74 Berkeley St,, Toronto, Ontario M5A 2W7 **t** 647-795-8153

Hydrogeological Investigation – Chickadee Lane Rounding Out Area B

Bolton, Ontario

Palmer Project #
170163

Prepared For
Zancor Homes (Bolton) Inc.

August 23, 2021

74 Berkeley St,, Toronto, Ontario M5A 2W7 t 647-795-8153

August 23, 2021

Zancor Homes (Bolton) Inc.
c/o
Frank Filippo
Senior Executive Vice President
Brookvalley Project Management Inc.
137 Bowes Road
Concord, ON L4K 1H3

Dear Mr. Filippo:

Re: Hydrogeological Investigation – Chickadee Lane Rounding Out Area B
Project #: 170163

Palmer Environmental Consulting Group Inc. is pleased to submit the attached report describing the results of our Hydrogeological Investigation for the proposed land development within the Chickadee Lane Rounding Out Area B, in Bolton, Ontario. This report has been updated from the version provided during the 1st Submission (dated December 29, 2020) to include the August 2021 Concept Plan. No substantive changes to the hydrogeological report findings or conclusions from the December 29, 2020 report are made in this updated report.

This report is intended to support the proposed urban boundary expansion of the Chickadee Lane Rounding Out Area B through the Local Official Plan Amendment (LOPA) process, as well as support a submission to the Town of Caledon for Draft Plan of Subdivision and Re-Zoning.

Please let us know if you have any questions or comments on this submission.

Thank you for the opportunity to work with your team on this project.

Yours truly,

Palmer Environmental Consulting Group Inc.

Jason Cole, M.Sc., P.Geo.
Principal, Senior Hydrogeologist

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1. Introduction

Palmer was retained by Zancor Homes (Bolton) Inc. to complete a Hydrogeological Investigation for the proposed Chickadee Lane residential land development project in Bolton, Ontario (the "project" or the "site"). The property is referred to as the Chickadee Lane Rounding Out Area B (**Figure 1**) and is part of the Bolton Residential Expansion Lands (BRES) Official Plan Amendment (ROPA 30). Prior to submission of a Draft Plan, these lands must be brought into the Bolton urban boundary through completion of a Comprehensive Environmental Impact Study and Management Plan (CEISMP), inclusive of a hydrogeological assessment. This report was prepared to support the CEISMP process as part of a Local Official Plan Amendment (LOPA), Draft Plan and Re-Zoning submission to the Town of Caledon.

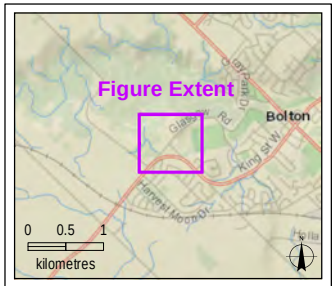
The site is located on an approximately 10.08 ha parcel of land, with 2.75 ha located within the Provincially designated Greenbelt Lands. The Draft Plan of Subdivision for the proposed Chickadee Lane Rounding Out Area B by Humphries Planning Group Inc. (HPG, 2021) is presented in **Appendix A1**. Stormwater Management (SWM) Plan and Site Servicing Plan drawings from Candevcon (2020) are presented in **Appendix A2**.

The subject property is located within the Humber River Watershed, under the jurisdiction of the Toronto and Region Conservation Authority (TRCA). The purpose of the hydrogeological investigation is to determine the existing hydrogeological conditions and identify potential impacts of the proposed development to local surface water and groundwater resources. This hydrogeological assessment was undertaken in tandem with the geotechnical investigation completed by Soil Engineers Inc. and includes an assessment of soil and groundwater conditions including groundwater levels, groundwater flow, aquifers and aquitards, local water use, a pre-to-post development water balance, and recommendations for Low Impact Development (LID) mitigation measures.

1.1 Scope of Work

The scope of work for Palmer's Hydrogeological Investigation to support site design and permitting includes the following main tasks:

- Characterize the surface and sub-surface geological and hydrogeological conditions through use of data from six (6) boreholes and four (4) groundwater monitoring wells as installed by Soil Engineers Ltd.;
- Develop and complete hydraulic testing at monitoring wells (response test) to estimate hydraulic conductivity;
- Complete one (1) groundwater chemistry sample for comparison with Ontario Drinking Water Standards (ODWS);
- Installation of one (1) drive-point piezometer to assess surface water/ groundwater interactions in the tributary to the Humber River located north of the site;
- Monthly groundwater and MP water level monitoring over a 1-year period to confirm seasonality of site water levels;
- Instrument two (2) wells with Solinst Leveloggers to continuously record groundwater levels;
- Conduct a pre-to-post-development site water balance and a dewatering assessment; and,
- Provide a Hydrogeological Investigation Report to support site design, permitting and CEISMP reporting.



Legend

- Mini Piezometer
- Monitoring Well
- Watercourse
- Contour (1 m)
- Study Area

0 25 50 75 100
metres

N

DRAWN: B. Elder
CHECKED: R. Rolick
PROJECT: 170163
DATE: Jul 11, 2018

Scale 1:4000
UTM Zone 17N
NAD 1983

Data Sources: Imagery ©2017 Google. Overview basemap credits at page bottom.

Prepared by:

Palmer

CLIENT: Brook Valley Homes
PROJECT: Chickadee Lane Ecology and Hydrogeology

Site Location

FIGURE 1

Document Path: C:\Egnyte\Shared\Projects\Active\17016 - Brook Valley Homes\170163 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\170163_Figure1_Site.mxd

2. Regional Existing Conditions

2.1 Physiography and Regional Geology

The site is located within the South Slope physiographic region, characterised as a slightly drumlinized region that lies to the south of the Oak Ridges Moraine and north of the Peel Plain (Chapman and Putman, 1984).

The surficial geology of the site, as described by Ontario Geological Survey (OGS) mapping, is characterized as Halton Till with clayey to silt-textured sediments derived from glaciolacustrine deposits or shale (**Figure 2**). The Halton Till overlies the Newmarket Till, and where present, these tills are separated by the sandy deposits of the Oak Ridges Moraine.

Paleozoic bedrock at the site is characterized by the shale and limestone of the Georgian Bay Formation. Bedrock was not encountered during the most recent borehole drilling, and based on Ministry of Environment, Conservation and Parks (MECP) water well database information, this formation is encountered at approximately 156 m below ground surface, or 100 meters above sea level (masl) at the site location.

2.2 Hydrostratigraphy

Hydrostratigraphic units can be classified into two distinct groups based on their capacity for permitting groundwater movement: an aquifer or an aquitard. An aquifer is generally defined as a layer of soil permeable enough to conduct a usable supply of water, while an aquitard is a layer of soil that inhibits groundwater movement due to low permeability. The major regional hydrostratigraphic units that control groundwater at the site are described below.

The ***Halton Till*** and underlying ***Newmarket Till*** are often grouped together in this area and act as significant regional aquitards of fine textured sediments. The low permeability of the unit limits groundwater recharge and contaminant migration, however the presence of sand and gravel within the tills can also act as confined aquifers on a local scale in some areas. The bulk hydraulic conductivity (K) of these units ranges from approximately $5x10^{-6}$ m/s to $5x10^{-8}$ m/s (CAMC-YPDT, 2006). Groundwater flow within these units is typically downwards towards more permeable units. Within the study area, Halton Till sediments are approximately 20 m to 40 m thick, making it the dominant aquitard unit. Based on location water well records from a series of municipal test wells near the site, the till units are approximately 123.4 m in thickness, overlying a sand aquifer.

The ***Oak Ridges Moraine (ORM)*** acts as a major aquifer and recharge complex within the region. Near the study area it is expected that the ORM is between approximately 1 m and 15 m in thickness and is confined by the lower permeability Halton Till and Newmarket Till aquitards. Local MECP well records did not identify this unit at the site.

The ***Thorncliffe Aquifer*** consists of glaciofluvial and glaciolacustrine sediments of stratified sands, silty sand, and silt and clay. This aquifer is confined by the ***Newmarket Till*** aquitard and is approximately 5 m to 10 m in thickness near to the study area. Overall groundwater flow within this aquifer is south towards Lake Ontario or within discharge areas in major river valleys.

2.3 Drainage

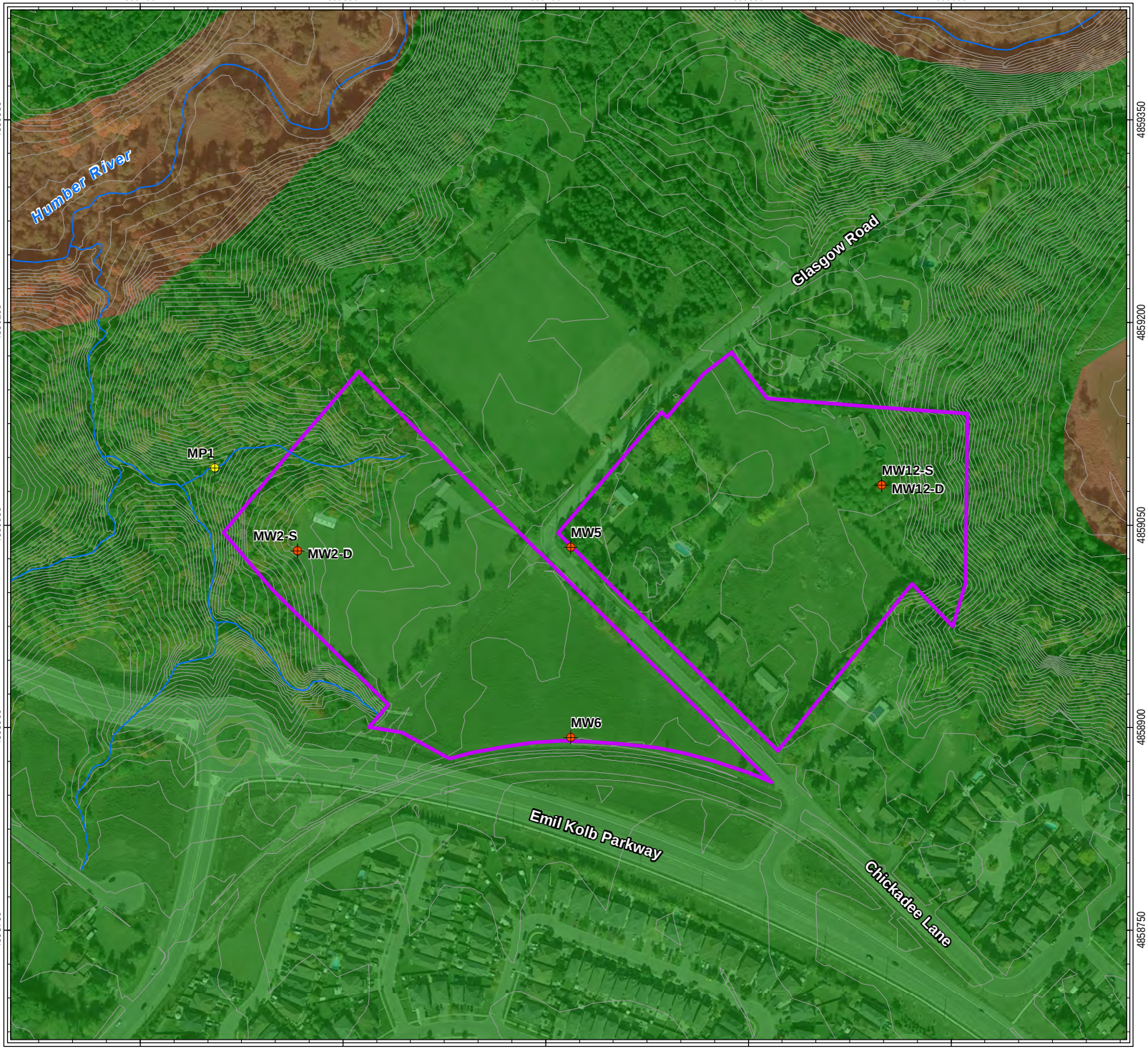
The study area lies within the Main Humber River Subwatershed, which forms the northernmost and largest portion of the Humber River Watershed, contributing 32% of total baseflow to the overall watershed. The subwatershed encompasses three secondary subwatersheds systems, Centreville Creek, Cold Creek, and Rainbow Creek. The subwatershed drains an area of approximately 357 km^2 and has the highest baseflow to total flow ratios (Baseflow Index, BFI) of the five primary subwatersheds that constitute the Humber River Watershed. This ratio indicates a largely groundwater dominated flow regime and a greater likelihood to contain cold water habitats for aquatic organisms (TRCA, 2008-a).

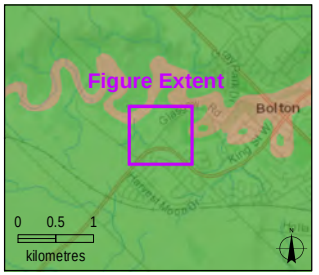
The subwatershed consists of primarily agriculture (40.8%) and natural (46.3%) land, and of the five primary subwatersheds has the lowest urban use (12.1%) and contains the majority of identified higher quality terrestrial habitat. However, the subwatershed is rated as fair for quality distribution of natural cover, and the lower reach is currently undergoing urbanization as part of municipal growth requirements.

2.4 MECP Water Wells

Based on an updated search of the MECP water well database, 34 water well records were identified within a 500 m radius of the site (**Figure 3**). A roadside water well screening identified up to 14 properties within 500 m of the site that have the potential to still rely on potable groundwater rather than municipal supply, although the municipal water is known to be available along Glasgow Road, Chickadee Lane, Emil Kolb Parkway and King Street. A detailed door-to-door water well survey will be completed at detailed design to document existing potable groundwater use near the site and to collect baseline data on groundwater quality and quantity.

A series of municipal supply test wells (and their associated decommissioning records) are found along Glasgow Road adjacent to the site. These wells are between approximately 135 and 145 m deep, and identified a confined sand aquifer below approximately 123.4 m of clayey silt to sandy silt till. These wells are not utilized for municipal water and confirm that there is a very thick, low permeability confining unit underlying the Chickadee Lane site protecting deep aquifers.





Legend

- Mini Piezometer
- Monitoring Well
- Watercourse
- Contour (1 m)
- Study Area

Surficial Geology

- **Halton Till:** brown loam to silt loam till
- **Modern Alluvium:** silt, sand, gravel

0 25 50 75 100
metres

N

DRAWN: B. Elder
CHECKED: R. Rolick
PROJECT: 170163
DATE: Jul 11, 2018

Scale 1:4000
UTM Zone 17N
NAD 1983

Data Sources: Imagery ©2017 Google. Overview basemap credits at page bottom. 1. Ontario Geological Survey 2010. Surficial geology of Southern Ontario.

Prepared by:

Palmer

CLIENT: Brook Valley Homes
PROJECT: Chickadee Lane Ecology and Hydrogeology

Surficial Geology

FIGURE 2

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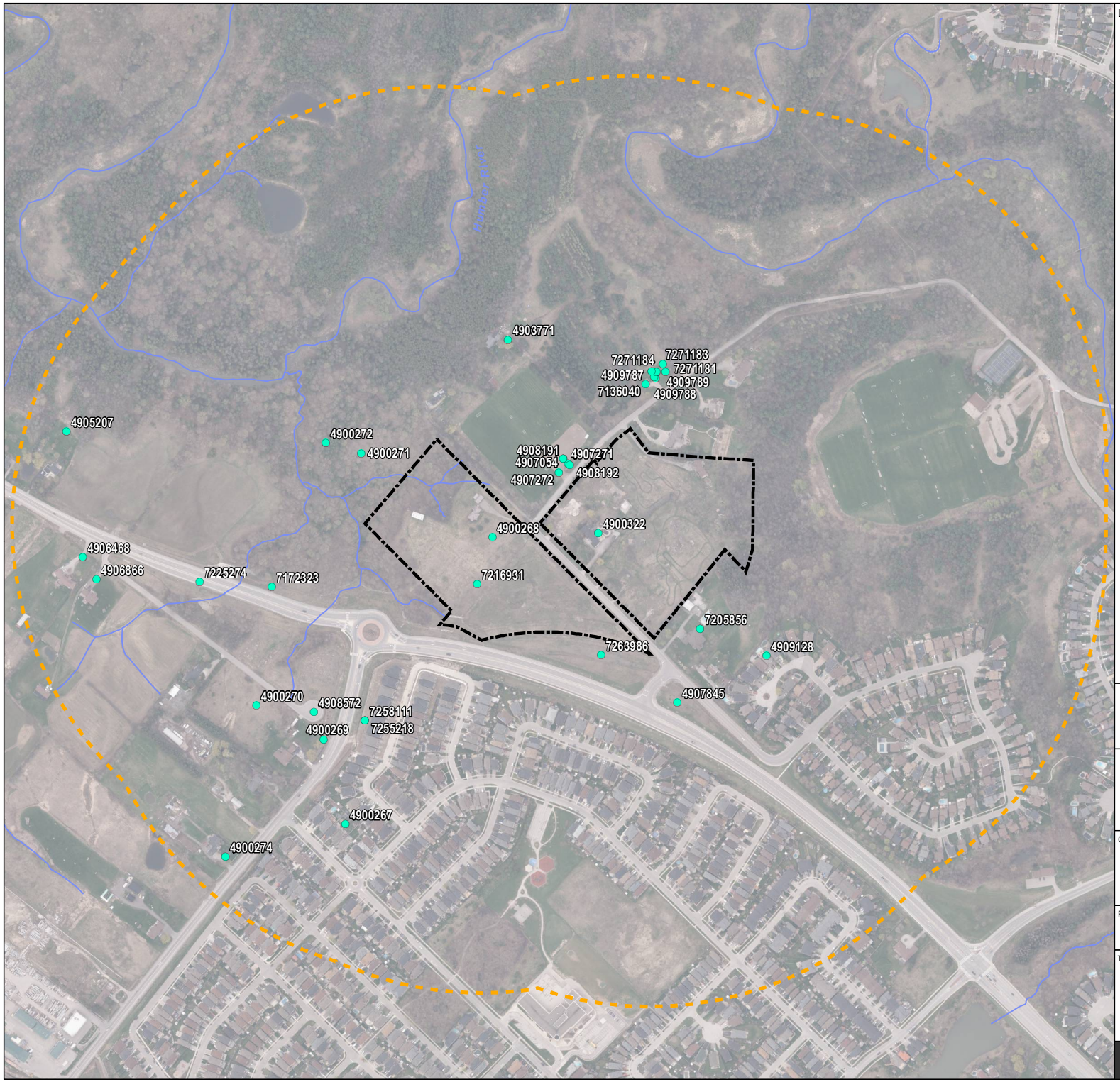
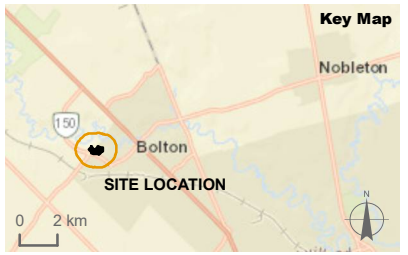


LEGEND:

- MECP Water Wells within 500m *w/ Well ID*
- Watercourse (MNRF)
- Study Area
- Study Area 500m Radius

Imagery (2019) provided by Peel Region. Contains information licensed under the Open Government Licence – Ontario



0 20 40 60 80
metres

N

PROJECT NO.	1701603	REVISION:	1-1
DATE:	Dec 16, 2020	SCALE:	1:7600
DRAWN:	CV	DATUM:	NAD 1983
CHECKED:	AL	PROJECTION:	UTM zone 17

CLIENT: Brook Valley Homes

PREPARED BY: Palmer

PROJECT: Chickadee Lane Ecology and Hydrogeology

TITLE:

MECP Water Wells within 500m

Figure 3

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3. Local Existing Conditions

3.1 Site Geology

3.1.1 Methodology

Borehole drilling at the site for hydrogeological purposes was conducted from February 23 to February 29, 2018. Fourteen boreholes were drilled under the supervision of Soil Engineers Ltd. staff to depths ranging from 6.10 mbgs to 32.0 mbgs. Borehole drilling was completed using solid stem augers, and six boreholes were completed as 51 mm diameter schedule 40 PVC pipe monitoring wells with 1.5 m long screens (MW2-S/N, MW2-D, MW5, MW6, MW12-S/N, and MW12-D). MW2S/D and MW12S/D were installed as nested wells, with S and D indicating shallow or deep well, respectively. The location of each monitoring well is shown on **Figure 1**, and well details are provided in **Table 2**. Borehole logs are presented in **Appendix B**.

