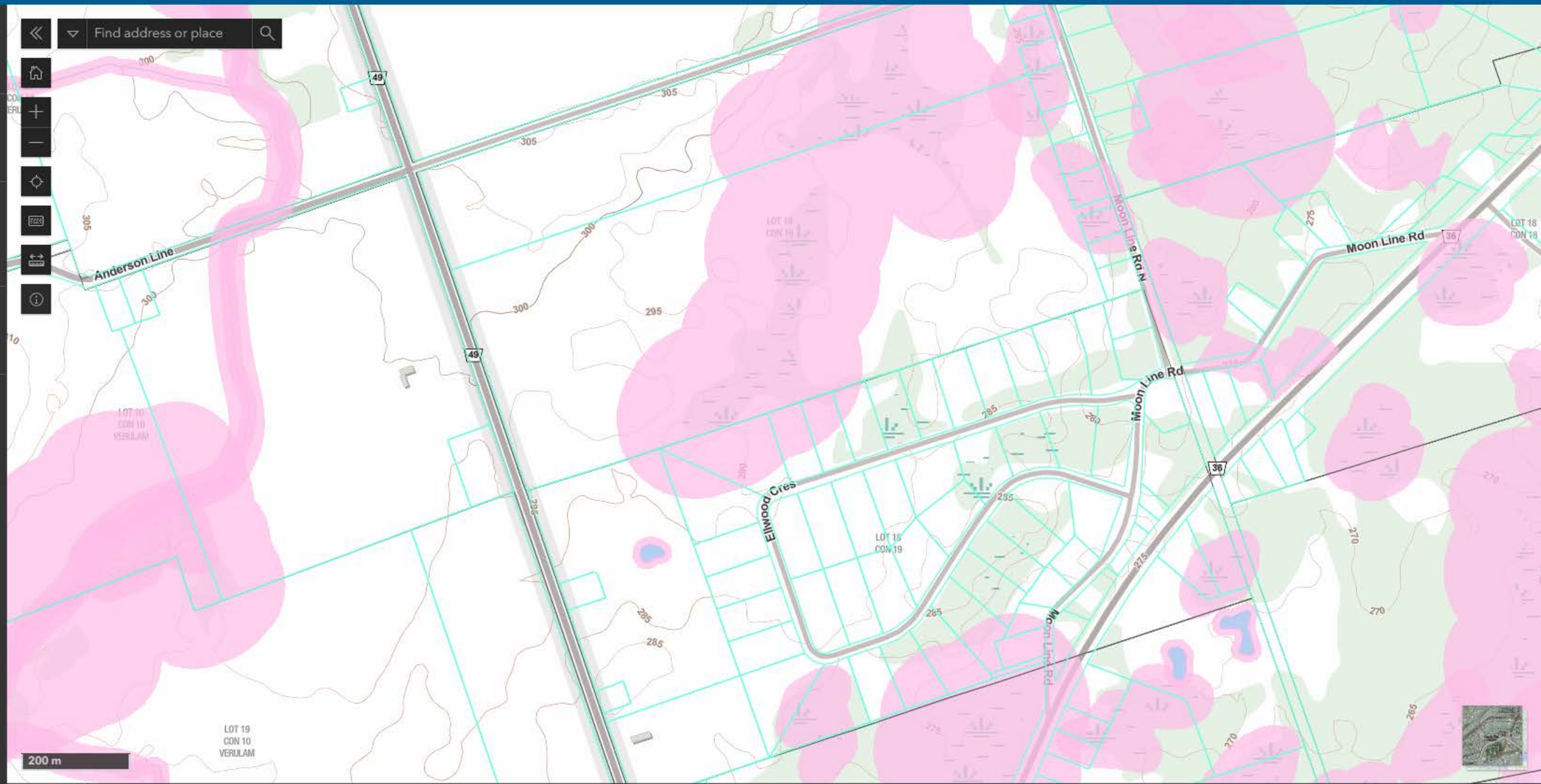
KRCA Assessment Parcels

KRCA_LIO_LotFabric

KRCA_RegulatedAreaBoundary

Wellhead Protection Area

Surface Water Intake Protection Zone



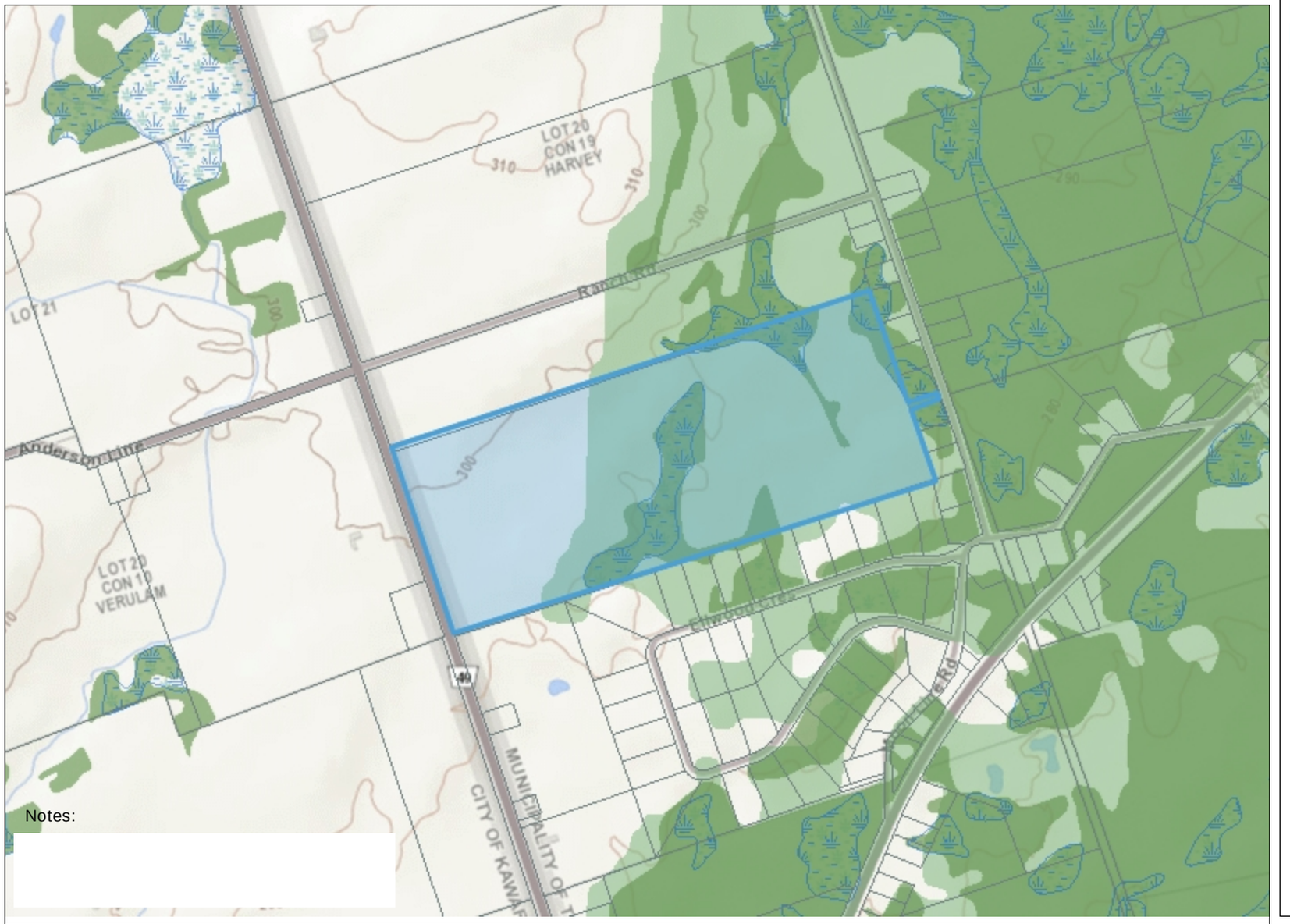
Ontario

Ministry of Natural Resources and Forestry

Make-a-Map: Natural Heritage Areas

Natural Heritage Areas Map

Map created:11/10/2023



Notes:

Legend

- Assessment Parcel
- Evaluated Wetland
- Provincially Significant/considérée d'importance provinciale
- Non-Provincially Significant/non considérée d'importance provinciale
- Unevaluated Wetland
- Woodland
- Natural Heritage System

0.7 0 0.33 0.7 Kilometres

Absence of a feature in the map does not mean they do not exist in this area.

This map should not be relied on as a precise indicator of routes or locations, nor as a guide to navigation. The Ontario Ministry of Natural Resources and Forestry(OMNRF) shall not be liable in any way for the use of, or reliance upon, this map or any information on this map.