A watercourse was noted in the Greenbelt lands to the northwest of the site which contributes to the tributary to the Humber River (**Figure 1**). One mini piezometer (MP1) was installed within the feature to measure the magnitude and direction of the hydraulic gradient within the tributary (**Table 3**).

3.1.2 Results

Surficial geology at the site is consistent with regional OGS mapping (**Figure 2**). The overall lithology of the silty clay till unit is consistent with the Halton Till, containing trace gravel and occasional sand seams, cobbles and boulders. This unit of silty clay till was encountered throughout the length of all boreholes, indicating a very thick aquitard unit stretching across the area. Site stratigraphy encountered during borehole drilling is summarized below.

Topsoil: All boreholes encountered topsoil ranging in thickness from 0.16 m to 0.46 m.

Earth Fill: Five boreholes encountered earth fill beneath the topsoil ranging in thickness from 0.39 m to 1.96 m. This fill is generally described as brown to grey silty clay with pockets of topsoil and occasional rootlets, wood debris, and brick fragments.

Silty Clay Till: Sediments of silty clay till from the Halton Till formation were encountered in all boreholes underlying either topsoil or earth fill. The thickness of this unit ranged from 4.10 m to 31.54 m, and the bottom of this unit was not encountered during drilling. This unit is expected to be approximately 40 m thick in this area.

Based on MECP water well records, underlying the silty clay Halton Till to a depth of 123.4 mbgs, is sandy silt till, interpreted to be part of the Newmarket Till formation, and layered clay, silt and fine sand of the upper Thorncliffe Fm.

3.2 Groundwater Levels

Groundwater levels in the monitoring wells were measured on March 15th and 19th, April 4th, May 17th, June 13th, July 19th, and August 27th, 2018. The shallow groundwater table ranged in depth from 0.12 mbgs (MW2-S on April 4, 2018) to 8.71 mbgs (MW12-S on March 19, 2018), and the deep groundwater table ranged from 11.35 mbgs (MW2-D on May 17, 2018) to 29.12 mbgs (MW12-D on March 19, 2018), as indicated in **Table 1**.

The shallow water levels measured in some wells indicate the presence of perched water table conditions at the site. These conditions arise due to the very poor drainage of the Halton Till aquitard to deeper material that results in slow downward percolation rates and an increased response of shallow soils to surface water inputs. The actual level of the *water table* ranges from approximately 5 m to 8 m below ground surface across the site, indicated by a shift in soil colour from brown (oxidized) to grey (wet, low oxygen) seen in borehole logs for MW2, MW6, and MW12S/D (**Appendix B**). The majority of boreholes were dry on completion and demonstrating the deeper water table and the low permeability of the soils.

It is therefore important to consider that groundwater levels are subject to fluctuations due to seasonality and precipitation input. As the monitoring events took place during the pre- and post-spring freshet, these values are unlikely to be representative of the seasonal highs, however late season manual ground water levels are likely indicative of seasonal lows (**Figure 4**).

Table 1. Monitoring Well Installation Details and Groundwater Levels

MW ID	Surface Elevation (masl)	Stick Up (m)	Depth (mbgs)	Screened Interval (mbgs)	Screened Geology	Water Level (mbgs)						
						Mar 15, 2018	Mar 19, 2018	Apr 4, 2018	May 17, 2018	Jun 13, 2018	Jul 19, 2018	Aug 27, 2018
MW2-S	256	0.79	7.60	6.10 – 7.60	Silty Clay Till	0.85	0.97	0.12	0.95	2.62	3.87	4.72
MW2-D	256	0.73	19.80	18.30 – 19.80	Silty Clay Till	11.94	11.88	11.98	11.35	11.81	12.72	13.70
MW5	261	0.64	5.98	4.60 – 6.10	Silty Clay Till	0.89	0.94	0.56	0.88	0.69	1.64	2.50
MW6	259	0.68	4.59	4.60 – 6.10	Silty Clay Till	0.47	1.80	0.48	0.47	1.05	1.83	1.26
MW12-S	256	0.71	9.16	6.10 – 7.60	Silty Clay Till	6.06	8.71	8.07	4.60	3.84	4.26	4.73
MW12-D	256	0.80	30.20	30.50 – 32.00	Silty Clay Till	23.29	29.12	21.85	14.30	22.31	25.33	25.93

3.3 Hydraulic Gradients

Groundwater flow at the site generally follows topography and flows either in a northeast direction, or northwest towards the Humber River tributary depending upon site location (**Figure 5**). Based on these results, there is a local groundwater flow divide through the middle of the site. A mean horizontal groundwater water gradient of 0.02 is observed towards both the northwest (MW2) and northeast (MW12) of the site area.

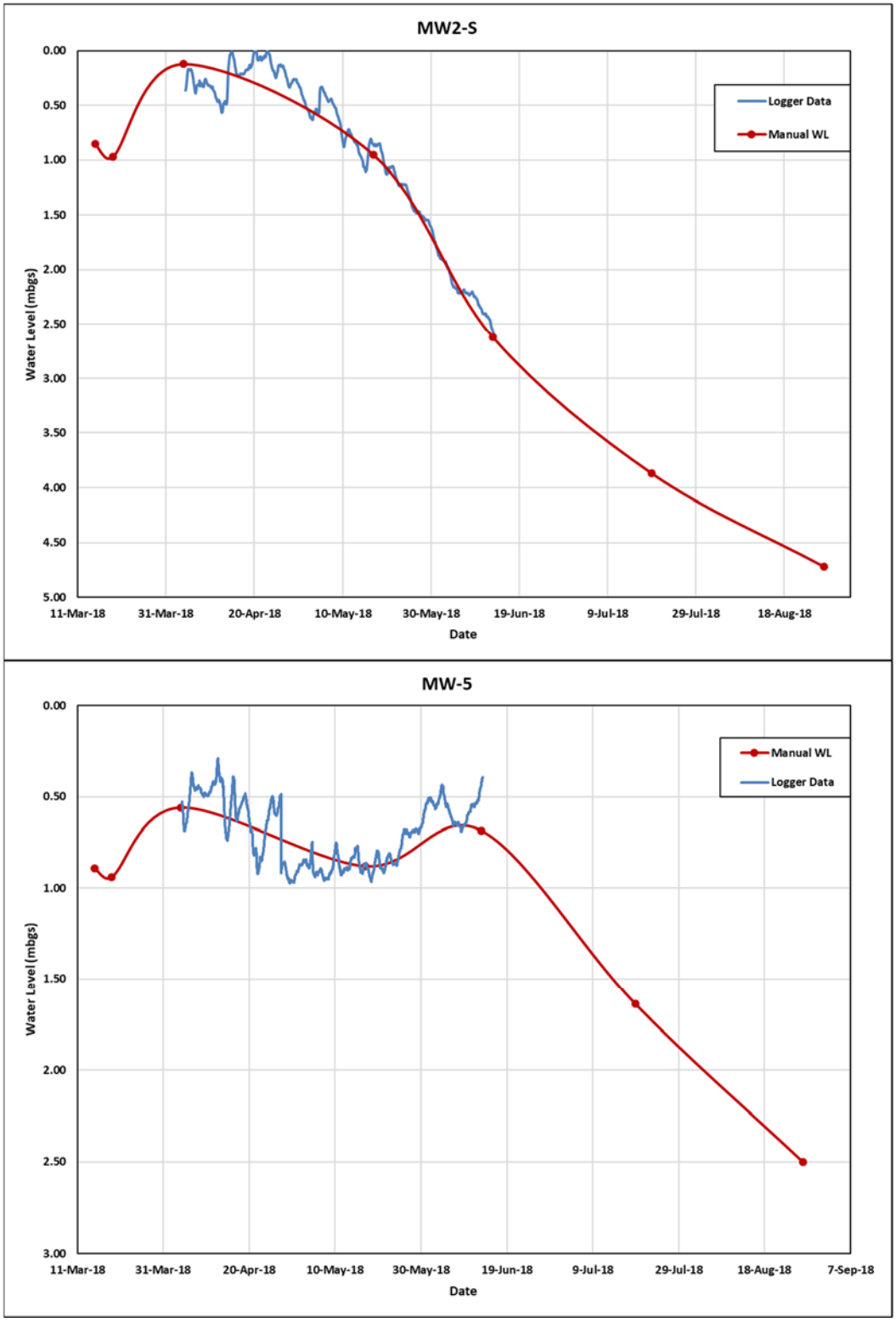
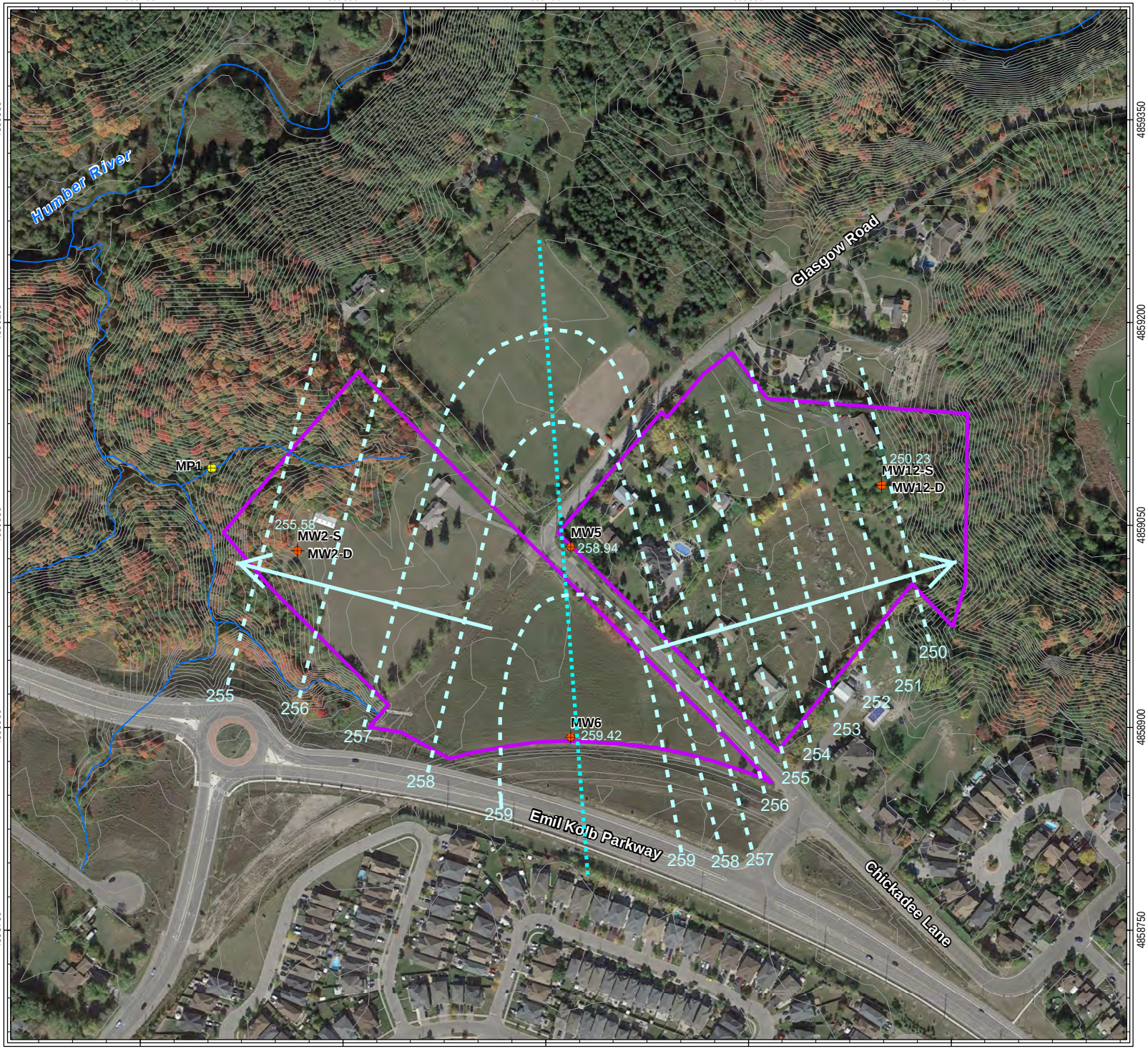
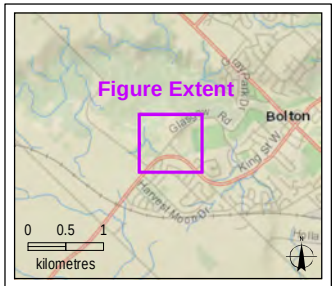


Figure 4. Recorded Groundwater Levels in MW-5 and MW-2S





Legend

- Mini Piezometer
- Monitoring Well
- Watercourse
- Contour (1 m)
- Study Area
- Potentiometric Surface (masl)
- Groundwater Flow Direction
- Local Groundwater Divide

*Manual Water Levels: April 4, 2018

0 25 50 75 100
metres

N

DRAWN: C. Veres
CHECKED: R. Rolick
PROJECT: 170163
DATE: Jun 08, 2018

Scale 1:4000
UTM Zone 17N
NAD 1983

Data Sources: Imagery ©2017 Google. Overview basemap credits at page bottom.

Prepared by:

Palmer

CLIENT: Brook Valley Homes
PROJECT: Chickadee Lane Ecology and Hydrogeology

Groundwater Flow

FIGURE 5

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A very strong downward hydraulic gradient was observed in the nested monitoring wells on the east (MW2 = -0.86 m/m) and west (MW12 = -1.22 m/m) margins of the site. This is expected due to the steep downwards topography of the Humber River Valley that is immediately adjacent to either of the well locations.

3.4 Groundwater – Surface Water Interactions

The Humber River tributary location northwest of the site showed a mean downward vertical hydraulic gradient of -0.45 m/m based on water level monitoring at MP1 (**Table 2**). Surface water flow was present within the feature on April 4th and May 17th, 2018, and absent during monitoring on June 13th, July 19th, and August 27th, 2018. This suggests that this feature is predominantly runoff supported and may be ephemeral.

Table 2. Mini Piezometer Installation Details, Water Levels, and Hydraulic Gradients

MP ID	Surface Elevation (masl)	Stick Up (m)	Depth to Screen (m)	Water Level (mbtoc)*	Apr 4, 2018	May 17, 2018	Jun 13, 2018	Jul 19, 2018	Aug 27, 2018
MP1	243	1.00	0.85	In	1.50	1.11	1.00	1.03	1.02
				Out	0.91	0.94	Dry	Dry	Dry
				Hydraulic Gradient	-0.69	-0.20	-	-	-

**In/Out measurements are expressed in meters below top of casing (mbtoc), Hydraulic gradients are unitless*

3.5 Hydraulic Conductivity

On March 19 and April 4, 2018, Palmer personnel conducted single well response tests (i.e., slug tests) at four locations to determine the hydraulic conductivity (K) of the surrounding soils. Both rising head (RH) and falling head (FH) tests were conducted by creating a head change, through the insertion (FH Test) or removal (RH Test) of a 1-m long slug. The rate of recovery in each well was measured using a datalogger to record water levels at a 1 or 2-second frequency. During the tests, manual water level measurements were also recorded to gauge recovery. Tests were terminated when either 30 minutes had elapsed or an 80% recovery in water level was attained.

Hydraulic conductivity (K) values were calculated using the displacement-time data and were analysed using the Hvorslev (1951) method for confined aquifers, modelled using Aqtesolv™ software. The analysis results are presented in **Appendix C**, and the range of calculated hydraulic conductivity values are summarized in **Table 3**. Calculated K values ranged from 3.5×10^{-6} m/s to 4.4×10^{-8} m/s, with a site-wide geometric mean K of 6.1×10^{-7} m/s. This value is within the expected range for the Halton Till Aquitard (5×10^{-6} m/s to 5×10^{-8} m/s).

Observed variations in K values measured across the site are likely due to spatial variations in soil horizons. For example, MW6 is screened within a sandier unit, resulting in higher K values (10^{-6} m/s), while MW5 is within a more continuous silt and clay unit, thus resulting in a lower observed hydraulic conductivity (10^{-8} m/s).

Table 3. Hydraulic Conductivity Results

Well	Test	Hydraulic Conductivity, (m/s)	Aquifer Material	Aquifer Type	K Geometric Mean ($m\ s^{-1}$)
MW2-S	FH	$5.1x10^{-7}$	Silty Clay Till	Confined	$6.1x10^{-7}$
	RH	$6.3x10^{-7}$			
MW2-D	FH	$1.2x10^{-7}$			
	RH	$1.3x10^{-7}$			
MW5	FH	$4.4x10^{-8}$			
	RH	-			
MW6	FH	$3.5x10^{-6}$			
	RH	$4.3x10^{-6}$			
MW12-S	FH	-			
	RH	-			
MW12-D	FH	-			
	RH	-			

**Response test data for MW12-S/D, and the RH component of MW5 was unable to be used for determination of K and was thus excluded from geometric mean K value*

Infiltration estimates were determined using empirical methods for converting between saturated hydraulic conductivity and percolation from the Low Impact Development Stormwater Management Planning and Design Guide (CVC and TRCA, 2010). Based on this method, the percolation rate of the soils at the Site are calculated to be 40 mm/hr. Site-specific infiltration testing will be completed at a later design stage once the LID locations and design have been finalized.

3.6 Groundwater Chemistry

Groundwater chemistry samples were collected on March 15, 2018 from MW6 and analyzed for a suite of water quality parameters such as turbidity, TSS, pH, metals, and cations and anions. A summary table of the groundwater analysis results is presented on **Table 4**, with the Certificate of Analysis provided in **Appendix D**. Results were compared against Ontario Provincial Water Quality Objectives (PWQO) and indicate that the sample exceeds PWQO criteria for both total aluminum (Al) and total iron (Fe), most likely as a result of high TSS in the collected sample.

Table 4. Groundwater Chemistry Results

Parameter	Units	Detection Limit	PWQO	Concentration (MW4)
Physical Tests (Water)				
Colour, Apparent	CU	2.0	-	30.9
Conductivity	umhos/cm	3.0	-	941
Hardness (as CaCO3)	mg/L	10	-	461
pH	pH units	0.10	6.5-8.5	7.88
Redox Potential	mV	-1000	-	317
Total Dissolved Solids	mg/L	20	-	560

Parameter	Units	Detection Limit	PWQO	Concentration (MW4)
Turbidity	NTU	0.10	-	72.0
Anions and Nutrients (Water)				
Acidity (as CaCO3)	mg/L	5.0	-	30.0
Alkalinity, Total (as CaCO3)	mg/L	10	-	387
Ammonia, Total (as N)	mg/L	0.020	-	0.022
Bromide (Br)	mg/L	0.10	-	<0.10
Chloride (Cl)	mg/L	0.50	-	55.8
Fluoride (F)	mg/L	0.020	-	0.226
Nitrate (as N)	mg/L	0.020	-	<0.020
Nitrite (as N)	mg/L	0.010	-	<0.010
Orthophosphate-Dissolved (as P)	mg/L	0.0030	-	<0.0030
Phosphorus, Total	mg/L	0.0030	-	0.0560
Sulfate (SO4)	mg/L	0.30	-	77.1
Bacteriological Tests (Water)				
Escherichia Coli	MPN/100mL	0	0	0
Total Coliforms	MPN/100mL	0	-	>201
Total Metals (Water)				
Aluminum (Al)-Total	mg/L	0.0050	0.075	***1.24***
Antimony (Sb)-Total	mg/L	0.00010	0.02	0.00017
Arsenic (As)-Total	mg/L	0.00010	0.005	0.00126
Barium (Ba)-Total	mg/L	0.00020	-	0.0943
Beryllium (Be)-Total	mg/L	0.00010	0.011-1.1	<0.00010
Bismuth (Bi)-Total	mg/L	0.000050	-	<0.000050
Boron (B)-Total	mg/L	0.010	0.2	0.027
Cadmium (Cd)-Total	ug/L	0.0000050	0.1-0.5	0.0000197
Calcium (Ca)-Total	mg/L	0.50	-	108
Cesium (Cs)-Total	mg/L	0.000010	-	0.000180
Chromium (Cr)-Total	mg/L	0.00050	CR(VI) 0.001; CR(III) 0.0089	0.00296
Cobalt (Co)-Total	mg/L	0.00010	-	0.00168
Copper (Cu)-Total	mg/L	0.0010	0.001-0.005	0.0026
Iron (Fe)-Total	mg/L	0.050	0.3	***2.07***
Lead (Pb)-Total	mg/L	0.000050	0.001-0.005	0.00144
Lithium (Li)-Total	mg/L	0.0010	-	0.0275
Magnesium (Mg)-Total	mg/L	0.050	-	46.3
Manganese (Mn)-Total	mg/L	0.00050	-	0.114
Molybdenum (Mo)-Total	mg/L	0.000050	-	0.00215
Nickel (Ni)-Total	mg/L	0.00050	-	0.00366
Phosphorus (P)-Total	mg/L	0.050	-	0.083
Potassium (K)-Total	mg/L	0.050	-	3.57
Rubidium (Rb)-Total	mg/L	0.00020	-	0.00324

Parameter	Units	Detection Limit	PWQO	Concentration (MW4)
Selenium (Se)-Total	mg/L	0.000050	0.01	0.000282
Silicon (Si)-Total	mg/L	0.10	-	8.78
Silver (Ag)-Total	mg/L	0.000050	-	<0.000050
Sodium (Na)-Total	mg/L	0.50	-	39.0
Strontium (Sr)-Total	mg/L	0.0010	-	0.431
Sulfur (S)-Total	mg/L	0.50	-	27.3
Tellurium (Te)-Total	mg/L	0.00020	-	<0.00020
Thallium (Tl)-Total	mg/L	0.000010	-	0.000028
Thorium (Th)-Total	mg/L	0.00010	-	0.00039
Tin (Sn)-Total	mg/L	0.00010	-	0.00156
Titanium (Ti)-Total	mg/L	0.00030	-	0.0342
Tungsten (W)-Total	mg/L	0.00010	-	<0.00010
Uranium (U)-Total	mg/L	0.000010	0.005	0.00481
Vanadium (V)-Total	mg/L	0.00050	-	0.00305
Zinc (Zn)-Total	mg/L	0.0030	0.02	0.0071
Zirconium (Zr)-Total	mg/L	0.00030	-	0.00054

Note: PWQO – Provincial Water Quality Objectives

4. Pre-Development Water Balance

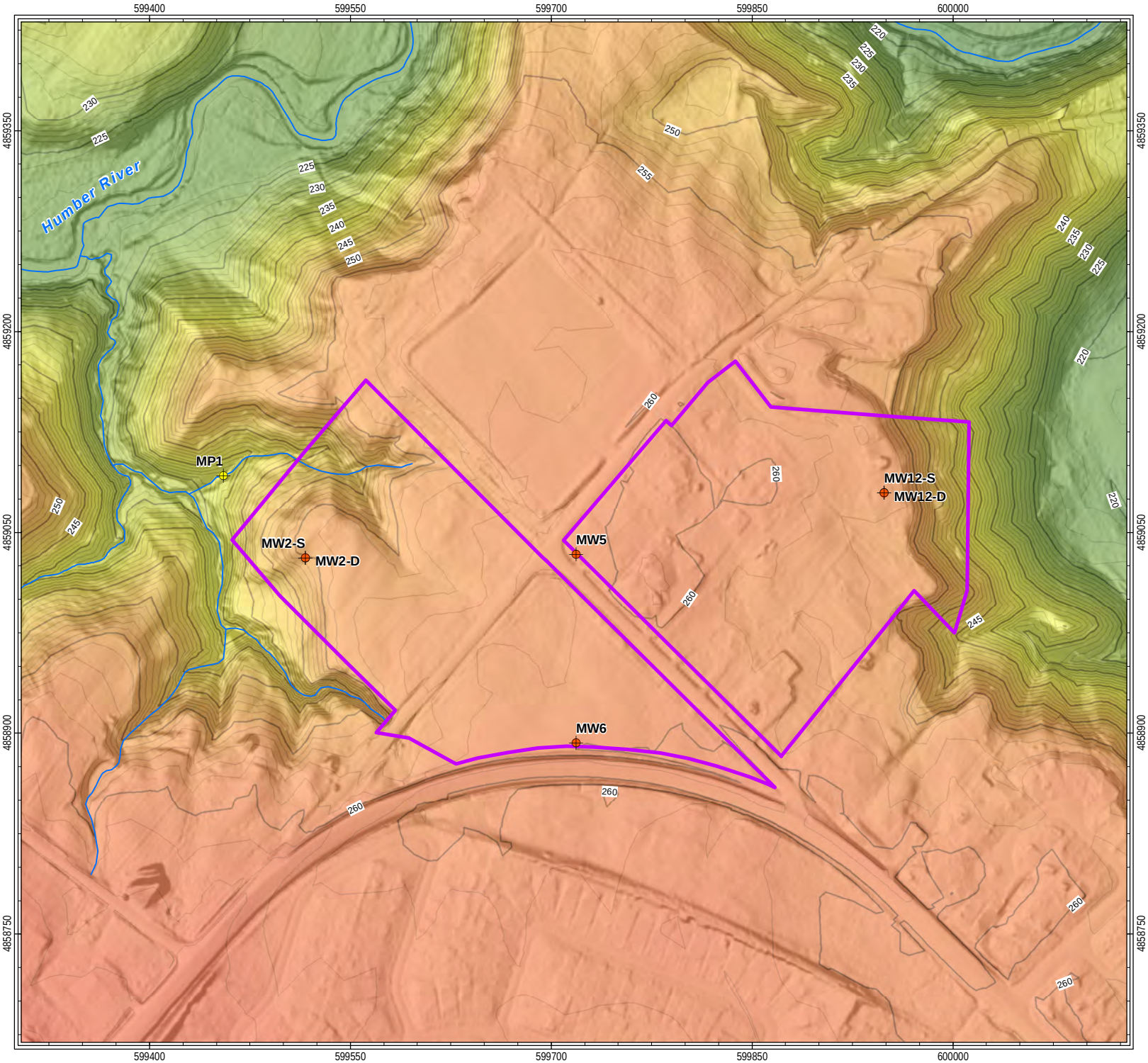
4.1 Methodology

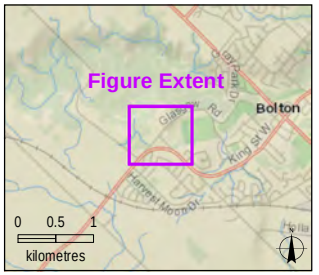
A pre-development water balance was completed for the site using a monthly soil-moisture balance approach (Thornthwaite and Mather, 1957). Water balance calculations use factors such as monthly precipitation, temperature, and latitude to estimate site specific average annual evapotranspiration (ET). Long-term climate data (30-year duration, 1981 to 2010) were obtained from the meteorological station at Albion Field Centre, approximately 7.6 km from to the study area (43°55' N, 79°50' W).

The site was divided into the two respective pre-development land use components of forested and agriculture/rural residential, and the mean annual water surplus (water available for infiltration and runoff processes) for each area was calculated by subtracting the mean annual evapotranspiration from the mean annual precipitation. To represent the silty clay till soils, soil moisture storage values of 250 mm and 400 mm were used to represent the respective agricultural/rural residential and forested components of the site.

The calculated mean annual water surplus was then partitioned using infiltration factors dependent on three components: soil type (**Figure 2**), topography/slope (**Figure 6**), and land use (**Figure 7**) (MOEE, 1995). Geographic Information System (GIS) mapping was used to divide the land use components into discrete sections and assign respective infiltration factors. Total average annual infiltration for each land use component was then determined by multiplying the appropriate water surplus value by the sum of the three individual factors. Infiltration factors used in the assessment are summarized in **Table 5**.

Proposed methods to balance infiltration volumes post-development include a storm water management (SWM) pond, as well as parkland and natural heritage system areas at locations shown in **Appendix A**. It should be noted that according to “Bolton Residential Expansion Study: Phase 3 Technical Memo – Development of a Preliminary Natural System” completed by Douglan and Associates (2014), and Palmer’s ecological study, no Provincially Significant Wetlands (PSWs) are found in the study area, and a feature-based water balance assessment is not required. A site wide water balance will address changes to groundwater recharge within the overall watershed.





Legend

- Mini Piezometer
- Monitoring Well
- Watercourse
- Contour (1 m)
- Study Area

Elevation

High : 265

Low : 215

0 25 50 75 100
metres

N

DRAWN: B. Elder
CHECKED: R. Rolick
PROJECT: 170163
DATE: Jul 11, 2018

Scale 1:4000
UTM Zone 17N
NAD 1983

Data Sources: Lidar hillshade provided by TRCA web map service.

Prepared by:

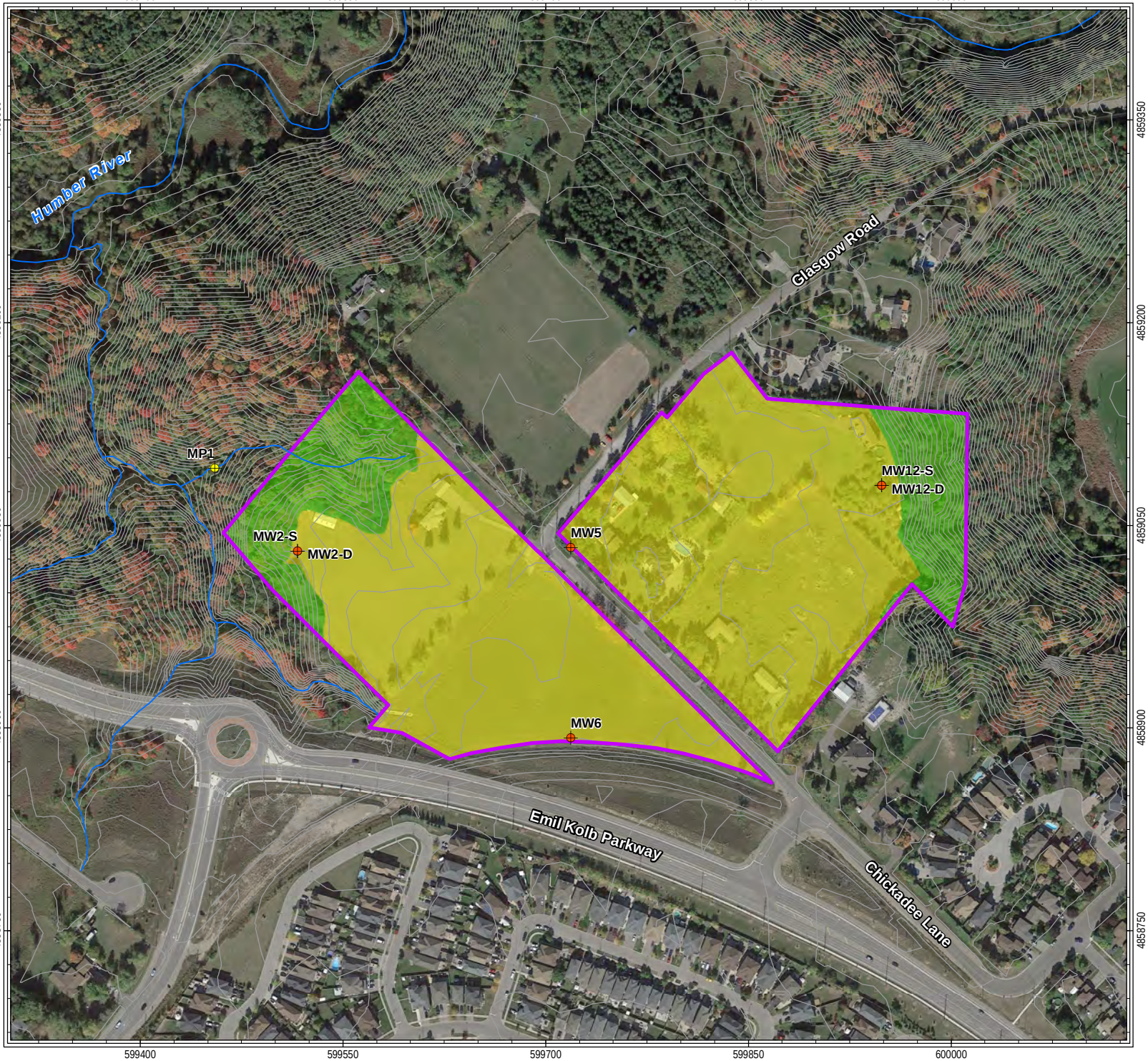
Palmer

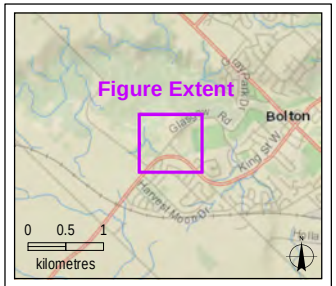
CLIENT: Brook Valley Homes
PROJECT: Chickadee Lane Ecology and Hydrogeology

Topography

FIGURE 6

Document Path: C:\Egnyte\Shared\Projects\Active\17016 - Brook Valley Homes\170163 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\170163_Figure4_Topography.mxd





Legend

- Mini Piezometer
- Monitoring Well
- Watercourse
- Contour (1 m)
- Study Area

Land Cover

- Agriculture (8.23 ha)
- Forest (1.85 ha)

0 25 50 75 100
metres

N

DRAWN: B. Elder
CHECKED: R. Rolick
PROJECT: 170163
DATE: Jul 11, 2018

Scale 1:4000
UTM Zone 17N
NAD 1983

Data Sources: Imagery ©2017 Google. Overview basemap credits at page bottom.

Prepared by:

Palmer

CLIENT: Brook Valley Homes
PROJECT: Chickadee Lane Ecology and Hydrogeology

FIGURE 7

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Table 5. Summary of Infiltration Factors (MOEE, 1995)

Area Description	Infiltration Factor
Surficial Geology	
Halton Till: Silty Clay Till	0.1
Topography/Slope (%)	
>10	0.001
10	0.05
5	0.1
2.5	0.15
1	0.2
0.5	0.25
0.1	0.3
Pre-development Landuse	
Agriculture/Rural Residential	0.1
Forest	0.15

A post-development water balance was then conducted using the same monthly soil-moisture balance approach (Thornthwaite and Mather, 1957) based on the Draft Plan land use design provided by Humphries Planning Group (HPG, 2021; **Appendix A1**). As impervious surfaces lack vegetation and prevent infiltration, the transpiration (T) component in the water balance is removed over these areas. Therefore, water available for both runoff and infiltration is considered as precipitation minus evaporation (P-E) in these areas. Evaporation over impervious areas is estimated to be approximately 10% of annual precipitation. Over pervious vegetated surfaces, the available water for infiltration and runoff is considered as precipitation minus evapotranspiration (P-ET).

Available water for infiltration over pervious areas was assumed to be the same from pre- to post-development scenarios as fill composition is not outlined in the proposed site plan.

Proposed methods to balance infiltration volumes post-development include a storm water management (SWM) pond, as well as parkland and natural heritage system areas at locations shown in **Appendix A**. The completed pre- to post-development water balance can be used to determine the appropriateness of these mitigation measures for this site, and whether additional Low Impact Development (LID) structures are recommended.

4.2 Pre-Development Water Balance Results

Based on 30-year climate normals from the Albion Field Centre Station, total precipitation at the site is approximately 821 mm/yr. This precipitation will either infiltrate through the unsaturated zone soils or be removed through evapotranspiration (ET). Actual ET (AET) is calculated based on potential evapotranspiration (PET) and soil-moisture storage withdrawal. Based on the Thornthwaite and Mather (1957) model, calculated AET for the Agricultural/Rural Residential and Forested land use areas is 528

mm/yr and 537 mm/yr, respectively (**Table 6**). These results are consistent with those reported by TRCA (2008-b) for the Humber River Watershed, which indicates a mean AET value of 525 mm/yr.

Monthly PET is estimated using monthly temperature data and is defined as water loss through evaporation or transpiration from a homogeneous vegetated area that does not lack water (Thornthwaite, 1948; Mather, 1978). Calculated PET for the total site area is 590 mm/yr (approximately 72% of total precipitation), while the soil moisture deficit is between 53 mm/yr (Forested) and 62 mm/yr (Agricultural/Rural Residential).

Estimated water surplus within the Site ranges from approximately 285 mm/yr (Forested; 35% of total precipitation) to 294 mm/yr (Agricultural; 36% of total precipitation) and is divided into two components: infiltration and runoff (**Table 7**). Using the method outlined in the MOE SWM manual and MOEE (1995), approximately 67% (219 mm/yr) of the surplus runs off, while the remaining 33% (91 mm/yr) infiltrates. Over the entire Site area (100,800 m^2), this translates to approximately 9,186 m^3/yr of infiltration, and approximately 22,113 m^3/yr of runoff (**Figures 8** and **9**). These values are consistent with the reported low permeability of the Halton Till combined with the very steep terrain bordering the northwest and northeast sections of the study area.

4.3 Post-Development Water Balance Results

The development of the subject lands will have an impact on the water balance due to the creation of impermeable surfaces. Impervious surfaces prevent infiltration of water into the soils and the removal of vegetation eliminates the evapotranspiration component of the natural water balance. Evaporation from impervious surfaces are relatively minor component of the water balance compared to the evapotranspiration component that occurs with vegetation. Therefore, the net effect of the construction of impervious surfaces is that most of the precipitation that falls into impervious surfaces becomes surplus water and direct runoff, reducing the natural infiltration.

Based on the Draft Plan land use design provided by Humphries Planning Group (HPG, 2021; **Appendix A1**), without mitigation, the post-development runoff is expected to increase to 46,542 mm/yr and the post-development infiltration is expected to decrease to 4,257 mm/yr (**Table 7**). This represents a 110% increase in runoff and 53% reduction in infiltration. The relatively high change in infiltration is due to the area of proposed medium density land-uses, relative to the existing conditions. Proposed methods to balance infiltration volumes post-development include series of rear-yard catch basin LID measures (at locations shown in **Appendix A2)**, as well as increased infiltration within restored passive recreational land use and natural heritage system areas.

The completed pre- to post-development water balance is provided in the Comprehensive Environmental Impact Study and Management Plan (CEISMP) Part B (Palmer, 2020) and provides the LID strategy and design measures to maintain infiltration post-development through adding at least 4,929 m^3/yr of infiltration.