Appendix B
Borehole Logs

CAMBIUM
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Log of Borehole: BH101-23

Client:	Jeffrey Homes	**Project Name:**	GEO - 168 County Road 49, Bobcaygeon	**Project No.:**	17986-002
Contractor:	Landshark	**Method:**	Hollow Stem Auger	**Date Completed:**	October 25, 2023
Location:	168 County Road 49, Bobcaygeon	**UTM:**	17T 694675.16 E, 4937141.01 N	**Elevation:**	292.72 masl

Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
293	-1										
292	0		TOPSOIL: 75mm thick layer of topsoil	1A	SS					Cap	
			CLAYEY SILT: Brown, clayey silt, some sand, trace gravel, drier than plastic limit, soft	1B	SS	25	2			Pipe Bentonite Plug	Small cobble throughout Water level measured at 0.33 mbgs on Nov. 10, 2023
291	1		TILL: Light brown, gravelly silty sand, trace clay, moist to wet, compact	2	SS	50	15				
	2			3	SS	42	15			Sand Pack	Groundwater first encountered at 2.29 mbgs
290			TILL: Grey, silty gravel and sand, trace clay, wet, dense	4	SS	70	43			PVC Screen	Water level upon completion at 2.44 mbgs SS4 GSA: 34% gravel 34% sand 25% silt 7% clay
	3		-becomes very dense	5	SS	100	50/75			Cap	
289			Borehole terminated at 3.12 mbgs after auger refusal on presumed bedrock or large boulders								Borehole open upon completion
	4										
288	5										

Logged By: J. Riseling **Input By:** J. Riseling

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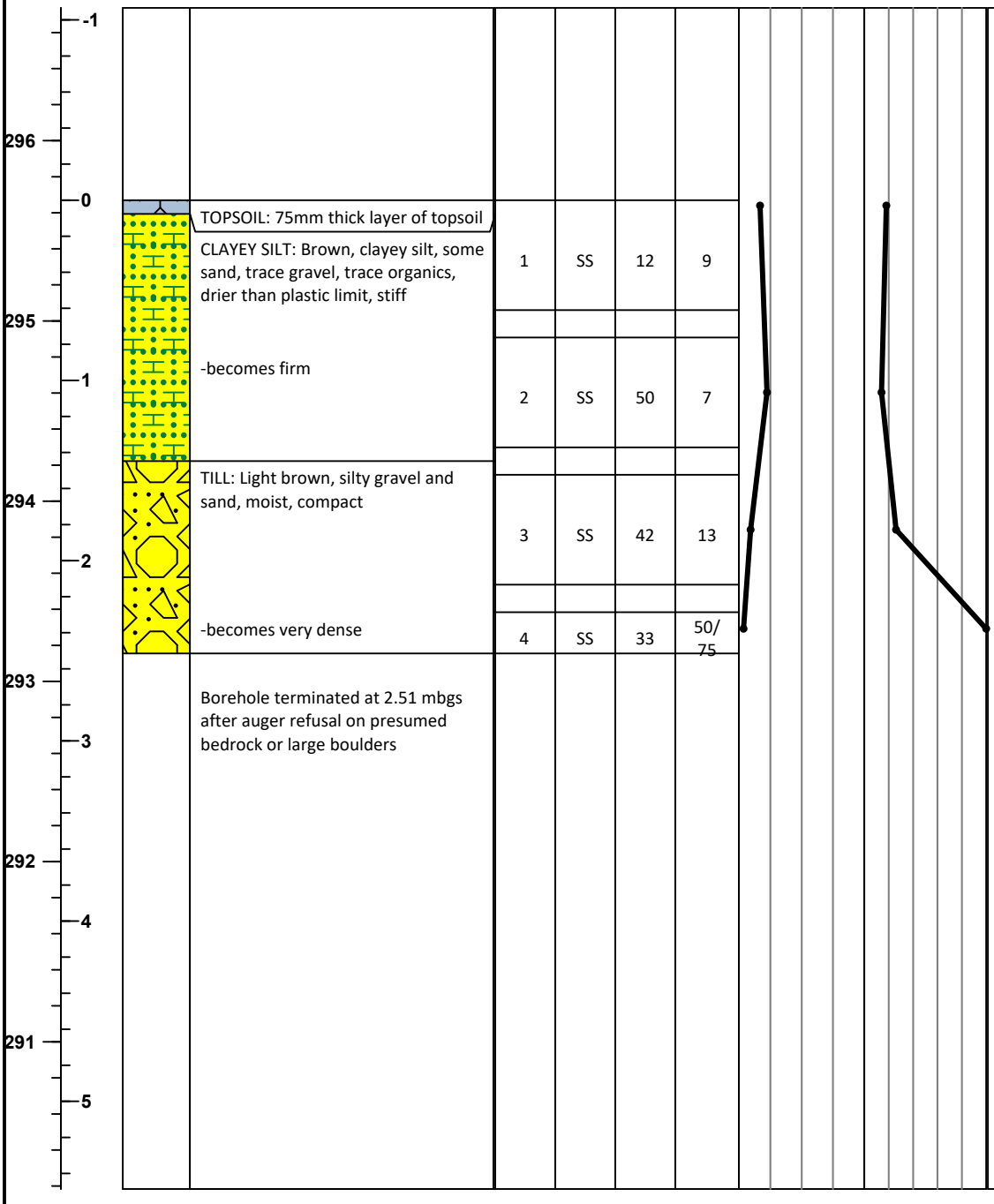
Log of Borehole: BH102-23

Client:	Jeffrey Homes	**Project Name:**	GEO - 168 County Road 49, Bobcaygeon	**Project No.:**	17986-002
Contractor:	Landshark	**Method:**	Hollow Stem Auger	**Date Completed:**	October 25, 2023
Location:	168 County Road 49, Bobcaygeon	**UTM:**	17T 694793.84 E, 4937195.17 N	**Elevation:**	295.67 masl

Elevation (m)	Depth	Description	Number	Type	% Recovery	SPT (N) / DCPT	Well Installation	Remarks
296	0	TOPSOIL: 75mm thick layer of topsoil CLAYEY SILT: Brown, clayey silt, some sand, trace gravel, trace organics, drier than plastic limit, stiff	1	SS	12	9		Small cobble throughout
295	1	-becomes firm	2	SS	50	7		SS2 GSA: 7% gravel 16% sand 50% silt 27% clay
294	2	TILL: Light brown, silty gravel and sand, moist, compact	3	SS	42	13		Borehole open and dry upon completion
		-becomes very dense	4	SS	33	50/75		
293	3	Borehole terminated at 2.51 mbgs after auger refusal on presumed bedrock or large boulders						
292	4							
291	5							



Logged By: J. Riseling **Input By:** J. Riseling

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Log of Borehole: BH103-23

Client:	Jeffrey Homes	**Project Name:**	GEO - 168 County Road 49, Bobcaygeon	**Project No.:**	17986-002
Contractor:	Landshark	**Method:**	Hollow Stem Auger	**Date Completed:**	October 25, 2023
Location:	168 County Road 49, Bobcaygeon	**UTM:**	17T 694882.12 E, 4937290.56 N	**Elevation:**	296.18 masl

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
296 / 0		TOPSOIL: 150mm thick layer of topsoil								
		TILL: Light brown, silty gravel and sand, moist, very dense	1	SS	24	8				
295 / 1			2	SS	58	54				Small cobble throughout
294 / 2			3	SS	75	56				Borehole open and dry upon completion
293 / 3			4	SS	67	52				
292 / 4			5	SS	92	68				
291 / 5		Borehole terminated at 4.65 mbgs after SPT refusal in silty gravel and sand till	6	SS	100	50/75				

Logged By: J. Riseling **Input By:** J. Riseling

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Log of Borehole: BH104-23

Client:	Jeffrey Homes	**Project Name:**	GEO - 168 County Road 49, Bobcaygeon	**Project No.:**	17986-002
Contractor:	Landshark	**Method:**	Hollow Stem Auger	**Date Completed:**	October 25, 2023
Location:	168 County Road 49, Bobcaygeon	**UTM:**	17T 695029.52 E, 4937418.20 N	**Elevation:**	292.26 masl

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
293 / -1										
292 / 0		TOPSOIL: 150mm thick layer of topsoil								
		TILL: Light brown, sandy silty gravel, some clay, moist, compact	1	SS	25	6				
291 / 1			2	SS	75	12				Small cobble throughout
			3	SS	25	11				Borehole open and dry upon completion
290 / 2		-becomes moist to wet	4	SS	75	19				
289 / 3		-becomes very dense	5	SS	0	50/150				
288 / 4		-becomes grey	6	SS	100	50/50				
287 / 5		Borehole terminated at 4.62 mbgs after SPT refusal in sandy silty gravel till								

Logged By: J. Riseling **Input By:** J. Riseling

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Log of Borehole: BH105-23

Client:	Jeffrey Homes	**Project Name:**	GEO - 168 County Road 49, Bobcaygeon	**Project No.:**	17986-002
Contractor:	Landshark	**Method:**	Hollow Stem Auger	**Date Completed:**	October 25, 2023
Location:	168 County Road 49, Bobcaygeon	**UTM:**	17T 695220.03 E, 4937348.23 N	**Elevation:**	290.23 masl

SUBSURFACE PROFILE			SAMPLE								
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
291 / -1										
290 / 0		TOPSOIL: 200mm thick layer of topsoil	1A	SS	58	8				
		TILL: Brown, sandy silty gravel, some clay, moist, loose	1B	SS						
289 / 1		-becomes dense	2	SS	25	37				Small cobble throughout
288 / 2			3	SS	75	31				SS3 GSA: 39% gravel 28% sand 23% silt 10% clay
		-becomes very dense	4	SS	100	50/ 125				
287 / 3			5	SS	100	50/ 150				Borehole open and dry upon completion
286 / 4			6	SS	25	50/ 100				
285 / 5		Borehole terminated at 4.67 mbgs after SPT refusal in sandy silty gravel till								

Logged By: J. Riseling **Input By:** J. Riseling

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Kingston
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Log of Borehole: BH106-23

Client:	Jeffrey Homes	**Project Name:**	GEO - 168 County Road 49, Bobcaygeon	**Project No.:**	17986-002
Contractor:	Landshark	**Method:**	Hollow Stem Auger	**Date Completed:**	October 26, 2023
Location:	168 County Road 49, Bobcaygeon	**UTM:**	17T 695333.16 E, 4937462.64 N	**Elevation:**	288.64 masl

Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
289	-1										
288	0		TOPSOIL: 200mm thick layer of topsoil	1	SS	33	7				Small cobble throughout
			TILL: Light brown, gravelly silty sand, trace clay, moist, dense								
	1			2	SS	42	49				Borehole open and dry upon completion
287				3	SS	83	41				
	2		-becomes very dense	4	SS	67	59				
286				5	SS	33	50/75				
	3										
285											
	4			6	SS	80	50/100				
284			Borehole terminated at 4.82 mbgs after SPT refusal in gravelly silty sand till								
	5										

Logged By: J. Riseling **Input By:** J. Riseling

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Kingston
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Log of Borehole: BH107-23

Client:	Jeffrey Homes	**Project Name:**	GEO - 168 County Road 49, Bobcaygeon	**Project No.:**	17986-002
Contractor:	Landshark	**Method:**	Hollow Stem Auger	**Date Completed:**	October 26, 2023
Location:	168 County Road 49, Bobcaygeon	**UTM:**	17T 695513.31 E, 4937433.93 N	**Elevation:**	286.35 masl

Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
287	-1										
286	0		TOPSOIL: 250mm thick layer of topsoil								
			TILL: Light brown, gravelly silty sand, trace clay, moist, very dense	1	SS	42	6				Small cobble throughout
285	1			2	SS	96	83				
				3	SS	50	50/100				Borehole open and dry upon completion
284	2			4	SS	100	80				
283	3			5	SS	55	50/125				
282	4			6	SS	67	50/75				
281	5		Borehole terminated at 4.80 mbgs after SPT refusal in gravelly silty sand till								

Logged By: J. Riseling **Input By:** J. Riseling

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Log of Borehole: BH108-23

Client:	Jeffrey Homes	**Project Name:**	GEO - 168 County Road 49, Bobcaygeon	**Project No.:**	17986-002
Contractor:	Landshark	**Method:**	Hollow Stem Auger	**Date Completed:**	October 26, 2023
Location:	168 County Road 49, Bobcaygeon	**UTM:**	17T 695459.31 E, 4937561.77 N	**Elevation:**	287.88 masl

Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
288	0		TOPSOIL: 150mm thick layer of topsoil	1A	SS	42	9			Cap	
			TILL: Light brown, gravelly silty sand, trace clay, moist, loose	1B	SS						
287	1		-becomes dense	2	SS	67	49			Pipe Bentonite Plug	Small cobble throughout
286	2		-becomes very dense	3	SS	58	69				SS3 GSA: 32% gravel 41% sand 20% silt 7% clay
				4	SS	0	50/75				Borehole open and dry upon completion
285	3			5	SS	50	50/50			Sand Pack PVC Screen	Monitoring well was found dry on Nov. 10, 2023
284	4										
				6	SS	67	50/150			Cap	
283	5		Borehole terminated at 4.72 mbgs after SPT refusal in gravelly silty sand till								

Logged By: J. Riseling **Input By:** J. Riseling

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Kingston
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Log of Borehole: BH109-23

Client:	Jeffrey Homes	**Project Name:**	GEO - 168 County Road 49, Bobcaygeon	**Project No.:**	17986-002
Contractor:	Landshark	**Method:**	Hollow Stem Auger	**Date Completed:**	October 26, 2023
Location:	168 County Road 49, Bobcaygeon	**UTM:**	17T 695333.74 E, 4937710.50 N	**Elevation:**	290.31 masl

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
291 / -1										
290 / 0		TOPSOIL: 200mm thick layer of topsoil	1A	SS	50	10			Cap	
		TILL: Light brown, gravelly silty sand, trace clay, moist, compact	1B	SS						Small cobble throughout
289 / -1		-becomes dense	2	SS	33	42			Pipe Bentonite Plug	Borehole open and dry upon completion
288 / -2		-becomes very dense	3	SS	75	53				
			4	SS	100	77				SS4 GSA: 33% gravel 35% sand 23% silt 9% clay
287 / -3			5	SS	67	50/150			Sand Pack PVC Screen	Monitoring well was found dry on Nov. 10, 2023
286 / -4			6	SS	100	50/125			Cap	
285 / -5		Borehole terminated at 4.85 mbgs after SPT refusal in gravelly silty sand till								

Logged By: J. Riseling **Input By:** J. Riseling

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Kingston
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Log of Borehole: BH110-23

Client:	Jeffrey Homes	**Project Name:**	GEO - 168 County Road 49, Bobcaygeon	**Project No.:**	17986-002
Contractor:	Landshark	**Method:**	Hollow Stem Auger	**Date Completed:**	October 26, 2023
Location:	168 County Road 49, Bobcaygeon	**UTM:**	17T 695259.48 E, 4937570.87 N	**Elevation:**	290.26 masl

Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
291	-1										
290	0		TOPSOIL: 75mm thick layer of topsoil	1A	SS						
			TILL: Light brown, gravelly silty sand, trace clay, moist, loose	1B	SS	46	6				
289	-1		-becomes dense	2	SS	33	37				Small cobble throughout
				3	SS	83	35				Borehole open and dry upon completion
288	-2		-becomes very dense	4	SS	67	50/ 75				
287	-3			5	SS	100	50/ 100				
286	-4			6	SS	88	50/ 250				
285	-5		Borehole terminated at 4.98 mbgs after SPT refusal in gravelly silty sand till								

Logged By: J. Riseling **Input By:** J. Riseling

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Log of Borehole: BH111-23

Client:	Jeffrey Homes	**Project Name:**	GEO - 168 County Road 49, Bobcaygeon	**Project No.:**	17986-002
Contractor:	Landshark	**Method:**	Hollow Stem Auger	**Date Completed:**	October 27, 2023
Location:	168 County Road 49, Bobcaygeon	**UTM:**	17T 694825.61 E, 4937424.12 N	**Elevation:**	294.96 masl

SUBSURFACE PROFILE			SAMPLE								
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
296 / -1										
295 / 0		TOPSOIL: 200mm thick layer of topsoil	1	SS	38	8				Small cobble throughout
		TILL: Light brown, sandy silty gravel, some clay, moist, loose								
294 / -1		-becomes compact	2	SS	33	18				Borehole open and dry upon completion
293 / -2			3	SS	12	24				
			4	SS	55	26				
292 / -3		-becomes very dense	5	SS	0	50/50				
		Borehole terminated at 3.35 mbgs after auger refusal on presumed bedrock or large boulder								
291 / -4										
290 / -5										

Logged By: J. Riseling **Input By:** J. Riseling

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Log of Borehole: BH112-23

Client:	Jeffrey Homes	**Project Name:**	GEO - 168 County Road 49, Bobcaygeon	**Project No.:**	17986-002
Contractor:	Landshark	**Method:**	Hollow Stem Auger	**Date Completed:**	October 27, 2023
Location:	168 County Road 49, Bobcaygeon	**UTM:**	17T 694713.62 E, 4937533.65 N	**Elevation:**	304.44 masl

SUBSURFACE PROFILE			SAMPLE								
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
305 / 0		TOPSOIL: 150mm thick layer of topsoil	1A	SS	75	11				
304 / 1		TILL: Light brown, sandy silty gravel, some clay, moist, compact	1B	SS						
		-becomes dense	2	SS	67	49				Small cobble throughout
303 / 2			3	SS	83	41				SS3 GSA: 34% gravel 29% sand 26% silt 11% clay
302 / 3		-becomes very dense	4	SS	0	50/ 225				
			5	SS	100	50/ 75				Borehole open and dry upon completion
301 / 4										
300 / 5			6	SS	67	50/ 75				
299		Borehole terminated at 4.80 mbgs after SPT refusal in sandy silty gravel till								

Logged By: J. Riseling **Input By:** J. Riseling

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Log of Borehole: BH113-23

Client:	Jeffrey Homes	**Project Name:**	GEO - 168 County Road 49, Bobcaygeon	**Project No.:**	17986-002
Contractor:	Landshark	**Method:**	Hollow Stem Auger	**Date Completed:**	October 27, 2023
Location:	168 County Road 49, Bobcaygeon	**UTM:**	17T 694578.13 E, 4937436.09 N	**Elevation:**	301.62 masl

SUBSURFACE PROFILE			SAMPLE								
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
302 / 0		TOPSOIL: 150mm thick layer of topsoil	1A	SS					Cap	
		TILL: Light brown, sandy silty gravel, some clay, moist, loose	1B	SS	33	7				
301 / 1		-becomes compact	2	SS	36	23			Pipe Bentonite Plug	Small cobble throughout Borehole open and dry upon completion
300 / 2			3	SS	50	22				
299 / 3		-becomes very dense	4	SS	33	50/225				
			5	SS	0	50/100			Sand Pack PVC Screen	Water level measured at 3.85 mbgs on Nov. 10, 2023
298 / 4										
297 / 5		Borehole terminated at 4.60 mbgs after SPT refusal in sandy silty gravel till	6	SS	100	50/25			Cap	

Logged By: J. Riseling **Input By:** J. Riseling

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Log of Borehole: BH114-23

Client:	Jeffrey Homes	**Project Name:**	GEO - 168 County Road 49, Bobcaygeon	**Project No.:**	17986-002
Contractor:	Landshark	**Method:**	Hollow Stem Auger	**Date Completed:**	October 27, 2023
Location:	168 County Road 49, Bobcaygeon	**UTM:**	17T 694694.37 E, 4937341.31 N	**Elevation:**	297.54 masl

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
298 / 0		TOPSOIL: 200mm thick layer of topsoil	1	SS	33	4				Small cobble throughout
297 / 1		TILL: Light brown, sandy silty gravel, some clay, moist, loose								
		-becomes compact	2	SS	50	21				Borehole open and dry upon completion
296 / 2		-becomes dense	3	SS	21	32				
		-becomes very dense	4	SS	20	50/125				
295 / 3			5	SS	0	50/50				
294 / 4		Borehole terminated at 3.66 mbgs after auger refusal on presumed bedrock or large boulder								
293 / 5										