Ecological studies completed by Palmer did not identify any groundwater supported natural features (i.e., groundwater supported wetlands or watercourses) on or within 120 m the Site that would specifically rely on groundwater recharge or surface water runoff from the Site. Therefore, a feature-based water balance (FBWB) is not recommended.

Table 6. Available Water Surplus Values by Pre-Development Land Use

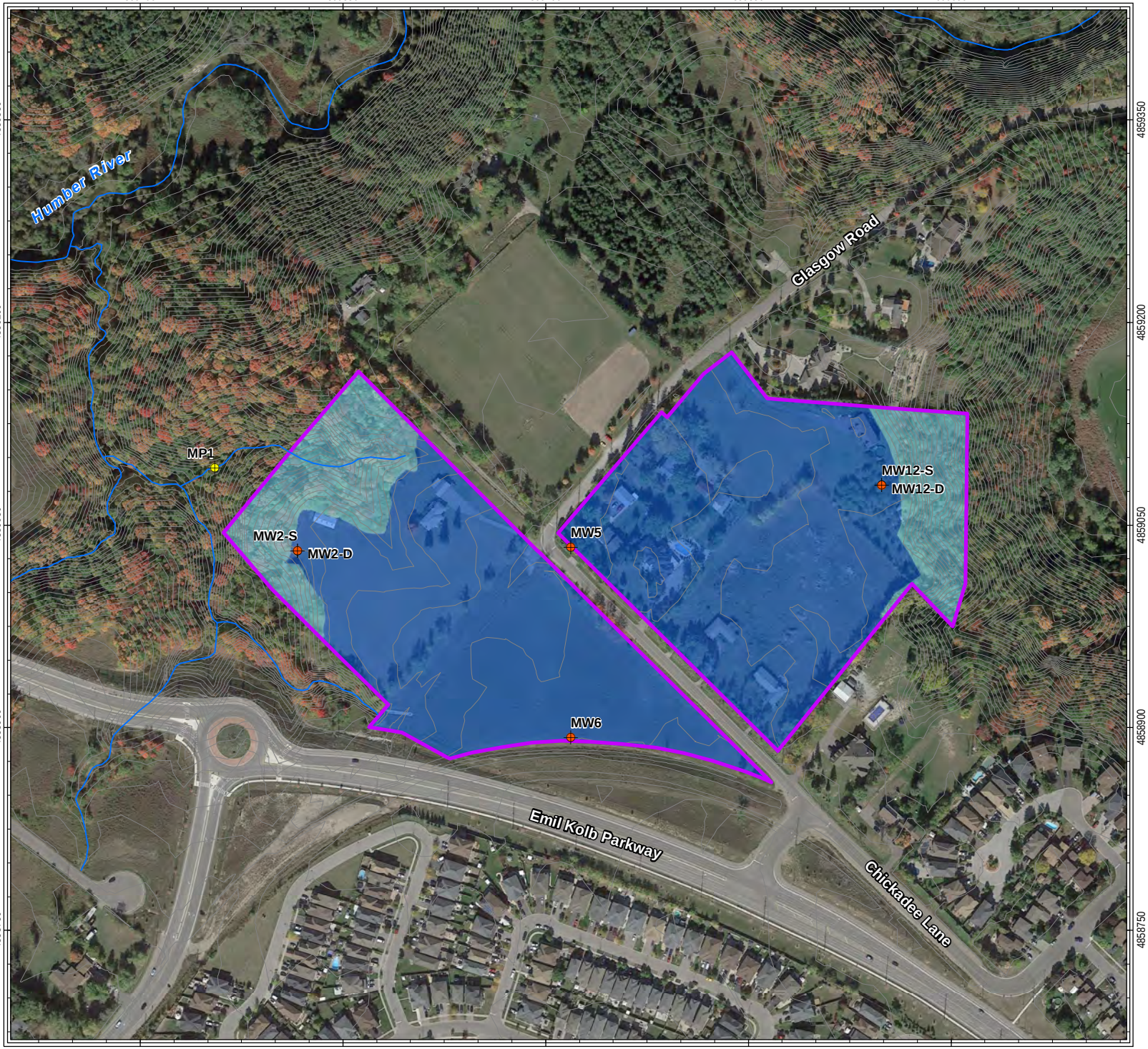
Water Balance		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Precipitation (mm)		60.4	50.2	50.3	67	76.1	75.5	81.8	77.4	75	68.3	81.7	57.7	821.4
Temperature (°C)		-7	-5.9	-1.4	6.1	12.4	17.3	19.9	19.1	14.3	8.1	2.1	-3.9	7.0
Potential Evapotranspiration (PET) (mm)		0	0	0	33	78	112	132	117	74	37	8	0	590
P – PET		60	50	50	34	-2	-36	-50	-39	1	31	74	58	231
Forested Area (400 mm)	**Change in Soil Moisture Storage**	0	0	0	-34	-38	-31	-16	11	33	36	27	0	-12
	Soil Moisture Storage	400	400	400	366	328	297	281	292	325	361	388	400	-
	Actual Evapotranspiration (AET)	0	0	0	33	114	107	98	66	74	37	8	0	537
	Soil Moisture Deficit (mm)	0	0	0	0	-36	5	34	50	0	0	0	0	53
	Surplus (P – AET)	60	50	50	34	-38	-31	-16	11	1	31	74	58	284.7
Agricultural/ Rural Residential Area (250 mm)	**Change in Soil Moisture Storage**	0	0	0	-33	-35	-26	-14	10	27	33	26	0	-12
	Soil Moisture Storage	250	250	250	217	182	156	142	152	179	212	238	250	-
	Actual Evapotranspiration (AET)	0	0	0	33	111	102	96	67	74	37	8	0	528
	Soil Moisture Deficit (mm)	0	0	0	0	-33	10	36	49	0	0	0	0	62
	Surplus (P – AET)	60	50	50	34	-35	-26	-14	10	1	31	74	58	293.7

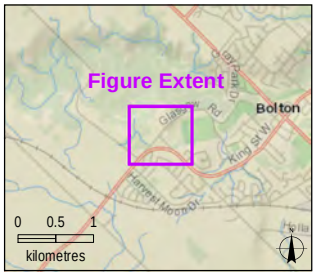
Table 7. Pre-and-Post Development Water Balance

Pre-Development Water Balance													
Land Use	**Total (ha)**	**Impervious Factor**	**Impervious area (ha)**	**Water Surplus on Impermeable Surfaces (m/a)**	**Run off from Impervious Area (m3/a)**	**Estimated Pervious Area (ha)**	**Water Surplus on Vegetated Pervious Areas (m/a)**	**Runoff Coefficient (MECP values)**	**Runoff Volume from Pervious Area (m3/a)**	**Infiltration Coefficient**	**Infiltration Volume from Pervious Area (m3/a)**	**Total Runoff Volume (m3/a)**	**Total Infiltration Volume (m3/a)**
Woodlot	1.85	0	0	0.739	0	1.85	0.285	0.74	3,902	0.26	1,371	3,902	1,371
Agricultural/ Rural Residential	8.23	0.05	0.41	0.739	3,041	7.82	0.294	0.66	15,171	0.34	7,815	18,212	7,815
Total	**10.08**		**0**		**3,041**	**9.67**		**0.67**	**19,073**	**0.33**	**9,186**	**22,113**	**9,186**
											mm/yr	**219**	**91**

Post-Development Water Balance													
Land Use	**Total (ha)**	**Impervious Factor**	**Impervious area (ha)**	**Water Surplus (m/a)**	**Run off from Impervious Area (m3/a)**	**Estimated Pervious Area (ha)**	**Water Surplus on Vegetated Pervious Areas (m/a)**	**Runoff Coefficient (MECP values)**	**Runoff Volume From Pervious Area (m3/a)**	**Infiltration Coefficient**	**Infiltration Volume from Pervious Area (m3/a)**	**Total Runoff Volume (m3/a)**	**Total Infiltration Volume (m3/a)**
Single Detached Residential	0.06	0.60	0.04	0.707	255	0.02	0.287	0.66	45	0.34	23	300	23
Street Townhouses	3.95	0.70	2.77	0.707	19,560	1.19	0.287	0.66	2,241	0.34	1,155	21,801	1,155
Existing Residential	0.99	0.25	0.25	0.707	1,751	0.74	0.287	0.66	1,404	0.34	724	3,155	724
Park	0.63	0.25	0.16	0.707	1,114	0.47	0.287	0.66	894	0.34	460	2,008	460
SWM Pond	0.60	1.00	0.60	0.707	4,244	0.00	0.287	0.66	0	0.34	0	4,244	0
Natural Heritage System	1.75	0.00	0.00	0.707	0	1.75	0.284	0.74	3,673	0.26	1,290	3,673	1,290
Restoration Area	0.46	0.00	0.00	0.707	0	0.46	0.287	0.66	871	0.34	449	871	449
Road + Road Widening	1.60	0.90	1.44	0.707	10,187	0.16	0.287	0.66	303	0.34	156	10,489	156
Total	**10.04**		**5.25**		**37,110**	**4.79**		**0.67**	**9,432**	**0.33**	**4,257**	**46,542**	**4,257**

Pre-to-Post Development Change		
% Change	**110%**	**-54%**
Pre-to-Post Volume Change (m^3/yr)	**24,429**	**-4,929**





Legend

- Mini Piezometer
- Monitoring Well
- Watercourse
- Contour (1 m)
- Study Area

Infiltration by Land Cover Type

- Forest (73 mm/year)
- Agricultural (97 mm/year)

0 25 50 75 100
metres

N

DRAWN: B. Elder
CHECKED: R. Rolick
PROJECT: 170163
DATE: Jul 11, 2018

Scale 1:4000
UTM Zone 17N
NAD 1983

Data Sources: Imagery ©2017 Google. Overview basemap credits at page bottom.

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Palmer

CLIENT: Brook Valley Homes
PROJECT: Chickadee Lane Ecology and Hydrogeology

Infiltration

FIGURE 8

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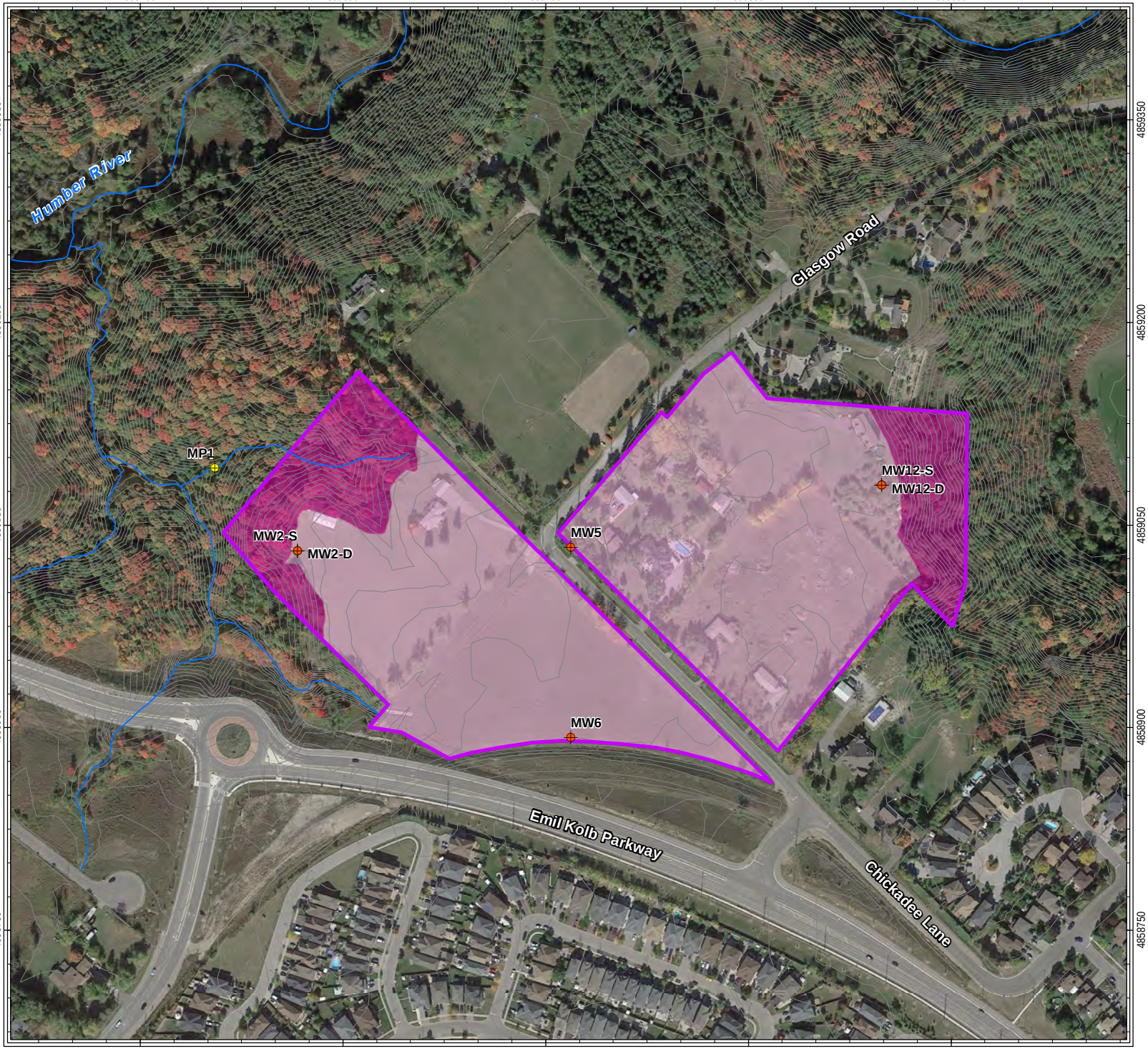
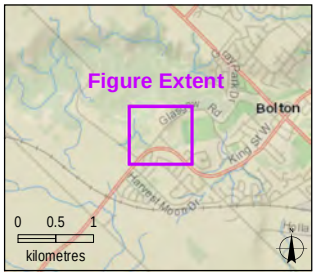




Legend

- Mini Piezometer
- Monitoring Well
- Watercourse
- Contour (1 m)
- Study Area

Runoff by Land Cover Type

- Agricultural (190 mm/year)
- Forest (211 mm/year)

0 25 50 75 100
metres

N

DRAWN: B. Elder
CHECKED: R. Rolick
PROJECT: 170163
DATE: Jul 11, 2018

Scale 1:4000
UTM Zone 17N
NAD 1983

Data Sources: Imagery ©2017 Google. Overview basemap credits at page bottom.

Prepared by:

Palmer

CLIENT: Brook Valley Homes
PROJECT: Chickadee Lane Ecology and Hydrogeology

Runoff

FIGURE 9

Document Path: C:\Egnyte\Shared\Projects\Active\17016 - Brook Valley Homes\170163 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\170163_Figure7_Runoff.mxd

5. Development Considerations

5.1 Dewatering

A preliminary construction dewatering assessment was made on the following project components:

- Linear trenches for site servicing;
- House foundations; and
- Stormwater Management Pond.

The groundwater table is expected range between approximately 4.5 m to 8 mbgs across the Site, indicated by a shift in soil colour from brown (oxidized) to grey (wet, low oxygen) in the borehole log records the Site (**Appendix B**). The shallower water levels measured in MW5 and MW6 are interpreted to represent a perched, poorly drained condition related to local infiltration of precipitation. The calculated K values for the till soils ranged from $3.5x10^{-6}$ m/sec to $4.4x10^{-8}$ m/sec, with a site-wide geometric mean K of $6.1x10^{-7}$ m/sec.

Under these conditions, project elements such as site servicing and house foundations are expected to be completed above the water table. Only minor seepage would be expected in an open excavation. No significant dewatering is expected for this project. The radius of influence would also be limited under these conditions.

To assess the maximum dewatering from the installation of site servicing to manage perched seeage, a preliminary dewatering assessment is provided. Under this scenario, the open cut construction is anticipated to be 3 m in depth, 2 m wide, and completed in 30 m long sections.

Based on the geology shown in the borehole logs, the open cut section will encounter Halton Till, which consists of primarily silty clay till. The silty clay till present has a geomean hydraulic conductivity of 6.1 x 10^{-7} m/s and an observed maximum hydraulic conductivity of 4.3 x 10^{-6} m/s. Based on the shallowest water level of approximately 0.12 mbgs or 255.88 masl (measured in MW2-S on April 4, 2018) and the open cut anticipated to be 3 m deep, approximately 2.9 m of soil will need to be dewatered under a worst-case conservative, scenario.

Dewatering rate estimates (Q) for the open cut was calculated using the following equation from Powers et. al (2007) and shown below:

$$Q_{open\ cut} = \frac{\pi K(H^2 - h^2)}{\ln(\frac{R}{r_e})} + 2\left[\frac{xK(H^2 - h^2)}{2L}\right] \quad m^3/s$$

Where K = hydraulic conductivity (m/s) – *4.3 x 10^{-6} m/s*
H = saturated thickness (m) – *2.9 m*
h = saturated thickness after dewatering (m) – *0 m*
R = radius of influence estimated using the Sichardt equation:
$R = r_e + 3000 * (H\text{-}h)*\sqrt{K}$ (m) – *range between 16.6 and 27.9 m*

r_e = equivalent radius of influence estimated by:
$r_e = \frac{a+x}{\pi}$ (m) – *9.9 m*
Where *a* = trench width (m) – *assumed to be 2 m for all*
x = trench length (m) – *assumed to be 30 m for all*

L = line source distance (m):
L = R/2 or 10 m, whichever is greater – *range between 10 and 13.9 m*

Using the maximum hydraulic conductivity throughout the subdivision, the dewatering rate (or seepage rate) for a 30 m of open cut section is estimated to be 16,164 L/day. It is expected that most of the water found will be perched water above the Halton Till and will quickly drain. Using the more reasonable geometric mean hydraulic conductivity, a seepage rate of 4,256 L/day would be expected. The Zone of Influence (ZOI) is estimated to rang from 16.6 m to 27.9 m. Based on the well water records mapping (**Figure 3**) and the shallow depth of the dewatering, no private wells or natural features will be impacted by dewatering for this project.

Minor seepage is only expected near the central portion of the site where the water level elevation is highest. Along the site margins, the water table is deep and infrastructure (sewer, watermain, SWM pond, etc.) will be constructed above it. The estimated dewatering rate is expected to be manageable through sump pumping at the base of the excavation and the groundwater retrieved can be discharged to ground surface at a location at least 30 m from a drainage feature. However, the contractor should make their own assessment of dewatering methods based on their proposed construction method and trench lengths.

Based upon the Site conditions, construction dewatering rates on the order of 50,000 L/day or less would be expected for a typical excavation. A registration on the MECP Environmental and Sector Registry (EASR) is required for all construction related water taking between 50,000 and 400,000 L/day. A Permit to Take Water (PTTW) is required for all water construction takings exceeding 400,000 L/day.

Given the ubiquitous presence of low permeability soils present at the site, construction dewatering rates are expected to be low for the installation of site servicing or SWM pond excavations (i.e., <50,000 L/day) and be manageable by sump pumping from the base of the excavation. Under these conditions, a PTTW or a registration on the EASR is not expected to be required. Based on this, the radius of water table drawdown would be minimal, no adverse effects to local water wells or natural features would be expected from the minor dewatering predicted.

5.2 Stormwater Pond

The proposed stormwater pond north of Glasgow Road is expected to be dug to between approximately 3.5 and 7 m in depth below existing grade or to an elevation of 253 masl (**Appendix A**). The large range in depths is due to the natural grade of the land.