Logged By: J. Riseling **Input By:** J. Riseling

Appendix C
Grain Size Analysis

Grain Size Distribution Chart

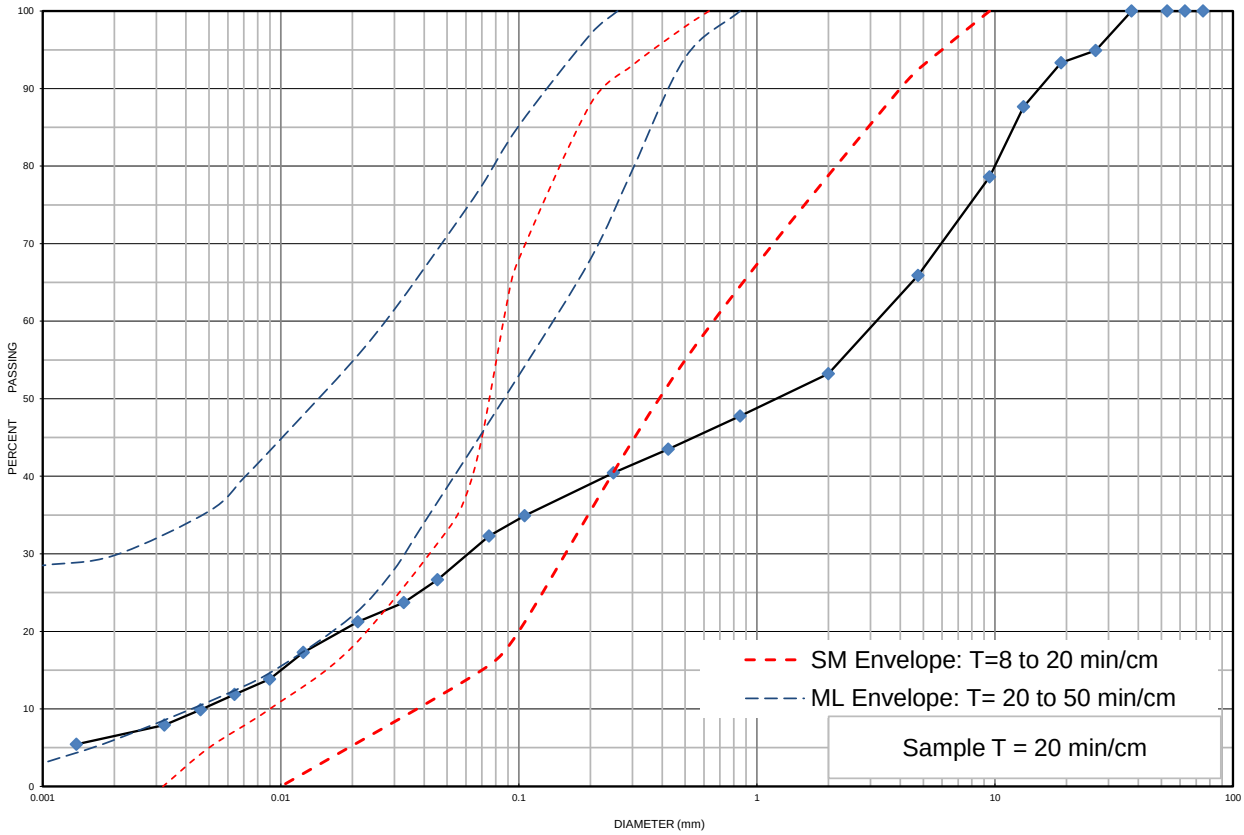
Project Number: *17986-002* **Client:** *Jeffery Homes*

Project Name: *Pt. Lot 19, Conc. 19 - Bobcaygeon Development*

Sample Date: *October 25-27, 2023* **Sampled By:** *Josh Riseling - Cambium Inc.*

Location: *BH 101-23 SS 4* **Depth:** *2.3 m to 2.9 m* **Lab Sample No:** *S-23-1845*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 101-23	SS 4	2.3 m to 2.9 m	34	34	25	7	7.5

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Silty Gravel and Sand trace Clay	SM	3.2500	0.0610	0.0047	691.49	0.24

Additional information availabe upon request

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Grain Size Distribution Chart

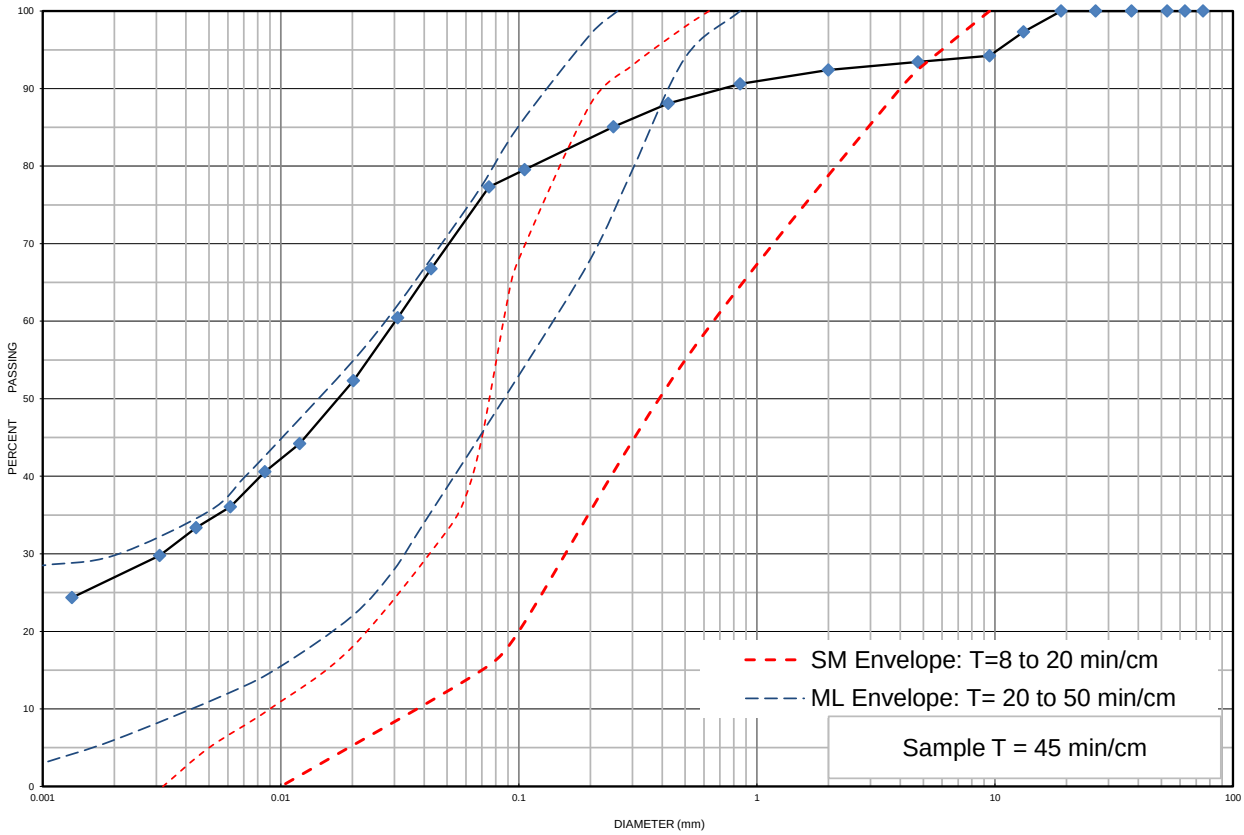
Project Number: *17986-002* **Client:** *Jeffery Homes*

Project Name: *Pt. Lot 19, Conc. 19 - Bobcaygeon Development*

Sample Date: *October 25-27, 2023* **Sampled By:** *Josh Riseling - Cambium Inc.*

Location: *BH 102-23 SS 2* **Depth:** *0.8 m to 1.4 m* **Lab Sample No:** *S-23-1846*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 102-23	SS 2	0.8 m to 1.4 m	7	16	50	27	22.3

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Clayey Silt some Sand trace Gravel	ML	0.0300	0.0032	-	-	-

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Grain Size Distribution Chart

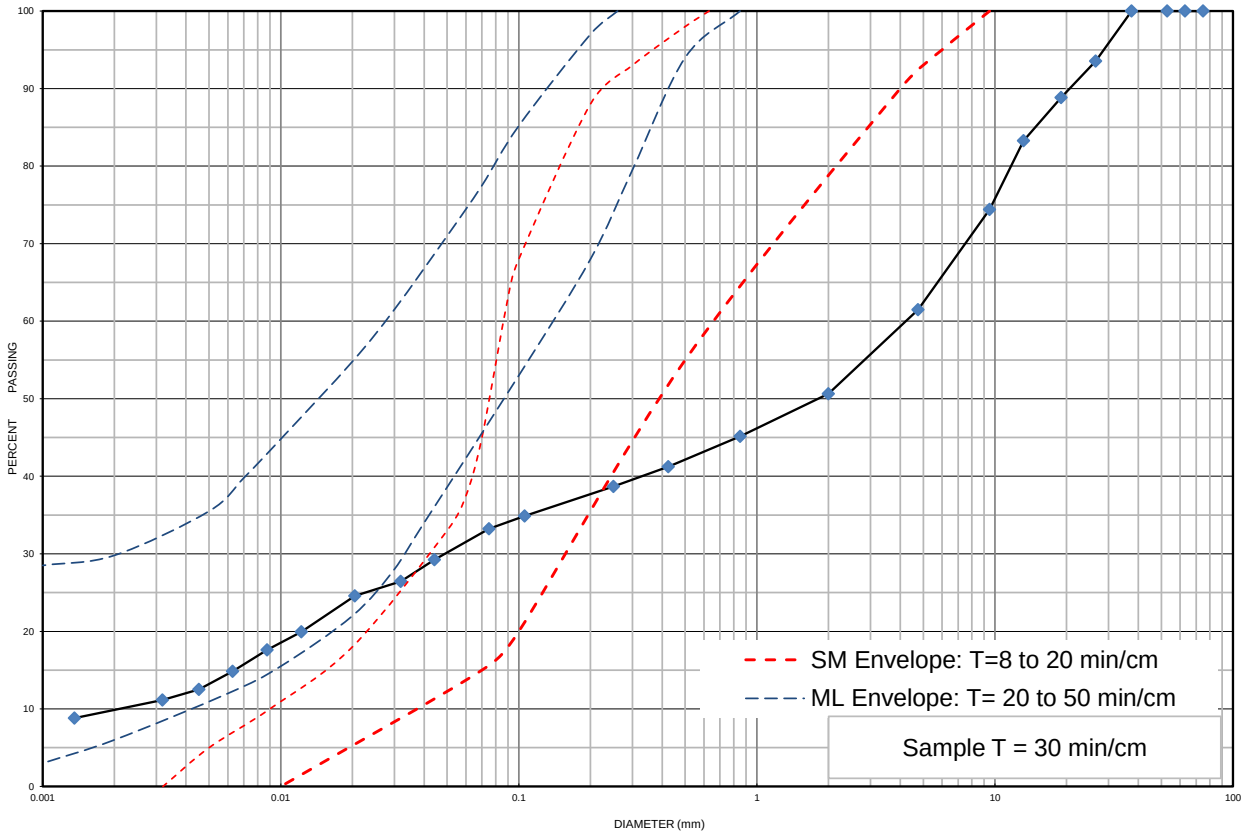
Project Number: *17986-002* **Client:** *Jeffery Homes*

Project Name: *Pt. Lot 19, Conc. 19 - Bobcaygeon Development*

Sample Date: *October 25-27, 2023* **Sampled By:** *Josh Riseling - Cambium Inc.*

Location: *BH 105-23 SS 3* **Depth:** *1.5 m to 2.1 m* **Lab Sample No:** *S-23-1847*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 105-23	SS 3	1.5 m to 2.1 m	39	28	23	10	6.2

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Sandy Silty Gravel some Clay	SM	4.200	0.050	0.002	2100.00	0.30

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Grain Size Distribution Chart

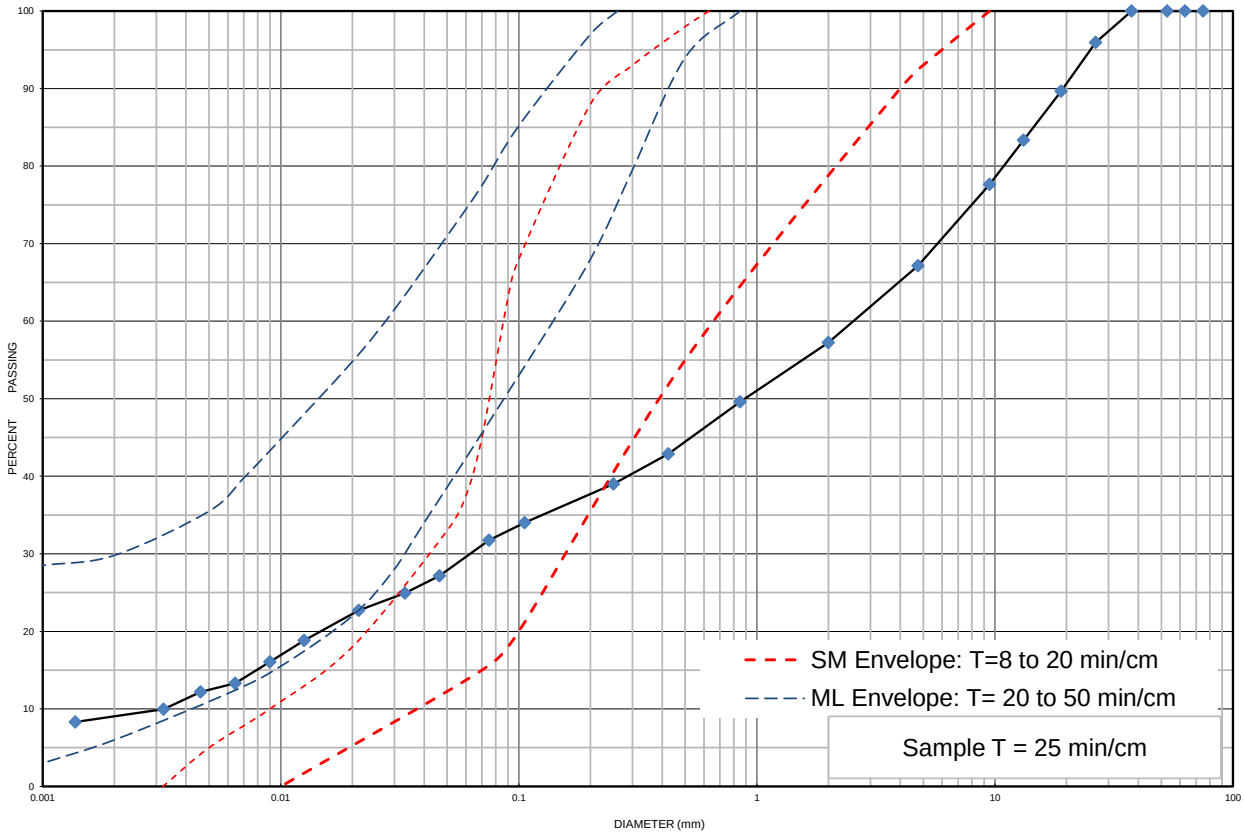
Project Number: *17986-002* **Client:** *Jeffery Homes*

Project Name: *Pt. Lot 19, Conc. 19 - Bobcaygeon Development*

Sample Date: *October 25-27, 2023* **Sampled By:** *Josh Riseling - Cambium Inc.*

Location: *BH 109-23 SS 4* **Depth:** *2.3 m to 2.9 m* **Lab Sample No:** *S-23-1849*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 109-23	SS 4	2.3 m to 2.9 m	33	35	23	9	5.5

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Gravelly Silty Sand trace Clay	SM	2.6000	0.0620	0.0031	838.71	0.48

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Grain Size Distribution Chart

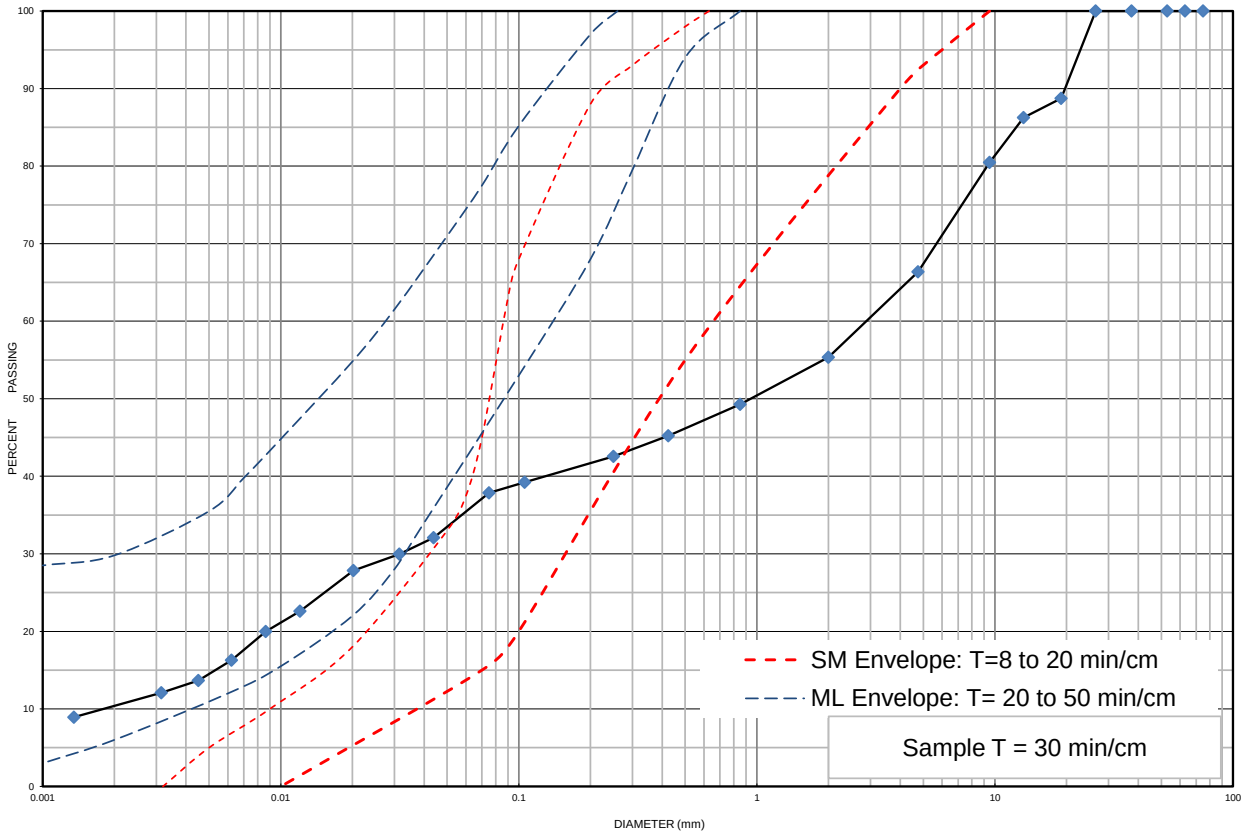
Project Number: *17986-002* **Client:** *Jeffery Homes*

Project Name: *Pt. Lot 19, Conc. 19 - Bobcaygeon Development*

Sample Date: *October 25-27, 2023* **Sampled By:** *Josh Riseling - Cambium Inc.*

Location: *BH 112-23 SS 3* **Depth:** *1.5 m to 2.1 m* **Lab Sample No:** *S-23-1850*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 112-23	SS 3	1.5 m to 2.1 m	34	29	26	11	6.8

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Sandy Silty Gravel some Clay	SM	2.9500	0.0330	0.0019	1552.63	0.19