Based on the borehole logs (Appendix D), the soils at the SWM pond location are consistently Silty Clay Till of the Halton Till formation to a depth of at least 19.8 mbgs. At this location, the groundwater table is estimated to be at approximately 251 masl (5.5 m below grade at BH1). Based on this, it is interpreted that the SWM pond will be constructed above the water table in low permeability silty clay till soils. It is our

opinion that the existing native Halton Till Aquitard is sufficient to protect groundwater quality at the pond location and a liner is not recommended.

5.3 LID Considerations

The use of Low Impact Development (LID) measures are recommended as part of the overall stormwater management plan to help achieve at least 5 mm of stormwater retention and minimize changes to the existing water budget. As stated in *Low Impact Development Stormwater Management Planning and Design Guide Version 1.0* (2010) by CVC and TRCA,

> "Developing stormwater management plans requires an understanding of the depth to water table, depth to bedrock, native soil infiltration rates, estimated annual groundwater recharge rates, locations of significant groundwater recharge and discharge, groundwater flow patterns and the characteristics of the aquifers and aquitards that underlay the area" (TRCA and CVC, 2010).

For sites with deep water table conditions and high permeability soils, LID practices can significantly improve infiltration and groundwater recharge to maintain the groundwater characteristics of the underlying aquifer. Conversely, for sites with low permeability soils and high-water table conditions, the amount of infiltration is limited by the saturated hydraulic conductivity of the soil (i.e., the rate at which water can infiltrate).

The Chickadee Lane Site has low permeability soils at surface with a calculated percolation rate of 40 mm/hr. The site is poorly drained and the true water table is interpreted to be at a depth ranging from approximately 5 – 8 mbgs. As the site acts as a groundwater recharge area (albeit a poor one), perched water in the poorly drained soils is expected. Under these conditions, infiltration trenches, vegetated swales and bioretention areas can all be effective in low permeability soils to increase infiltration. Increasing topsoil depth can also be effective. It is recommended that site grading and rear yard grading should be directed to the tributaries of the Humber River and the associated supporting areas to maintain the water balance, where applicable.

Details on the use and design of LID measures is provided by Candevcon in the FSR Report (Candevcon, 2020) and detailed in the CEISMP Report (Palmer, 2020).

5.4 Source Water Protection

The Clean Water Act (2006) classifies the hydrogeological vulnerability of areas into categories such as Significant Groundwater Recharge Areas (SGRA), Highly Vulnerable Aquifer (HVA), and Wellhead Protection Areas (WHPA). Based on available Source Water Protection Information Mapping compiled by the MECP, the site is not located within a HVA or WHPA. A small portion of the site area that corresponds with Lot 27 (Existing Residential) of the concept plan is characterized as a SGRA with a low vulnerability score of 2. Based on the 2017 Tables of Drinking Water Threats for Pathogens and Chemicals, no activities in these areas have been identified that could pose a threat to groundwater under various circumstances.

In addition, ecological studies completed by Palmer did not identify any groundwater supported natural features (i.e., groundwater supported wetlands and watercourses) on or near the site. It is expected that vertical groundwater movement is restricted at the site due to the presence of the thick silty clay Halton Till aquitard unit (greater than 40 m thick). The low permeability of the till (geometric mean K = 6.1×10^{-7} m/s) greatly limits groundwater recharge and contaminant migration.

6. Summary and Conclusions

The following summarizes the key results of the Hydrogeological Investigation and Water Balance Analyses conducted for the Chickadee Lane Rounding Out Area B Land Development:

- The Chickadee Lane study area lies within the South Slope physiographic region, characterized by silty clay loam sediments of the Halton Till. This was confirmed through OGS mapping of the site and borehole drilling results. On a regional scale the Halton Till acts as an unconfined aquitard, limiting groundwater recharge and discharge.

- Based on a search of the MECP water well database, 34 water well records were identified within a 500 m radius of the site. A roadside water well screening identified up to 14 properties within 500 m of the site that have the potential to still rely on potable groundwater rather than municipal supply, although the municipal water is known to be available along Glasgow Road, Chickadee Lane, Emil Kolb Parkway and King Street. A detailed door-to-door water well survey will be completed at detailed design to document existing potable groundwater use near the site and to collect baseline data on groundwater quality and quantity.

- A series of municipal supply test wells (and their associated decommissioning records) are found along Glasgow Road adjacent to the site. These wells are between approximately 135 and 145 m deep, and identified a confined sand aquifer below approximately 123.4 m of clayey silt to sandy silt till. These wells are not utilized for municipal water and confirm that there is a very thick, low permeability confining unit underlying the Chickadee Lane site protecting deep aquifers.

- Based on the single well response tests conducted in the monitoring wells (MW2-S/D, MW5, MW6, and MW12-S/D), the calculated geometric mean hydraulic conductivity value of the silty clay till is 6.1×10^{-7} m/s. The highest hydraulic conductivity was calculated to be 4.3×10^{-6} m/s.

- Groundwater quality is considered typical for the area and shows an exceedance in PWQO criteria for total iron and total aluminum related to high TSS in the groundwater sample.

- The actual level of the *water table* ranges from approximately 5 m to 8 m below ground surface across the site, indicated by a shift in soil colour from brown (oxidized) to grey (wet, low oxygen) seen in borehole logs for MW2, MW6, and MW12S/D. The majority of boreholes were dry on completion and demonstrating the deeper water table and the low permeability of the soils.

- Based on groundwater monitoring, shallow groundwater levels at the site are expected to be encountered between 0.12 mbgs to 8.71 mbgs, and deep groundwater levels range from 11.35

mbgs to 29.12 mbgs. A groundwater flow divide is present running southeast to northwest through the center of the site, such that groundwater flow east of the divide flows northeast, and west of the divide flows northwest.

- One drive-point piezometer (MP1) was installed within the watercourse in the northwest corner of the site. Based on monitoring in April and May 2018, surface water flow was present within the feature, and there was a mean downward vertical hydraulic gradient within the MP (-0.45 m/m). In June, July, and August 2018 surface water flow was absent. The lack of surface water flow in late season, combined with the downwards hydraulic gradient indicates this feature is runoff supported.

- A pre-development water balance was completed for the site based on data from the Albion Field Centre Station. The estimated water surplus within the site ranges from approximately 285 mm/yr (Forested; 35% of total precipitation) to 294 mm/yr (Agricultural; 36% of total precipitation) and is divided into two components: infiltration and runoff. Using the method outlined in the MOE SWM manual and MOEE (1995), approximately 67% (219 mm/yr) of the surplus runs off, while the remaining 33% (91 mm/yr) infiltrates. Over the entire Site area (100,800 m^2), this translates to approximately 9,186 m^3/yr of infiltration, and approximately 22,113 m^3/yr of runoff These values are consistent with the reported low permeability of the Halton Till combined with the very steep terrain bordering the northwest and northeast sections of the study area.

- No PSWs or groundwater supported features are found in the study area, and therefore, a feature-based water balance assessment is not recommended.

- Without mitigation, the post-development runoff is expected to increase to 46,542 mm/yr and the post-development infiltration is expected to decrease to 4,257 mm/yr. This represents a 110% increase in runoff and 53% reduction in infiltration.

- The use of LID is recommended to increase infiltration post-development. Based on the site geology, depth to water table and proposed development plan, rear yard infiltration trenches are expected to be effective to support infiltration. Additional details on the LID measures is provided in the FSR report (Candevcon, 2020) and the CEIMSP Report (Palmer, 2020).

  Minor seepage is only expected near the central portion of the site where the water level elevation is highest (calculated to be up to 16,164 L/day). Along the site margins, the water table is deep and infrastructure (sewer, watermain, SWM pond, etc.) will be constructed above it. The estimated dewatering rate is expected to be manageable through sump pumping at the base of the excavation and the groundwater retrieved can be discharged to ground surface at a location at least 30 m from a drainage feature. A seepage rates are less than 50,000 L/day, a PTTW or EASR would not be required from the MECP.

- The site is not located within a HVA or WHPA. A small portion of the site area that corresponds with Lot 27 (Existing Residential) of the concept plan is characterized as a SGRA with a low vulnerability score of 2. No requirements under source water protection are needed for this site.

7. Signatures

This report was prepared and reviewed by the undersigned.

In recognition of the Practice of Geoscience in Ontario, this report was prepared by Adrian Lo, GIT who is no longer with Palmer. The minor report updates from the December 29, 2020 version of this report to reflect the 2021 Concept Plan was completed by Jason Cole, M.Sc., P.Geo.

Reviewed By:

Jason Cole, M.Sc., P.Geo.
Principal, Senior Hydrogeologist

8. References

Candevcon, 2020. Functional Servicing and Stormwater Management Report - Chickadee Lane Rounding Out Area B.

Chapman, L.J. and D.F. Putnam. 1984. Physiography of Southern Ontario. Ontario Geological Survey, Special Volume 2: 270 p.

Dougan & Associates. 2014. Bolton Residential Expansion Study: Phase 3 Technical Memorandum – Development of A Preliminary Natural Heritage System.

Fisheries and Oceans Canada (DFO). 2017. Aquatic Species at Risk Maps: Ontario South West Map 11. (http://www.dfo-mpo.gc.ca/species-especes/fpp-ppp/onsw-soon-11-eng.htm).

Kassenaar, J. D. C. and E. J. Wexler. 2006. Groundwater Modelling of the Oak Ridges Moraine Area. (YPDT-CAMC Technical Report No. 01-06).

Palmer, 2020. Comprehensive Environmental Impact Study and Management Plan (CEISMP), Chickadee Lane Rounding Out Area B. Dated Dec, 29, 2020.

Mather, J.R., 1978. The climatic water budget in environmental analysis. Farnborough, Hants: Teakfield. xxi + 239 p.

Ministry of the Environment and Energy (MOEE), 1995. Technical Information Requirements of Land Development Applications.

Thornthwaite, C.W., 1948. An approach toward a rational classification of climate. Geographical Review, Volume 38. 55-94 p.

Thornthwaite, C.W. and J.R. Mather, 1957. Instructions and tables for computing potential evapotranspiration and water balance. Drexel Institute of Technology, Laboratory of Climatology. Publications in Climatology, Volume X. No. 3, 311p.

Toronto and Region Conservation Authority (TRCA). 2008-a. Humber River: State of the Watershed Report.

Toronto and Region Conservation Authority (TRCA). 2008-b. Humber River Watershed: Scenario Modelling and Analysis Report.

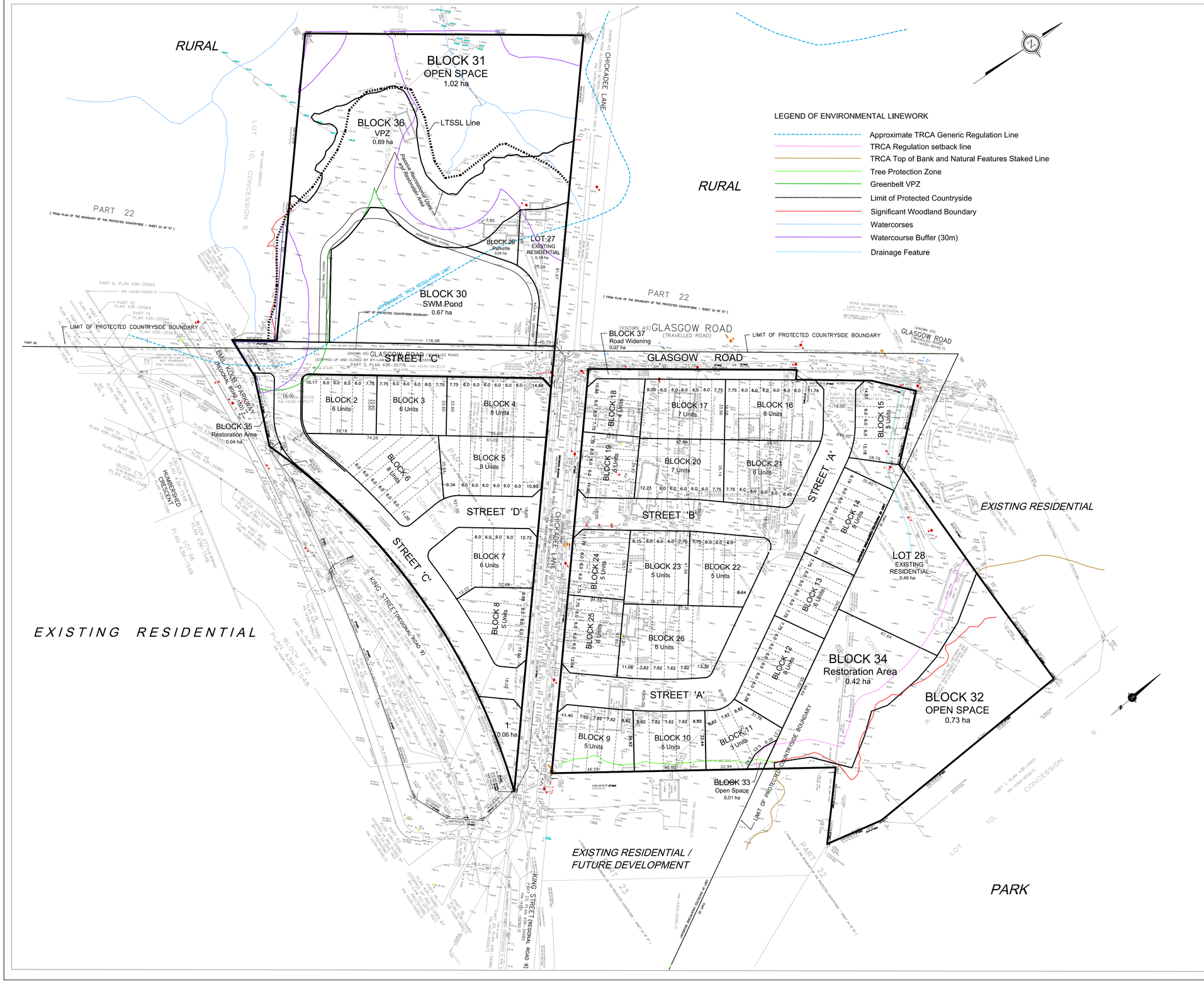
Appendix A1

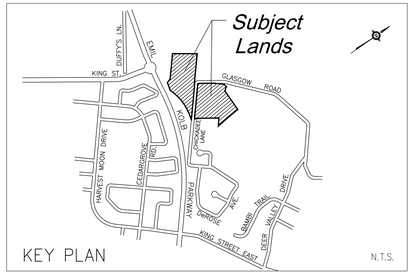
Appendix A1 - Draft Plan of Subdivision (HPG, 2021)

Appendix A2 - Preliminary Storm Drainage Area Plan, Infiltration Plan, and Preliminary Servicing Plan (Candevcon, 2020)

Appendix A1

Chickadee Lane Rounding Out Area B Concept Plan (HPG, 2021)





HUMPHRIES PLANNING GROUP INC.
216 CHRISLEA ROAD, SUITE 103, VAUGHAN, ONTARIO, L4L 8S5
TEL (905)264-7678, FAX (905)264-8073
www.humphriesplanning.com

DEVELOPMENT STATISTICS:

LAND USE	LOT/ BLK.#	UNITS	AREA
Single Detached Residential	1	1	0.06 ha
Street Townhouses	2-26		3.95 ha
6.0m Units		132	
7.62m Units		19	
Existing Residential	27-28	2	0.60 ha
Parkette	29		0.04 ha
Storm Water Management Pond	30		0.67 ha
Open Space	31-33		1.75 ha
Restoration Area	34-35		0.46 ha
VPZ	36		0.89 ha
Road Widening	37		0.07 ha
Roads STREETS A-D - 16.0m-18.0m R.O.W. = 885m			1.55 ha
TOTAL		154	10.04 ha

OWNER'S CERTIFICATE:

I authorize Humphries Planning Group Inc. to prepare and submit this plan for draft approval.

Date: DECEMBER 28, 2020

Zancor Homes (Bolton) Ltd.
137 Bowes Road
Concord, ON

SURVEYOR'S CERTIFICATE:

I hereby certify that the boundaries of the lands being subdivided and their correct relationship to the adjacent lands are accurately and correctly shown on this plan.

Date: DECEMBER 28, 2020

Krcmar Surveyors Ltd.
1137 Centre Street, Suite 101
Thornhill, ON

ADDITIONAL INFORMATION:

[Section 51(17) of the Planning Act, R.S.O. 1990, c. P. 13, as amended to April 11, 1997]
a), b), e), f), g), & j) - on plan.
c) - on key plan
d) - see statistics
h) - piped water to be installed by developer
i) - clay loam soil
k) - all services to be made available by developer
l) - none

DRAFT PLAN OF SUBDIVISION

PART OF LOT 10, CONCESSION 5
AND PART OF KING STREET
(STOPPED UP AND CLOSED BY BY-LAW 53-2015, INST. PR2797098)
PART OF LOT 10, CONCESSION 6
(FORMERLY TOWNSHIP OF ALBION, COUNTY OF PEEL)
PART OF BLOCK 272 AND
PART OF BLOCK 293 (0.30 RESERVE)
PLAN 43M-1548
TOWN OF CALEDON
REGIONAL MUNICIPALITY OF PEEL

SCALE 1:1000

10 0 10 20 50 100m

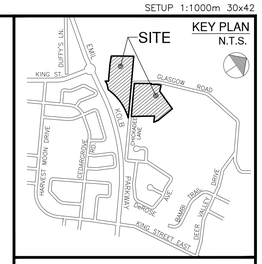
HUMPHRIES PLANNING GROUP INC.
216 CHRISLEA ROAD, SUITE 103, VAUGHAN, ONTARIO, L4L 8S5
TEL (905)264-7678, FAX (905)264-8073
www.humphriesplanning.com

File Number:	Drawing Number:
Date Drawn: 2 MAR 2019	A1
Drawn By: BT	
Checked By: R.H.	
Date Revised: 20 AUG 2021	
CAD File No. :	

Appendix A2

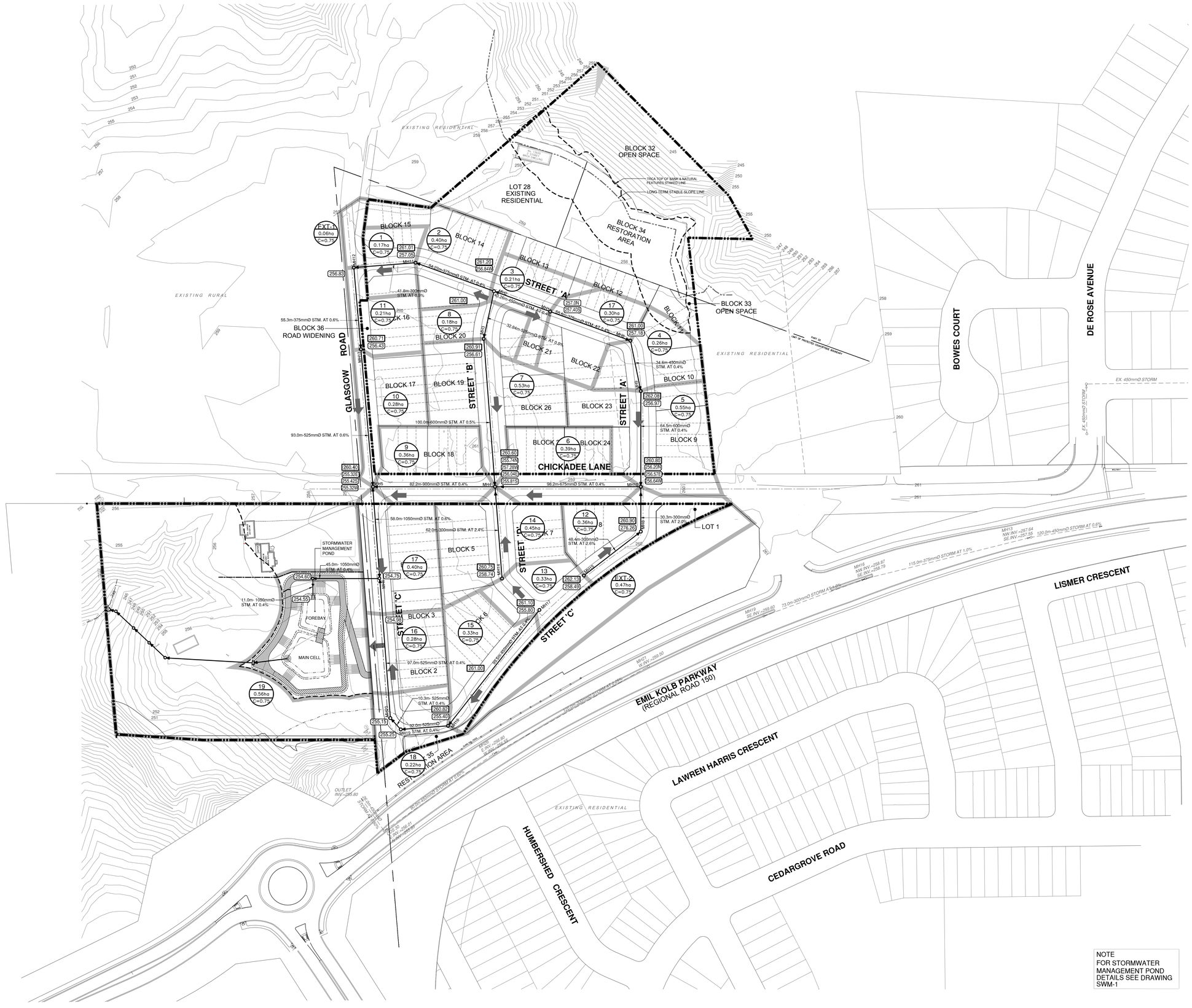
Preliminary Storm Drainage Area Plan, Infiltration Plan, and Preliminary Servicing Plan (Candevcon, 2020)

SETUP 1:1000m 30x42



LEGEND:

- LIMIT OF SUBDIVISION
- 261 — EXISTING CONTOUR LINE
- PROPOSED STORM SEWER
- DRAINAGE BOUNDARY
- 1 / 0.17ha / C=0.75 — DENOTES AREA NUMBER; DENOTES AREA IN HECTARES; DENOTES RUN-OFF COEFFICIENT
- OVERLAND FLOW
- LONG TERM STABLE SLOPE LINE
- TRCA GENERIC REGULATION LINE
- TRCA TOP OF BANK & NATURAL FEATURES STAKED LINE
- WATERCOURSE BUFFER (30m)
- WATERCOURSE



NOTE
FOR STORMWATER MANAGEMENT POND DETAILS SEE DRAWING SWM-1

NO.	DESCRIPTION	DATE	BY
1	REVISED AS PER DRAFT PLAN DATED DEC 7, 2020.	15.12.20.	D.K.H.

REVISIONS

CANDEVCON LIMITED
CONSULTING ENGINEERS AND PLANNERS
9358 GOREWAY DRIVE BRAMPTON, ONTARIO L6P 0M7
TEL. (905) 794-0800 FAX (905) 794-0611

TOWN OF CALEDON

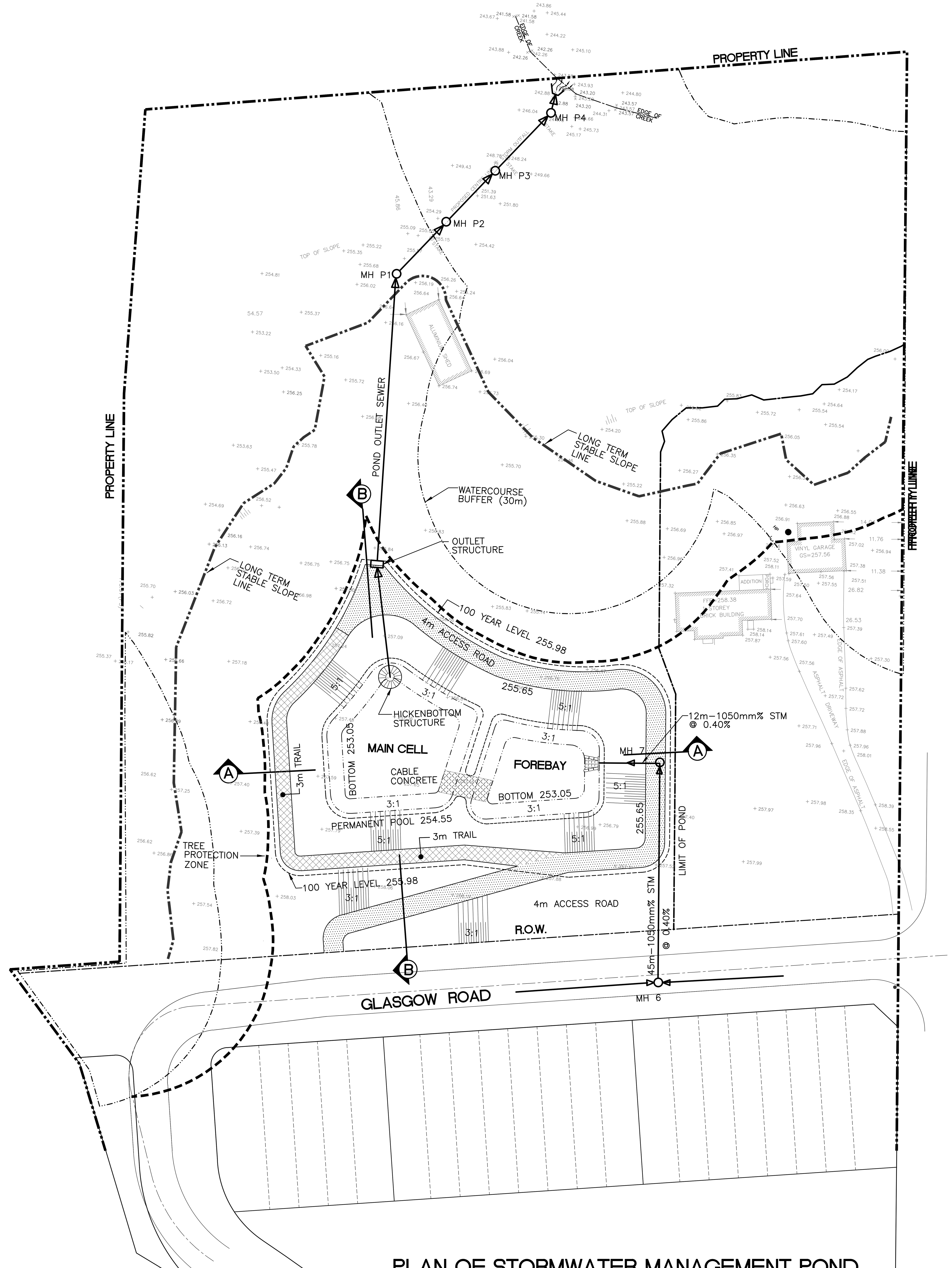
ZANCOR HOMES (BOLTON) LTD.
CHICKADEE LANE
RESIDENTIAL SUBDIVISION
ROUNDING OUT AREA "B"

13935, 13951 & 13999 CHICKADEE LANE, 0 KING STREET
AND
550, 600 AND 615 GLASGOW ROAD
PART OF LOT 10, CONCESSION 5 & 6
TOWN OF CALEDON
REGIONAL MUNICIPALITY OF PEEL

SHEET TITLE:

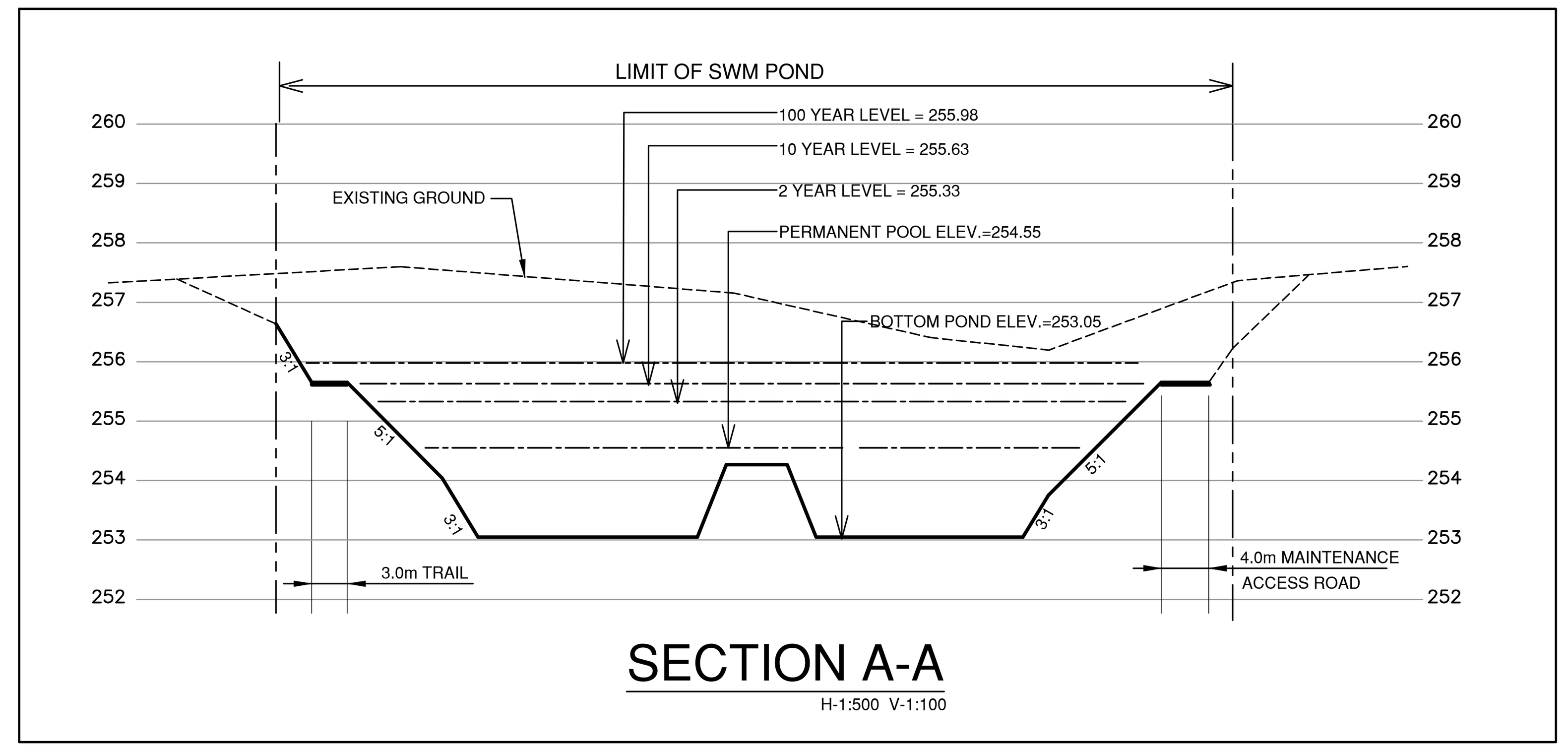
PRELIMINARY STORM DRAINAGE AREA PLAN

DRAWN BY: E.M.	PROJECT No. W17003
CHECKED BY: D.K.H.	DRAWING No. ST-1
SCALE: 1:1000	
DATE: FEB., 19th 2020	1



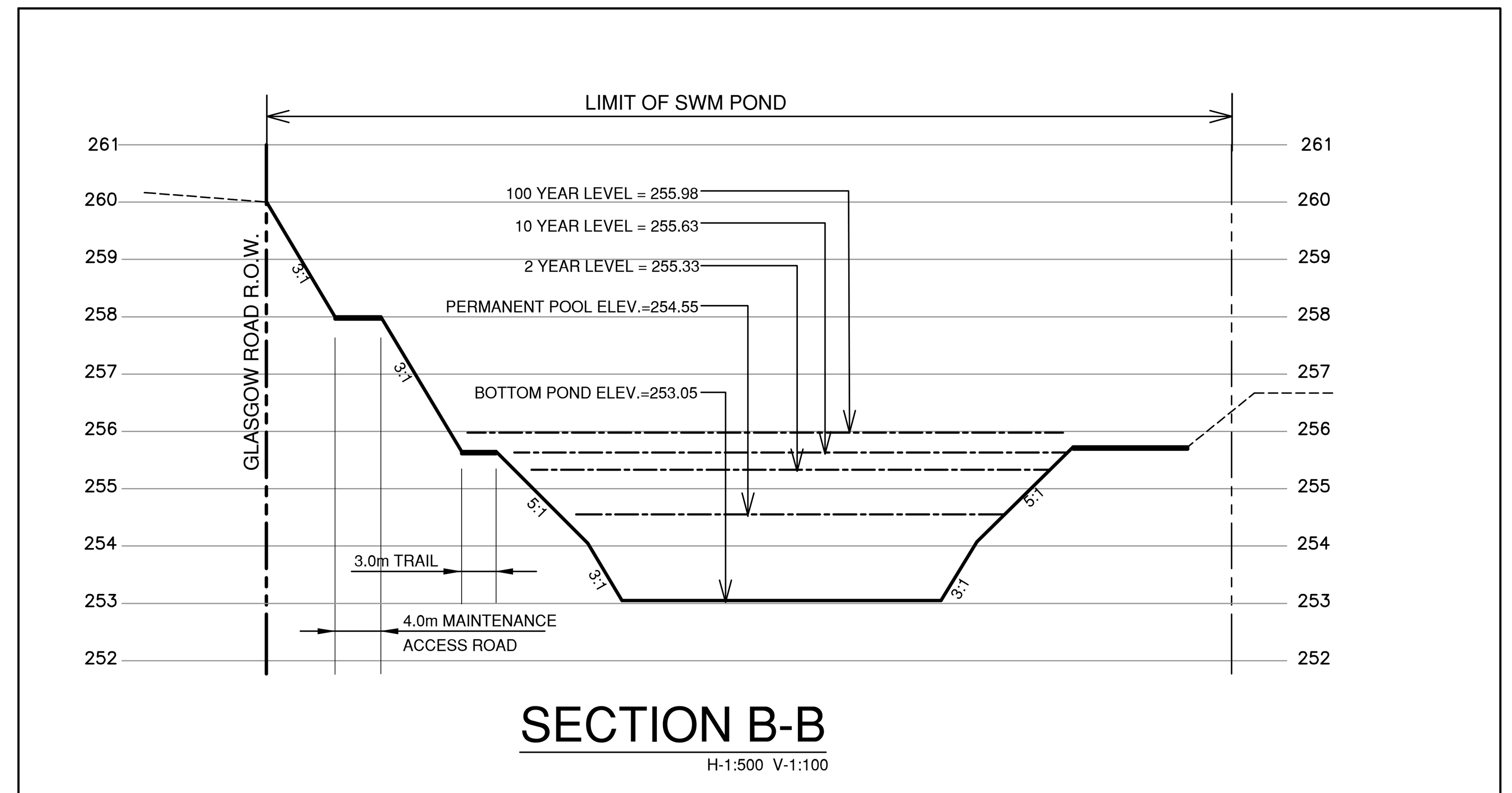
PLAN OF STORMWATER MANAGEMENT POND

1:500



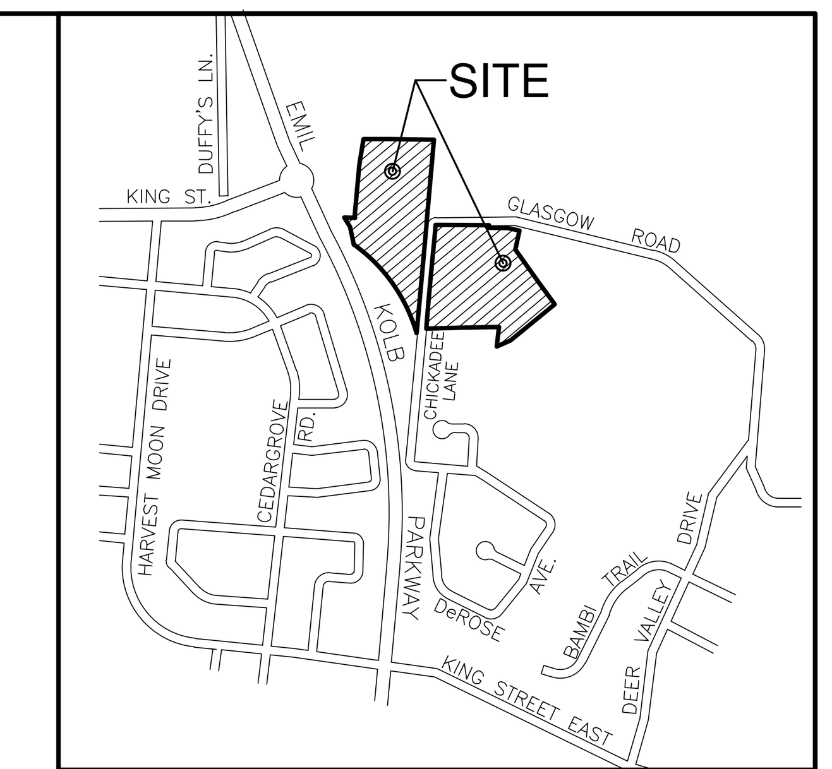
SECTION A-A

H-1:500 V-1:100



SECTION B-B

H-1:500 V-1:100



KEY PLAN
N.T.S.

NO.	DESCRIPTION	DATE	BY

REVISIONS

CANDEVCON LIMITED
CONSULTING ENGINEERS AND PLANNERS
9358 GOREWAY DRIVE BRAMPTON, ONTARIO L6P 0M7
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13935, 13951 & 13999 CHICKADEE LANE, 0 KING STREET
AND
550, 600 AND 615 GLASGOW ROAD
PART OF LOT 10, CONCESSION 5 & 6
TOWN OF CALEDON
REGIONAL MUNICIPALITY OF PEEL

SHEET TITLE:
STORMWATER MANAGEMENT POND

DRAWN BY: E.M.	PROJECT No. W17003
CHECKED BY: D.K.H.	DRAWING No.
SCALE: AS NOTED	SWM-1
DATE: DEC., 15th 2019	

Appendix B

Borehole Logs

Appendix B

Borehole Logs

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger (Solid-Stem)

PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 26, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
256.5	Ground Surface							
0.0	**160 mm TOPSOIL**				0			
	Brown, hard weathered	1	DO	4				
	SILTY CLAY TILL trace of gravel occ. sand seams, cobbles and boulders	2	DO	28	1		17	
		3	DO	41	2		15	
		4	DO	33			16	
		5	DO	32	3		16	
		6	DO	41	4		18	
	brown grey	7	DO	23	5		19	
		8	DO	22	6		18	
8.1	**END OF BOREHOLE**				7			
					8			
					9			
					10			
					11			
					12			

50

Dry on completion

Soil Engineers Ltd.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger (Solid-Stem)

PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 26, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
255.7	Ground Surface							
0.0	**160 mm TOPSOIL**	1	DO	6	0		36	
	Brown, stiff to hard — weathered							
	SILTY CLAY TILL	2	DO	18	1		18	
	trace of gravel							
	occ. sand seams, cobbles and boulders	3	DO	19	2		20	
		4	DO	34			18	
		5	DO	46	3		12	
					4			
		6	DO	31	5		18	
	— brown grey	7	DO	32	6		20	
					7			
		8	DO	27	8		17	
					9			
		9	DO	15			19	
					10			
		10	DO	9	11		28	
					12			

W.L @ Ele. 252.7 m upon completion.
W.L @ Ele. 251.4 m upon completion.