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Appendix D

AquiferTest Pro Results

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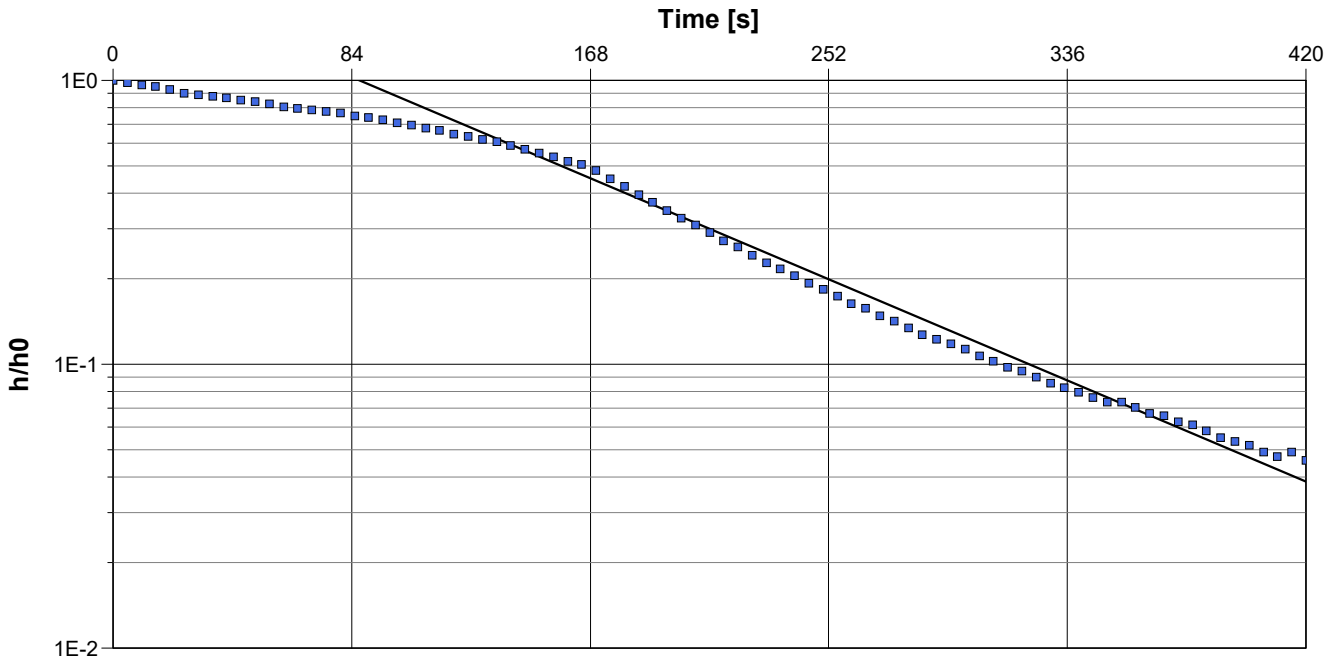
Slug Test Analysis Report

Project: 168 County Road 49, Bobcaygeon

Number: 17986-002

Client: Jeffrey Homes

Location: Bobcaygeon, ON	Slug Test: Slug Test 1	Test Well: MW101-23
Test Conducted by: J. Munro		Test Date: 11/10/2023
Analysis Performed by: W. Young	Hvorslev	Analysis Date: 11/13/2023
Aquifer Thickness: 2.44 m		



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]	
MW101-23	8.38×10^{-6}	

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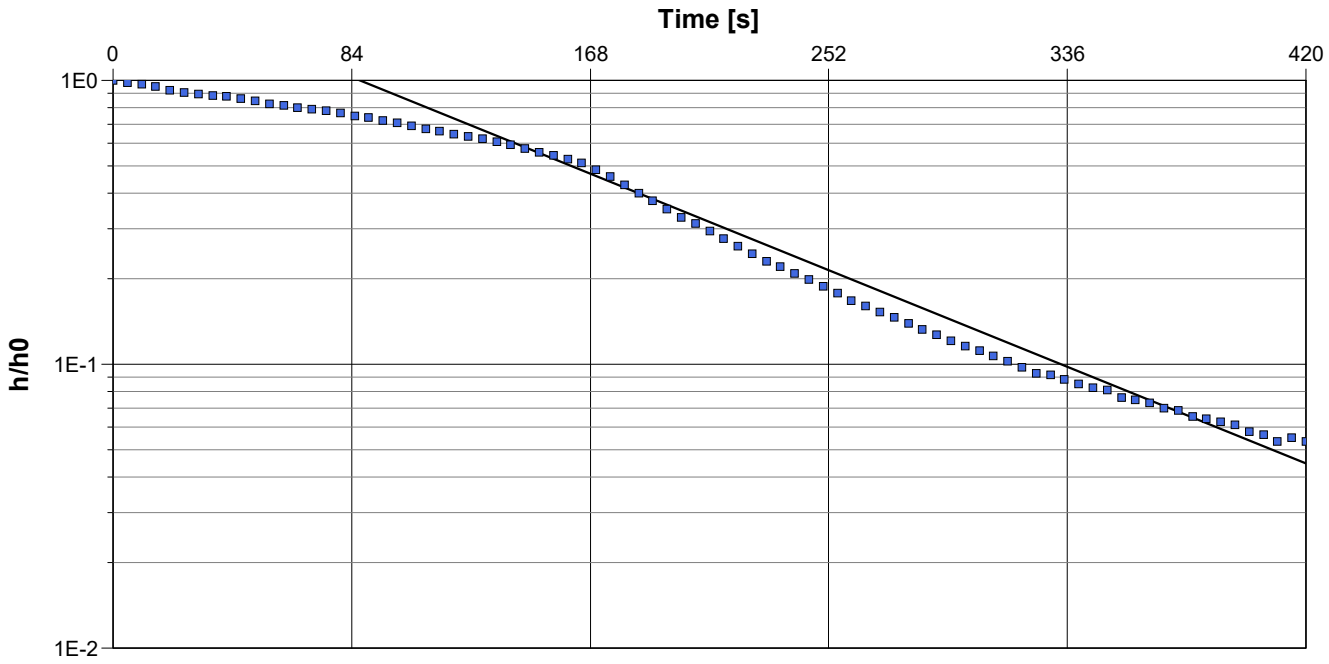
Slug Test Analysis Report

Project: 168 County Road 49, Bobcaygeon

Number: 17986-002

Client: Jeffrey Homes

Location: Bobcaygeon, ON	Slug Test: Slug Test 2	Test Well: MW101-23
Test Conducted by: J.Munro		Test Date: 11/10/2023
Analysis Performed by: W. Young	Hvorslev	Analysis Date: 11/13/2023
Aquifer Thickness: 2.44 m		



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]	
MW101-23	8.00×10^{-6}	

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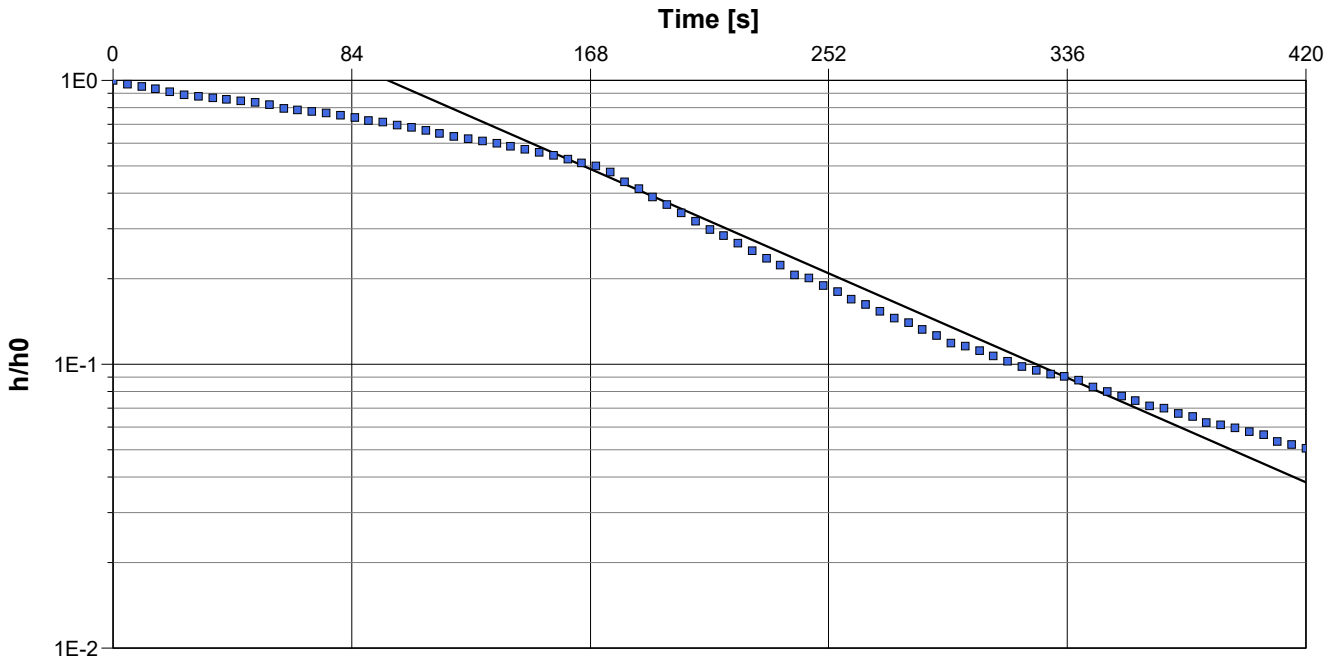
Slug Test Analysis Report

Project: 168 County Road 49, Bobcaygeon

Number: 17986-002

Client: Jeffrey Homes

Location: Bobcaygeon, ON	Slug Test: Slug Test 3	Test Well: MW101-23
Test Conducted by: J. Munro		Test Date: 11/10/2023
Analysis Performed by: W. Young	Hvorslev	Analysis Date: 11/13/2023
Aquifer Thickness: 2.44 m		



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]	
MW101-23	8.64×10^{-6}	

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K9H 1E5

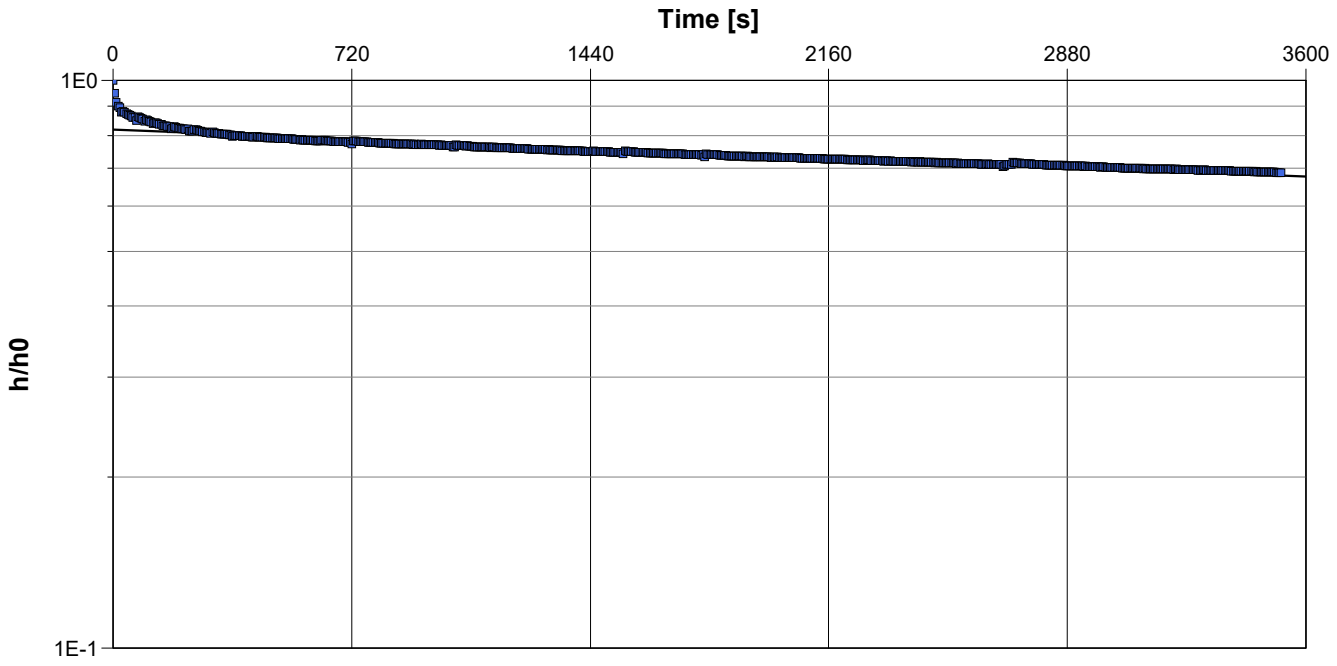
Slug Test Analysis Report

Project: 168 County Road 49, Bobcaygeon

Number: 17986-002

Client: Jeffrey Homes

Location: Bobcaygeon, ON	Slug Test: Slug Test 1	Test Well: MW113-23
Test Conducted by: J, Munro		Test Date: 11/10/2023
Analysis Performed by: W. Young	Hvorslev	Analysis Date: 11/13/2023
Aquifer Thickness: 0.58 m		



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]	
MW113-23	4.51×10^{-8}	

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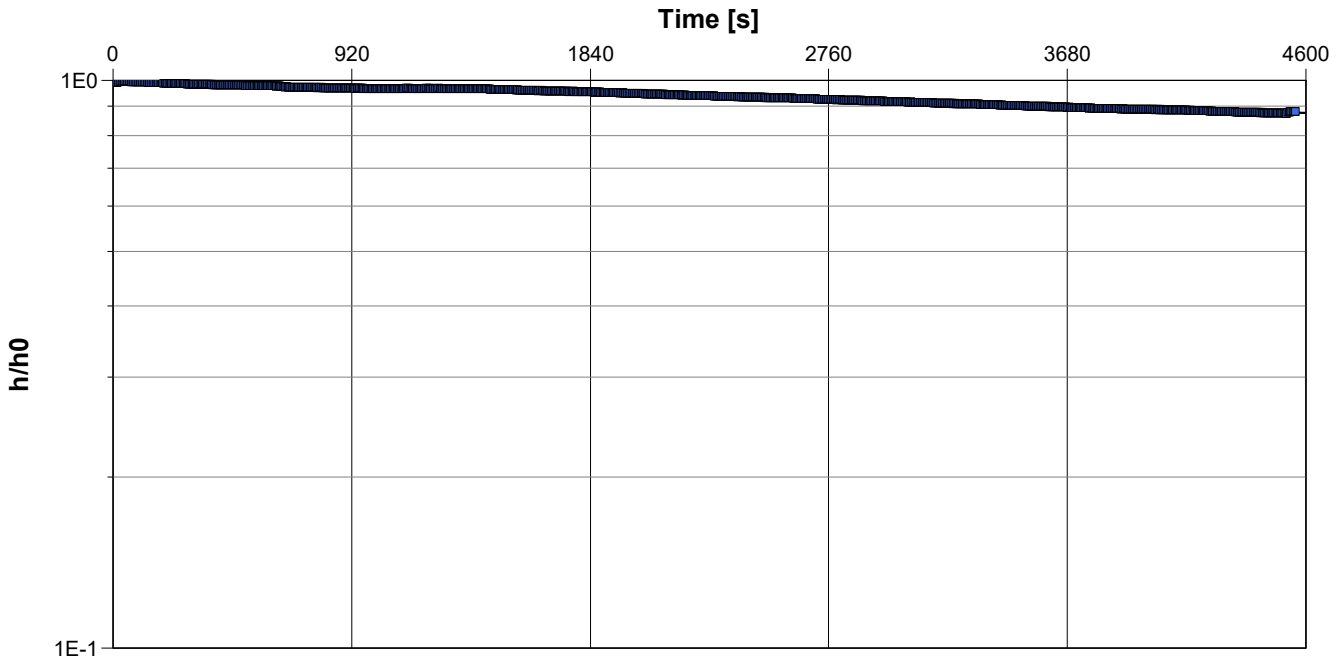
Slug Test Analysis Report

Project: 168 County Road 49, Bobcaygeon

Number: 17986-002

Client: Jeffrey Homes

Location: Bobcaygeon, ON	Slug Test: Slug Test 2	Test Well: MW113-23
Test Conducted by: J. Munro		Test Date: 11/10/2023
Analysis Performed by: W. Young	Hvorslev	Analysis Date: 11/13/2023
Aquifer Thickness: 0.58 m		



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]	
MW113-23	2.45×10^{-8}	

Appendix E

Water Balance Calculations

Water Balance Calculations

Part of Lot 19, Concession 19, Township of Galway-Cavendish and Harvey, County of Peterborough

THORNTHWAITE-TYPE MONTHLY WATER-BALANCE MODEL

modified from Dingman 2015: Box 6-8 (pg 299) using ET model of Hamon (1963)

		Input Data				Computed Values							
											Surplus	342	mm/yr
Weather Station Location:	**Peterborough Trent U**					**Latitude:**	**44.2**	**degree**					
Solar Declination (degree)	-20.6	-12.6	-1.5	10.0	19.0	23.1	21.0	13.4	2.6	-9.0	-18.5	-23.0	
DayLength (hr)*	9.1	10.3	11.8	13.3	14.6	15.3	14.9	13.8	12.3	10.8	9.5	8.7	
Available Water Storage Capacity		0.18	m/m		**Root Depth**	1500	mm			**SOILmax**	270.0	mm	

MONTHLY WATER BALANCE DATA

Temperatures in C, water-balance terms in mm.

Month:	J	F	M	A	M	J	J	A	S	O	N	D	Year
TEMPERATURE (T)	-8.4	-6.5	-1.3	6.3	12.8	18.0	20.7	19.4	15.0	8.4	2.4	-4.0	
PRECIPITATION (P)	57.3	48.8	56.5	66.4	88.7	83.0	73.6	87.0	92.4	77.0	85.5	66.0	882
RAIN	22.4	23.1	34.0	60.9	88.7	83.0	73.6	87.0	92.4	75.7	73.3	35.0	749
SNOW	35	26	23	6	0	0	0	0	0	1	12	31	133
MELT FACTOR (F)	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.40	0.00	
PACK	73	99	121	0	0	0	0	0	0	0	7	38	
MELT	0	0	0	127	0	0	0	0	0	1	5	0	133
INPUT (W)	22	23	34	188	89	83	74	87	92	77	78	35	882
POTENTIAL ET (PET)	0	0	0	41	70	97	115	98	65	39	22	0	548
NET INPUT (ΔW)	22	23	34	147	19	-14	-41	-11	27	38	56	35	
SOIL MOISTURE (SOIL)	270	270	270	270	270	256	220	211	238	270	270	270	
ΔSOIL	0	0	0	0	0	-14	-36	-9	27	32	0	0	0
ET	0	0	0	41	70	97	110	96	65	39	22	0	540
SURPLUS=W-ET-DSOIL	22	23	34	147	19	0	0	0	0	6	56	35	342

Notes:

Precipitation, Rain, Temperature, and Latitude are inputted parameters

SOILmax = available water storage capacity * root depth

m = month

D = Day length (hrs) $=2*\cos^{-1}(-\tan(\text{Latitude})*\tan(\text{Declination}))/0.2618$ [calculation is in radians]

$SNOW_m = P_m - RAIN_m$

$F_m = 0$ if $T_m <= 0^oC$; $F_m = 0.167*T_m$ if $0^oC<T_m<6^oC$; $F_m = 1$ if $T_m>=6^oC$

$PACK_m = (1-F_m)*(SNOW_m+PACK_{m-1})$

$MELT = F_m*(SNOW_m+PACK_{m-1})$

$W_m = RAIN_m+MELT_m$.