Soil Engineers Ltd.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger (Solid-Stem)

PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 26, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
		11	DO	21
		12	DO	22
		13	DO	21
		14	DO	28
		15	DO	39
19.8	**END OF BOREHOLE** **Installed 50 mm Ø monitoring well to 19.8 m completed with 1.5 m screen. Sand backfill from 17.7 m to 19.8 m. Bentonite seal from 0 m to 17.7 m. Provided with protective monument casing.**			

Depth Scale (m): 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22

Dynamic Cone (blows/30 cm) 10 30 50 70 90

Shear Strength (kN/m²) 50 100 150 200

Penetration Resistance (blows/30 cm) 10 30 50 70 90

Atterberg Limits PL LL

Moisture Content (%) 10 20 30 40

Moisture Content values: 18, 18, 16, 12, 13

WATER LEVEL: Cave

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 2N

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger (Solid-Stem)

PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 26, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES: Number	SAMPLES: Type	SAMPLES: N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
255.7	Ground Surface							
0.0	Direct Auger to Water Table to Install Nested Monitoring Well				0 1 2 3 4 5 6 7			W.L @ Ele. 252.7 m upon completion. Cave-In @ Ele. 251.4 m upon completion.
7.6	**END OF BOREHOLE Installed 50 mm Ø monitoring well to 7.6 m completed with 1.5 m screen. Sand backfill from 5.5 m to 7.6 m. Bentonite seal from 0 m to 5.5 m. Provided with protective monument casing.**				8 9 10 11 12			

Soil Engineers Ltd.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger (Solid-Stem)

PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 26, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
255.8	Ground Surface							
0.0	**260 mm TOPSOIL**	1	DO	5	0		31	Dry on completion
	Brown, very stiff to hard							
	weathered							
	SILTY CLAY TILL	2	DO	28	1		17	
	trace of gravel							
	occ. sand seams, cobbles and boulders	3	DO	35	2		16	
		4	DO	38			18	
		5	DO	29	3		18	
		6	DO	37	4		15	
	brown grey	7	DO	24	5		18	
6.5	**END OF BOREHOLE**				6			
					7			
					8			
					9			
					10			
					11			
					12			

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger (Solid-Stem)

PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 29, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
258.9	Ground Surface							
0.0	**210 mm TOPSOIL**				0			Dry on completion
	EARTH FILL brown and grey silty clay pockets of sand and gravel some topsoil and rootlets	1	DO	30			19	
		2	DO	8	1		19	
1.6	Brown, very stiff to hard	3	DO	18	2		18	
	SILTY CLAY TILL trace of gravel occ. sand seams, cobbles and boulders	4	DO	35			18	
		5	DO	39	3		15	
		6	DO	61	4		16	
	brown / grey				5			
		7	DO	26	6		14	
6.5	**END OF BOREHOLE**				7			
					8			
					9			
					10			
					11			
					12			

Soil Engineers Ltd.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 5

FIGURE NO.: 5

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger (Solid-Stem)

PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 29, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
259.5	Ground Surface							
0.0	**440 mm TOPSOIL**	1	DO	5	0		32	
	EARTH FILL brown and grey silty clay pockets of topsoil some rootlets occ. wood pieces	2	DO	3	1		33	
		3	DO	6	2		34	
2.4	Grey and brown, stiff to hard	4	DO	10			21	
	SILTY CLAY TILL trace of gravel occ. sand seams, cobbles and boulders	5	DO	17	3		19	
		6	DO	69	4 5		18	
		7	DO	20	6		21	
6.5	**END OF BOREHOLE** **Installed 50 mm Ø monitoring well to 6.1 m completed with 1.5 m screen.** **Sand backfill from 4 m to 6.1 m.** **Bentonite seal from 0 m to 4 m.** **Provided with protective monument casing.**				7 8 9 10 11 12			W.L @ Ele. 255.7 m upon completion.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 6

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger (Solid-Stem)

PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 25, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
259.9	Ground Surface							
0.0	**230 mm TOPSOIL** Very stiff to hard	1	DO	6	0		32	
	SILTY CLAY TILL weathered trace of gravel occ. sand seams, cobbles and boulders	2	DO	19	1		23	
		3	DO	32	2		17	
		4	DO	44			15	
		5	DO	43	3		14	
		6	DO	28	4		14	
	brown grey	7	DO	18	5		18	
6.5	**END OF BOREHOLE** **Installed 50 mm Ø monitoring well to 6.1 m completed with 1.5 m screen.** **Sand backfill from 4 m to 6.1 m.** **Bentonite seal from 0 m to 4 m.** **Provided with protective monument casing.**				6 7 8 9 10 11 12			W.L @ Ele. 255.9 m upon completion. Cave-In @ Ele. 254.1 m upon completion.

Soil Engineers Ltd.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 7

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger (Solid-Stem)

PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 23, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
260.0	Ground Surface							
0.0	**280 mm TOPSOIL**	1	DO	9	0		26	W.L @ Ele. 259.7 m upon completion.
	EARTH FILL brown silty clay mixed with topsoil some brick fragments							
0.9	Stiff to hard	2	DO	14	1		21	
	SILTY CLAY TILL trace of gravel occ. sand seams, cobbles and boulders	3	DO	30	2		16	
		4	DO	33			17	
		5	DO	40	3		17	
	brown / grey	6	DO	21	4 5		17	
		7	DO	30	6		16	
6.5	**END OF BOREHOLE**				7 8 9 10 11 12			

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 8

FIGURE NO.: 8

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger (Solid-Stem)

PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 23, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
259.5	Ground Surface							
0.0 0.2	**210 mm TOPSOIL** Very stiff to hard	1	DO	5	0		25	Dry on completion
	SILTY CLAY TILL weathered trace of gravel occ. sand seams, cobbles and boulders	2	DO	23	1		17	
		3	DO	25	2		18	
		4	DO	44			15	
		5	DO	23	3		16	
	brown grey	6	DO	23	4 5		16	
		7	DO	24	6		16	
6.5	**END OF BOREHOLE**				7 8 9 10 11 12			

Soil Engineers Ltd.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 9

FIGURE NO.: 9

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger (Solid-Stem)

PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 23, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
260.0	Ground Surface							
0.0	**280 mm TOPSOIL**	1	DO	3	0		38	
0.3	**EARTH FILL** brown silty clay pockets of topsoil occ. rootlets Very stiff to hard	2	DO	7	1		20	
0.8	**SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders	3	DO	7	2		25	
		4	DO	27	3		19	
	brown / grey	5	DO	33	4		16	
		6	DO	25	5		16	
		7	DO	25	6		19	
6.5	**END OF BOREHOLE**				7			
					8			
					9			
					10			
					11			
					12			

W.L @ Ele. 258.5 m upon completion.

Cave-In @ Ele. 256 m upon completion.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 10

FIGURE NO.: **10**

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger (Solid-Stem)

PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 23, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
257.8	Ground Surface							
0.0	**280 mm TOPSOIL**	1	DO	2	0		26	Dry on completion
0.3	Very stiff to hard weathered **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders	2	DO	28	1		17	
		3	DO	31	2		16	
		4	DO	30	3		17	
	brown grey	5	DO	33	4		16	
		6	DO	26	5		17	
		7	DO	22	6		15	
6.5	**END OF BOREHOLE**				7			
					8			
					9			
					10			
					11			
					12			

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 11

FIGURE NO.: 11

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger (Solid-Stem)

PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 23, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
259.3	Ground Surface							
0.0	**210 mm TOPSOIL**				0			Dry on completion
0.2	**EARTH FILL** dark brown silty clay mixed with topsoil some gravel	1	DO	5			32	
0.6	Very stiff to hard	2	DO	23	1		17	
	SILTY CLAY TILL trace of gravel occ. sand seams, cobbles and boulders	3	DO	28	2		16	
		4	DO	45			15	
	brown / grey	5	DO	25	3		15	
		6	DO	23	4 5		17	
		7	DO	31	6		13	
6.5	**END OF BOREHOLE**				7 8 9 10 11 12			

Soil Engineers Ltd.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 12

FIGURE NO.: 12

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger (Solid-Stem)

PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 24, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
258.3	Ground Surface							
0.0	**460 mm TOPSOIL**	1	DO	12	0		30	
	Very stiff to hard — weathered							
	SILTY CLAY TILL trace of gravel occ. sand seams, cobbles and boulders	2	DO	10	1		16	
		3	DO	38	2		16	
		4	DO	32			16	
		5	DO	39	3		16	
		6	DO	31	4		16	
		7	DO	25	5		17	
	— brown grey	8	DO	28	6		13	
		9	DO	24	7		16	
		10	DO	18	8		17	
					9			
					10			
					11			
					12			

W.L @ Ele. 252.2 m upon completion.

Soil Engineers Ltd.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 12

FIGURE NO.: 12

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger (Solid-Stem)

PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 24, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
		11	DO	11	12		20	
		12	DO	17	13		20	
		13	DO	11	14		29	
		14	DO	19	15		19	
		15	DO	20	16		18	
		16	DO	25	17		18	
		17	DO	18	18		29	
		18	DO	39	19		12	
					20			
					21			
					22			
					23			
					24			

Cave-In @ Ele. 243.1 m upon completion.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 12

FIGURE NO.: 12

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger (Solid-Stem)

PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 24, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
					24			
		19	DO	37	25		15	
		20	DO	29	26		13	
	sandy	21	DO	43	27		12	
		22	DO	78	28		14	
		23	DO	52	29		12	
					30			
					31			
					32			
32.0	**END OF BOREHOLE** **Installed 50 mm Ø monitoring well to 32 m completed with 1.5 m screen. Sand backfill from 29.9 m to 32 m. Bentonite seal from 0 m to 29.9 m. Provided with protective monument casing.**				33			
					34			

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 12N

FIGURE NO.: 12

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger (Solid-Stem)

PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 24, 2018

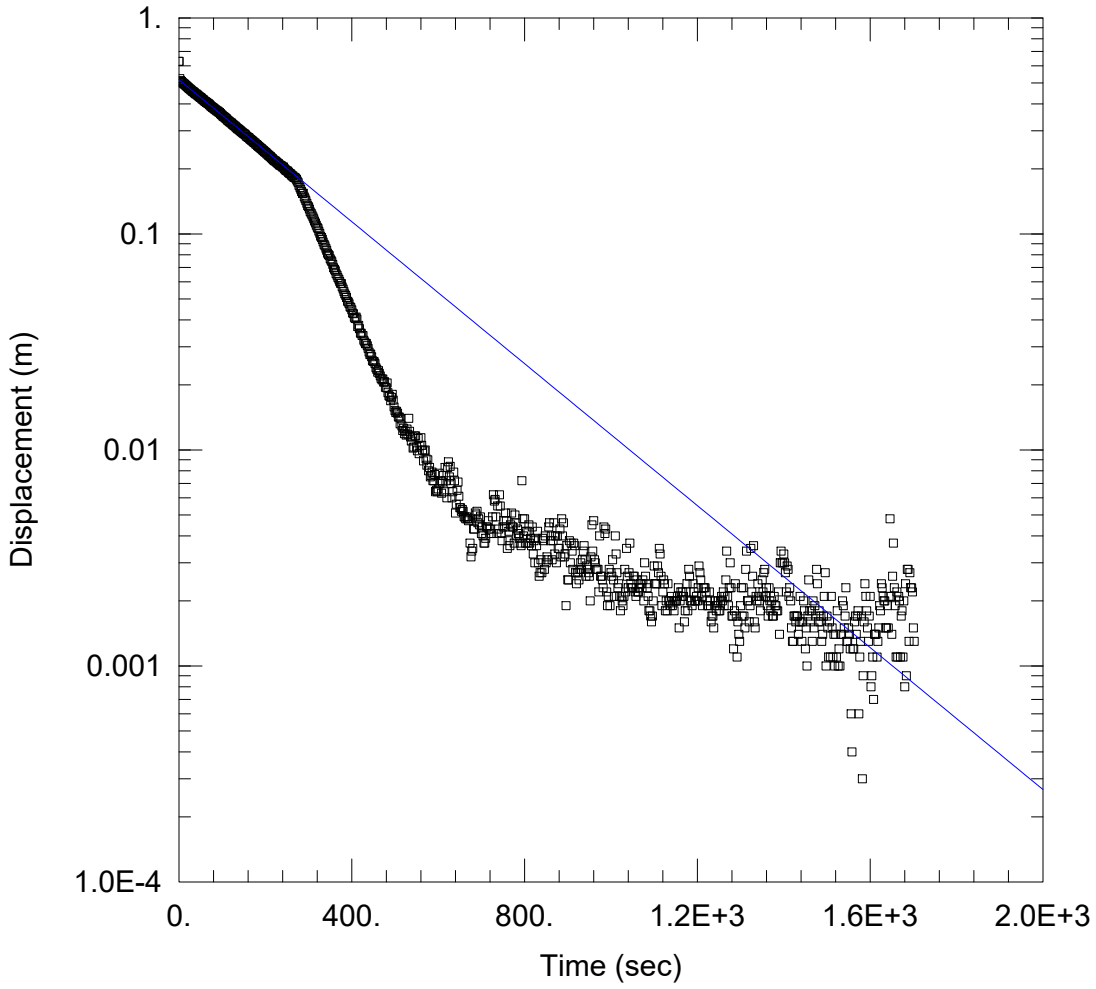
El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES: Number	SAMPLES: Type	SAMPLES: N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
258.3	Ground Surface							
0.0	Direct Auger to Water Table to Install Nested Monitoring Well				0 1 2 3 4 5 6 7			W.L @ Ele. 252.2 m upon completion. Cave-In @ Ele. 243.1 m upon completion.
7.6	**END OF BOREHOLE Installed 50 mm Ø monitoring well to 7.6 m completed with 1.5 m screen. Sand backfill from 5.5 m to 7.6 m. Bentonite seal from 0 m to 5.5 m. Provided with protective monument casing.**				8 9 10 11 12			

Appendix C

Single Well Response Test Analyses

Appendix C

Single Well Response Test Analyses



WELL TEST ANALYSIS

Data Set: C:\...\MW6R2.aqt
Date: 10/12/18 Time: 17:16:01

PROJECT INFORMATION

Company: PECG
Client: Brook Valley Homes
Project: 170163
Location: Bolton
Test Well: MW6
Test Date: April 4, 2018

AQUIFER DATA

Saturated Thickness: 5.94 m Anisotropy Ratio (Kz/Kr): 0.1

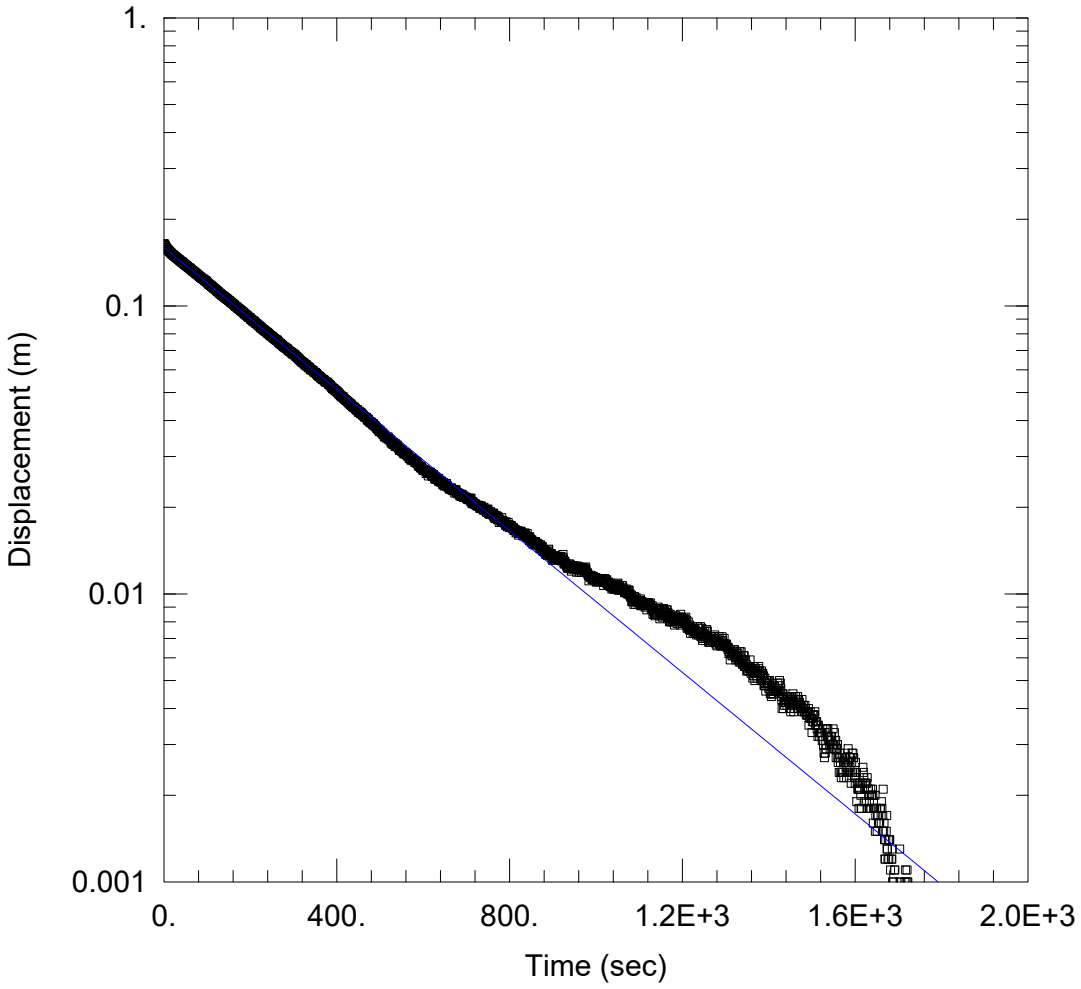
WELL DATA (MW6)

Initial Displacement: 0.6292 m
Total Well Penetration Depth: 4.94 m
Casing Radius: 0.0254 m
Static Water Column Height: 4.94 m
Screen Length: 1.5 m
Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 4.255E-6 m/sec y0 = 0.5174 m



WELL TEST ANALYSIS

Data Set: C:\...\MW6R1.aqt
Date: 10/12/18 Time: 17:15:38

PROJECT INFORMATION

Company: PECG
Client: Brook Valley Homes
Project: 170163
Location: Bolton
Test Well: MW5
Test Date: March 19, 2018