PET = 0 if $T_m<0$; otherwise $PET = 2.98*0.611*\exp(17.3*T_m/(T_m+237))/(T_m+237.2)*$Number of days in month [Hamon ET model (1963)]

$\Delta W_m = W_m - PET_m$

$SOIL = \min\{[\Delta W_m+SOIL_{m-1}], SOILmax\}$, if $\Delta Wm>0$; otherwise $SOIL = SOIL_{m-1} * \exp(\Delta W/SOILmax)$

$\Delta SOIL = SOIL_{m-1} - SOIL_m$

ET = PET if W_m > PET; otherwise, $ET=W_m-\Delta SOIL$

Pre- and Post-Development
Phase 1 Water Balance Calculations
Part of Lot 19, Concession 19, Township of Galway-Cavendish and Harvey, County of Peterborough

1 Climate Information

Precipitation	882	mm/yr
Actual Evapotranspiration	540	mm/yr
Water Surplus	342	mm/yr

2 Infiltration Rates

Table 2 Approach - Infiltration factors		
Topography: Rolling hills	0.2	
Soil Type: Till(Combination of sand,silt and gravel)	0.3	
Cover: Cultivated land/Woodland	0.15	
Total Infiltration Factor	**0.65**	
Infiltration (Water Surplus * Infiltration Factor)	**222**	mm/yr
Run-off (Water Surplus - Infiltration)	**120**	mm/yr

Table 3 Approach - Typical Recharge Rates		
Coarse Sand and Gravel	>250	mm/yr
Fine to medium sand	200-250	mm/yr
Silty sand to sandy silt	150-200	mm/yr
Silt	125-150	mm/yr
Clayey Silt	100- 125	mm/yr
Clay	<100	mm/yr

Site development area is underlain predominantly by a glacial till sand, silt and gravel combination

Based on the above, the recharge rate is typically	150-200	mm/yr

3 Phase 1 - Pre-Development Property Statistics	**ha**	**m^2**
Total Paved Area	0.07	700
Total Roof Area	0.03	300
Total Landscape Area	21.71	217,080
Total	**21.81**	**218,080**

4 Phase 1 - Post-Development Property Statistics	**ha**	**m^2**
Total Paved Area	3.33	33,254
Total Roof Area	0.63	6,250
Total Landscape Area	17.86	178,576
Total	**21.81**	**218,080**

Pre- and Post-Development
Phase 1 Water Balance Calculations
Part of Lot 19, Concession 19, Township of Galway-Cavendish and Harvey, County of Peterborough

5 Phase 1 Pre-Development Water Balance

Land Use		Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Impervious Areas	Paved Area	700	617	62	-	556
	Roof Area	300	265	26	-	238
Pervious Areas	Landscape Area	217,080	191,465	117,223	48,257	25,984
	Totals	218,080	192,347	117,311	48,257	26,778

Assuming no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

6 Phase 1 Post-Development Water Balance

Land Use		Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Impervious Areas	Paved Area	33,254	29,330	2,933	-	26,397
	Roof Area	6,250	5,513	551	-	4,961
Pervious Areas	Landscape Area	178,576	157,504	96,431	39,697	21,376
	Totals	218,080	192,347	99,915	39,697	52,734

Assuming no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

7 Comparision of Pre- and Post -Development for Phase 1

	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Pre-Development	192,347	117,311	48,257	26,778
Post-Development	192,347	99,915	39,697	52,734
Change in Volume	-	- 17,396	- 8,559	25,956
Change in %	-	- 15	- 18	97

8 Requirement for Infiltration of Roof Run-off

Volume of Pre-Development Infiltration (m^3/yr)	48,257
Volume of Post-Development Infiltration (m^3/yr)	39,697
Deficit from Pre to Post Development Infiltration (m^3/yr)	8,559
Percentage of Roof Runoff required to match the pre-development infiltration (%)	173

Pre- and Post-Development
Phase 2 Water Balance Calculations
Part of Lot 19, Concession 19, Township of Galway-Cavendish and Harvey, County of Peterborough

1 Climate Information

Precipitation	882	mm/yr
Actual Evapotranspiration	540	mm/yr
Water Surplus	342	mm/yr

2 Infiltration Rates

Table 2 Approach - Infiltration factors	
Topography: Rolling hills	0.2
Soil Type: Till(Combination of sand,silt and gravel)	0.3
Cover: Cultivated land/Woodland	0.15
Total Infiltration Factor	**0.65**

Infiltration (Water Surplus * Infiltration Factor)	**222**	mm/yr
Run-off (Water Surplus - Infiltration)	**120**	mm/yr

Table 3 Approach - Typical Recharge Rates		
Coarse Sand and Gravel	>250	mm/yr
Fine to medium sand	200-250	mm/yr
Silty sand to sandy silt	150-200	mm/yr
Silt	125-150	mm/yr
Clayey Silt	100- 125	mm/yr
Clay	<100	mm/yr

Site development area is underlain predominantly by a glacial till sand, silt and gravel combination

Based on the above, the recharge rate is typically	150-200	mm/yr

3 Phase 2 - Pre-Development Property Statistics	**ha**	**m^2**
Total Paved Area	0.00	0
Total Roof Area	0.00	0
Total Landscape Area	26.34	263,420
Total	**26.34**	**263,420**

4 Phase 2 - Post-Development Property Statistics	**ha**	**m^2**
Total Paved Area	4.08	40,847
Total Roof Area	0.85	8,500
Total Landscape Area	21.41	214,073
Total	**26.34**	**263,420**

Pre- and Post-Development
Phase 2 Water Balance Calculations
Part of Lot 19, Concession 19, Township of Galway-Cavendish and Harvey, County of Peterborough

5 Phase 2 Pre-Development Water Balance

Land Use		Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Impervious Areas	Paved Area	-	-	-	-	-
	Roof Area	-	-	-	-	-
Pervious Areas	Landscape Area	263,420	232,336	142,247	58,558	31,531
	Totals	263,420	232,336	142,247	58,558	31,531

Assuming no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

6 Phase 2 Post-Development Water Balance

Land Use		Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Impervious Areas	Paved Area	40,847	36,027	3,603	-	32,424
	Roof Area	8,500	7,497	750	-	6,747
Pervious Areas	Landscape Area	214,073	188,812	115,599	47,588	25,625
	Totals	263,420	232,336	119,952	47,588	64,796

Assuming no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

7 Comparision of Pre- and Post -Development for Phase 2

	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-off (m^3)
Pre-Development	232,336	142,247	58,558	31,531
Post-Development	232,336	119,952	47,588	64,796
Change in Volume	-	- 22,295	- 10,970	33,265
Change in %	-	- 16	- 19	105

8 Requirement for Infiltration of Roof Run-off

Volume of Pre-Development Infiltration (m^3/yr)	58,558
Volume of Post-Development Infiltration (m^3/yr)	47,588
Deficit from Pre to Post Development Infiltration (m^3/yr)	10,970
Percentage of Roof Runoff required to match the pre-development infiltration (%)	163

Appendix F

Nitrate Mass Balance Calculations

Water Balance Calculations

THORNTHWAITE-TYPE MONTHLY WATER-BALANCE MODEL

modified from Dingman 2015: Box 6-8 (pg 299) using ET model of Hamon (1963)

Input Data | Computed Values

											Surplus	342	mm/yr
Weather Station Location:	**Peterborough Trent U**					**Latitude:**	**44.2**	**degree**					
Solar Declination (degree)	-20.6	-12.6	-1.5	10.0	19.0	23.1	21.0	13.4	2.6	-9.0	-18.5	-23.0	
DayLength (hr)*	9.1	10.3	11.8	13.3	14.6	15.3	14.9	13.8	12.3	10.8	9.5	8.7	
Available Water Storage Capacity			0.18	m/m	**Root Depth**		1500	mm		**SOILmax**	270.0	mm	

MONTHLY WATER BALANCE DATA

Temperatures in C, water-balance terms in mm.

Month:	J	F	M	A	M	J	J	A	S	O	N	D	Year
TEMPERATURE (T)	-8.4	-6.5	-1.3	6.3	12.8	18.0	20.7	19.4	15.0	8.4	2.4	-4.0	
PRECIPITATION (P)	57.3	48.8	56.5	66.4	88.7	83.0	73.6	87.0	92.4	77.0	85.5	66.0	882
RAIN	22.4	23.1	34.0	60.9	88.7	83.0	73.6	87.0	92.4	75.7	73.3	35.0	749
SNOW	35	26	23	6	0	0	0	0	0	1	12	31	133
MELT FACTOR (F)	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.40	0.00	
PACK	73	99	121	0	0	0	0	0	0	0	7	38	
MELT	0	0	0	127	0	0	0	0	0	1	5	0	133
INPUT (W)	22	23	34	188	89	83	74	87	92	77	78	35	882
POTENTIAL ET (PET)	0	0	0	41	70	97	115	98	65	39	22	0	548
NET INPUT (ΔW)	22	23	34	147	19	-14	-41	-11	27	38	56	35	
SOIL MOISTURE (SOIL)	270	270	270	270	270	256	220	211	238	270	270	270	
ΔSOIL	0	0	0	0	0	-14	-36	-9	27	32	0	0	
ET	0	0	0	41	70	97	110	96	65	39	22	0	540
SURPLUS=W-ET-DSOIL	22	23	34	147	19	0	0	0	0	6	56	35	342

Notes:

Precipitation, Rain, Temperature, and Latitude are inputted parameters

SOILmax = available water storage capacity * root depth

m = month

D = Day length (hrs) $=2*\cos^{-1}(-\tan(\text{Latitude})*\tan(\text{Declination}))/0.2618$ [calculation is in radians]

$SNOW_m = P_m - RAIN_m$

$F_m = 0$ if $T_m <= 0^oC$; $F_m = 0.167*T_m$ if $0^oC<T_m<6^oC$; $F_m = 1$ if $T_m>=6^oC$

$PACK_m = (1-F_m)*(SNOW_m+PACK_{m-1})$

$MELT = F_m*(SNOW_m+PACK_{m-1})$

$W_m = RAIN_m+MELT_m$.

PET = 0 if $T_m<0$; otherwise $PET = 2.98*0.611*\exp(17.3*T_m/(T_m+237))/(T_m+237.2)*$Number of days in month [Hamon ET model (1963)]

$\Delta W_m = W_m - PET_m$

$SOIL = \min\{[\Delta W_m+SOIL_{m-1}], SOILmax\}$, if $\Delta Wm>0$; otherwise $SOIL = SOIL_{m-1} * \exp(\Delta W/SOILmax)$

$\Delta SOIL = SOIL_{m-1} - SOIL_m$

ET = PET if W_m > PET; otherwise, $ET=W_m-\Delta SOIL$

CAMBIUM

Nitrate Attenuation

Calculations for Subdivision Developments

Input Data		Computed Values
Areas		Total
LOT AREA (m^2)		383530
BLDG FOOTPRINT (m^2)		0
ROAD AREA (m^2)		0
Avaible Infiltration Area (m^2)		383530

Surplus water		Infiltration Factor	
0.342	m/yr	Rolling	0.2
0.000937	m/day	Silt, sand,gravel till	0.3
359.4998	m^3/day	Woodland/Cultivated	0.15
		Total	0.65

Infiltrated water				
0.000609	m/day			
233.6749	m^3/day	Runoff	125.8249	m^3/day

PREDICTED NITRATE CONCENTRATIONS

Combined Concentrations at Property Boundaries

59 Lots
59000
40
233674.9
0.1
292674.9
8.14