AQUIFER DATA

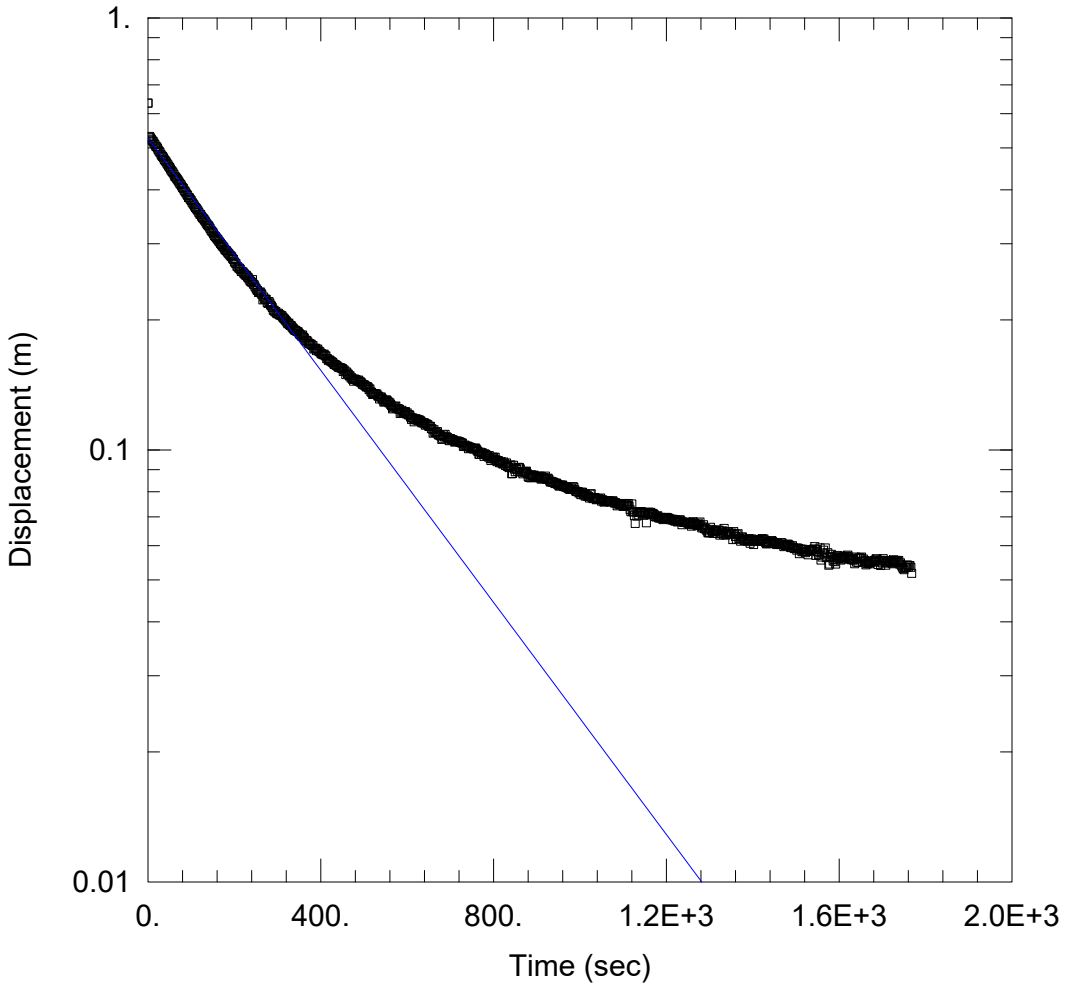
Saturated Thickness: 4.62 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW6)

Initial Displacement: 0.1645 m
Total Well Penetration Depth: 3.62 m
Casing Radius: 0.0254 m
Static Water Column Height: 3.62 m
Screen Length: 1.5 m
Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 3.183E-6 m/sec
y0 = 0.1594 m



WELL TEST ANALYSIS

Data Set: C:\...\MW6F2.aqt
Date: 10/12/18 Time: 17:15:22

PROJECT INFORMATION

Company: PECG
Client: Brook Valley Homes
Project: 170163
Location: Bolton
Test Well: MW6
Test Date: April 4, 2018

AQUIFER DATA

Saturated Thickness: 5.94 m Anisotropy Ratio (Kz/Kr): 0.1

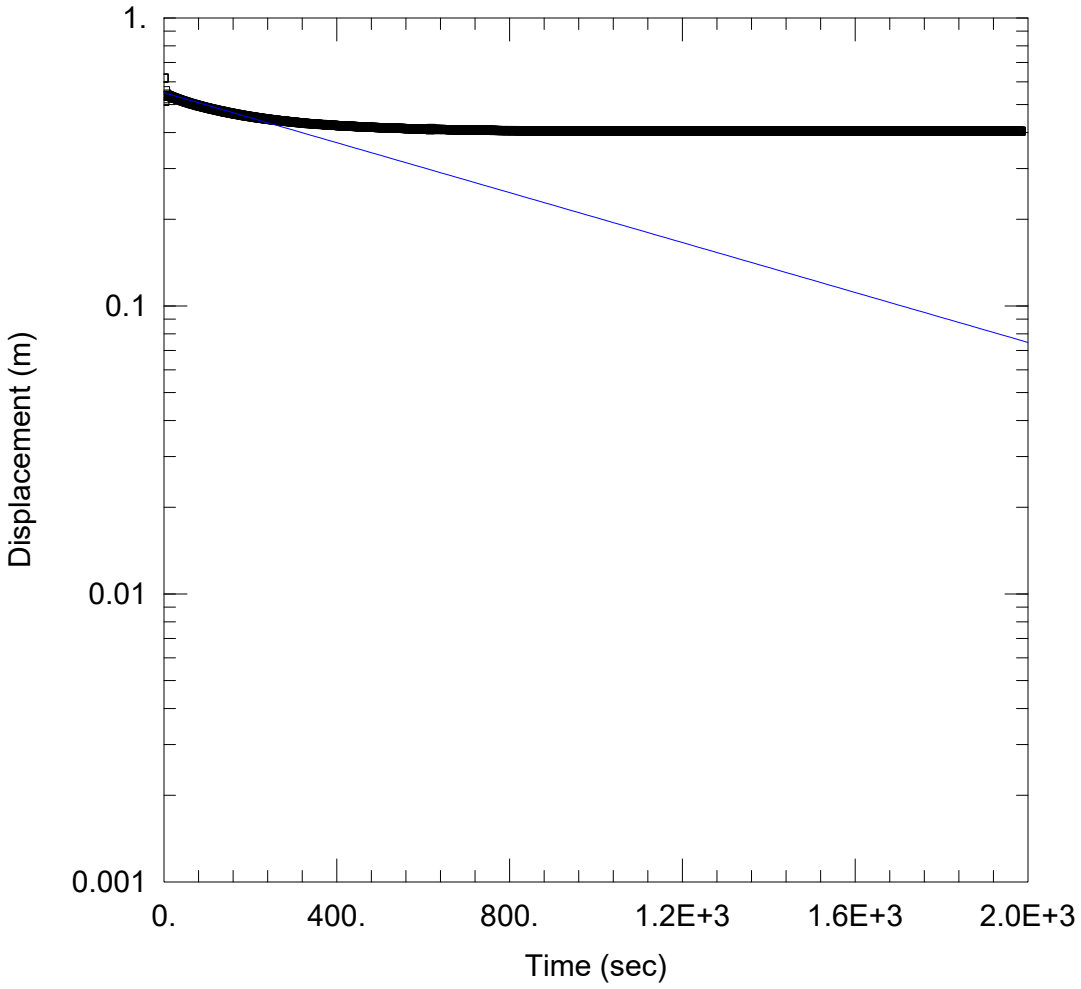
WELL DATA (MW6)

Initial Displacement: 0.6349 m
Total Well Penetration Depth: 4.94 m
Casing Radius: 0.0254 m
Static Water Column Height: 4.94 m
Screen Length: 1.5 m
Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 3.478E-6 m/sec y0 = 0.5265 m



WELL TEST ANALYSIS

Data Set: C:\...\MW6F1.aqt
Date: 10/12/18 Time: 17:15:06

PROJECT INFORMATION

Company: PECG
Client: Brook Valley Homes
Project: 170163
Location: Bolton
Test Well: MW5
Test Date: March 19, 2018

AQUIFER DATA

Saturated Thickness: 4.62 m Anisotropy Ratio (Kz/Kr): 0.1

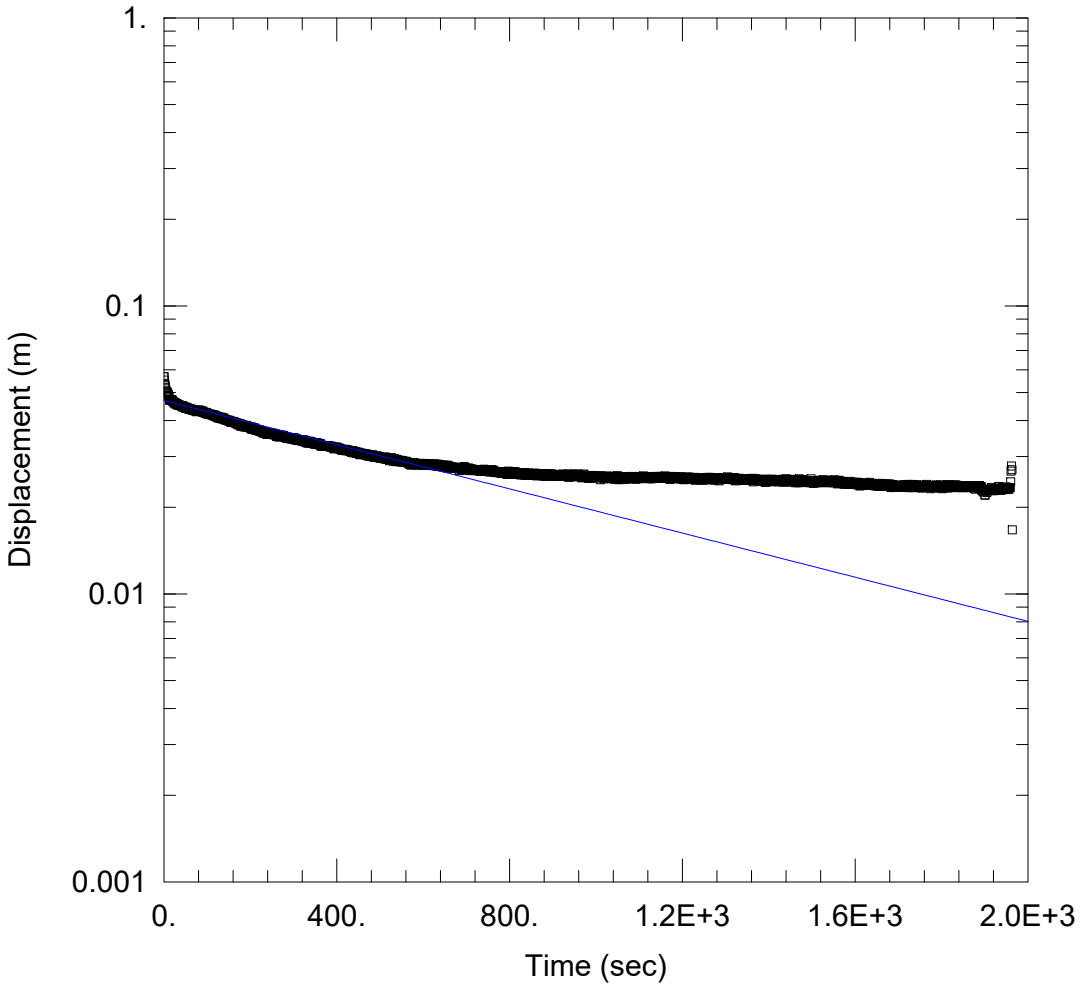
WELL DATA (MW6)

Initial Displacement: 0.6174 m
Total Well Penetration Depth: 3.62 m
Casing Radius: 0.0254 m
Static Water Column Height: 3.62 m
Screen Length: 1.5 m
Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 1.122E-6 m/sec y0 = 0.5497 m



WELL TEST ANALYSIS

Data Set: C:\...\MW5R.aqt
Date: 10/12/18 Time: 17:14:46

PROJECT INFORMATION

Company: PECG
Client: Brook Valley Homes
Project: 170163
Location: Bolton
Test Well: MW5
Test Date: March 19, 2018

AQUIFER DATA

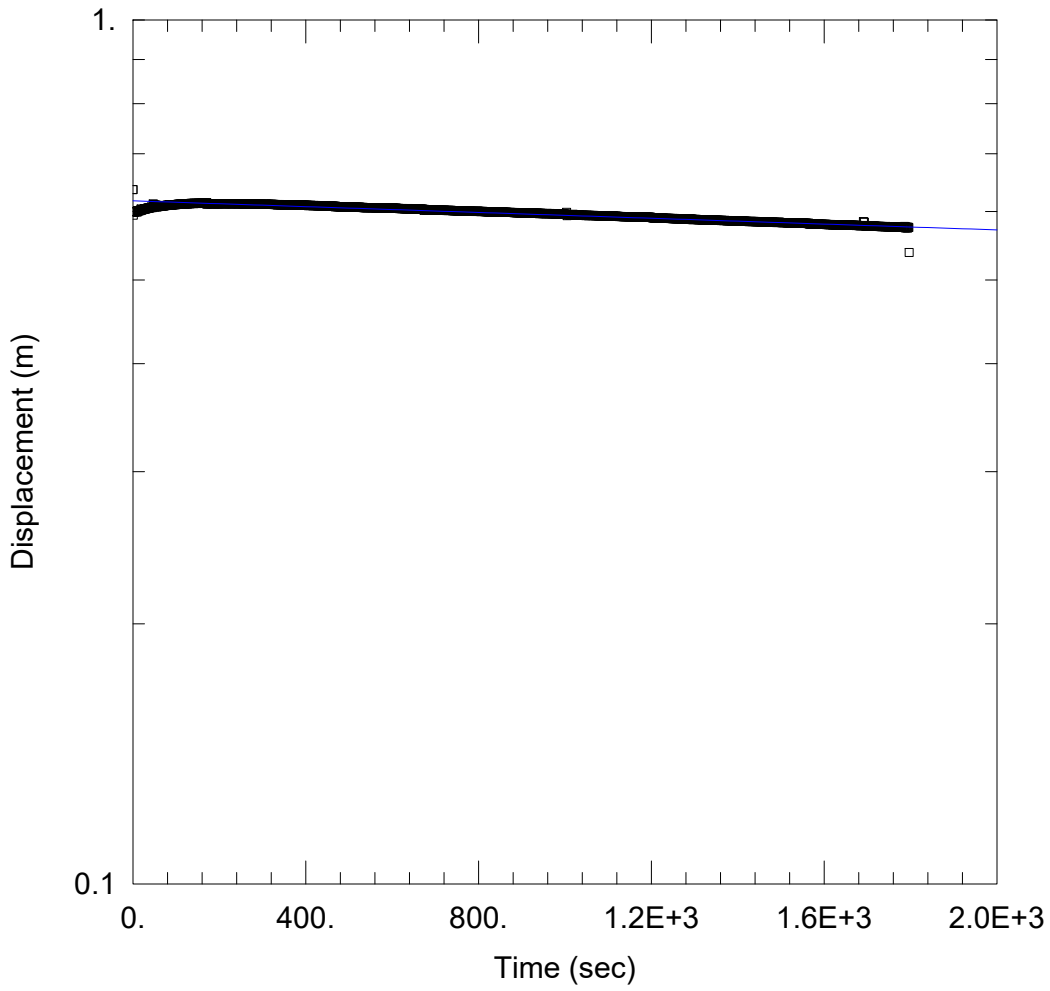
Saturated Thickness: 5.52 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW5)

Initial Displacement: 0.0568 m
Total Well Penetration Depth: 4.52 m
Casing Radius: 0.0254 m
Static Water Column Height: 4.52 m
Screen Length: 1.5 m
Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 9.929E-7 m/sec
y0 = 0.04692 m



WELL TEST ANALYSIS

Data Set: C:\...\MW5F.aqt
Date: 10/12/18 Time: 17:14:14

PROJECT INFORMATION

Company: PECG
Client: Brook Valley Homes
Project: 170163
Location: Bolton
Test Well: MW5
Test Date: March 19, 2018

AQUIFER DATA

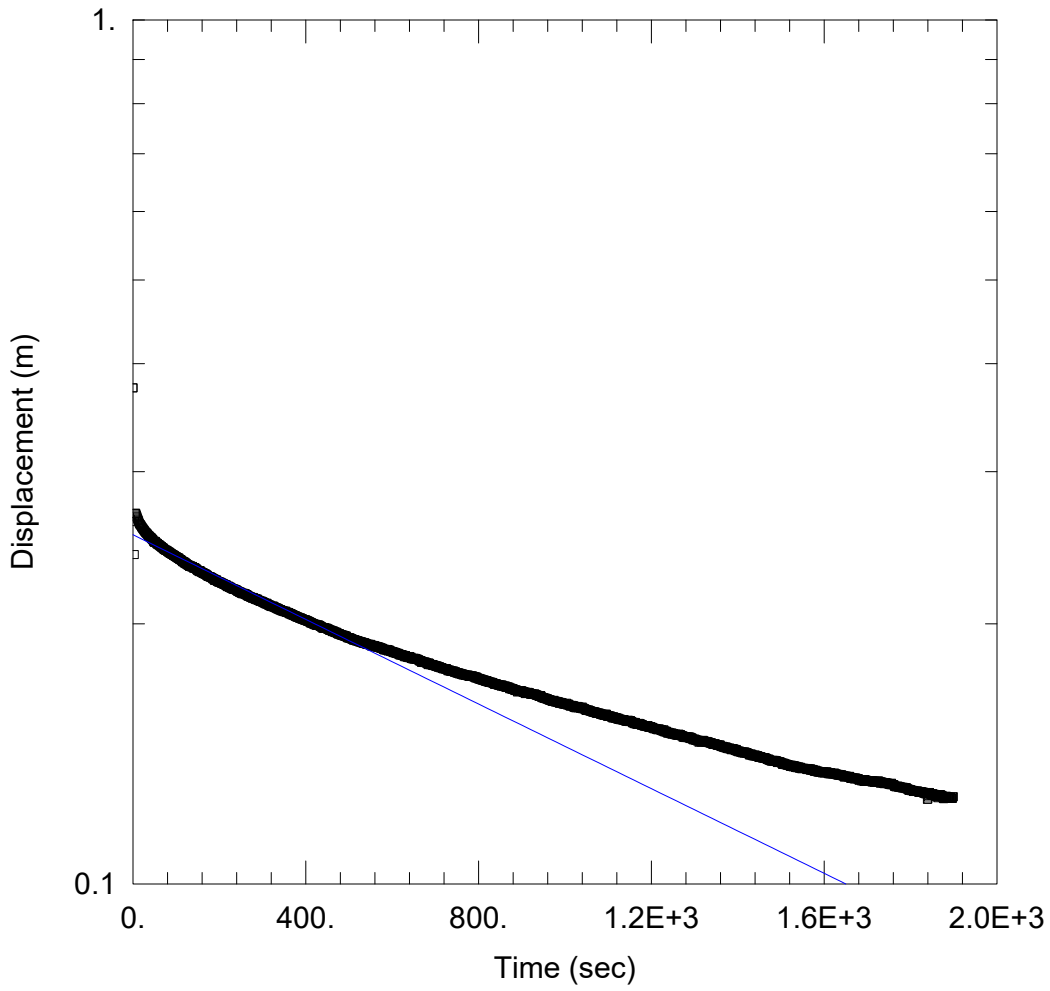
Saturated Thickness: 5.52 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW5)

Initial Displacement: 0.6361 m
Total Well Penetration Depth: 4.52 m
Casing Radius: 0.0254 m
Static Water Column Height: 4.52 m
Screen Length: 1.5 m
Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 4.357E-8 m/sec
y0 = 0.6175 m



WELL TEST ANALYSIS

Data Set: C:\...\MW2SR.aqt
Date: 10/12/18 Time: 17:13:58

PROJECT INFORMATION

Company: PECG
Client: Brook Valley Homes
Project: 170163
Location: Bolton
Test Well: MW2S
Test Date: March 19, 2018

AQUIFER DATA

Saturated Thickness: 6.84 m Anisotropy Ratio (Kz/Kr): 0.1

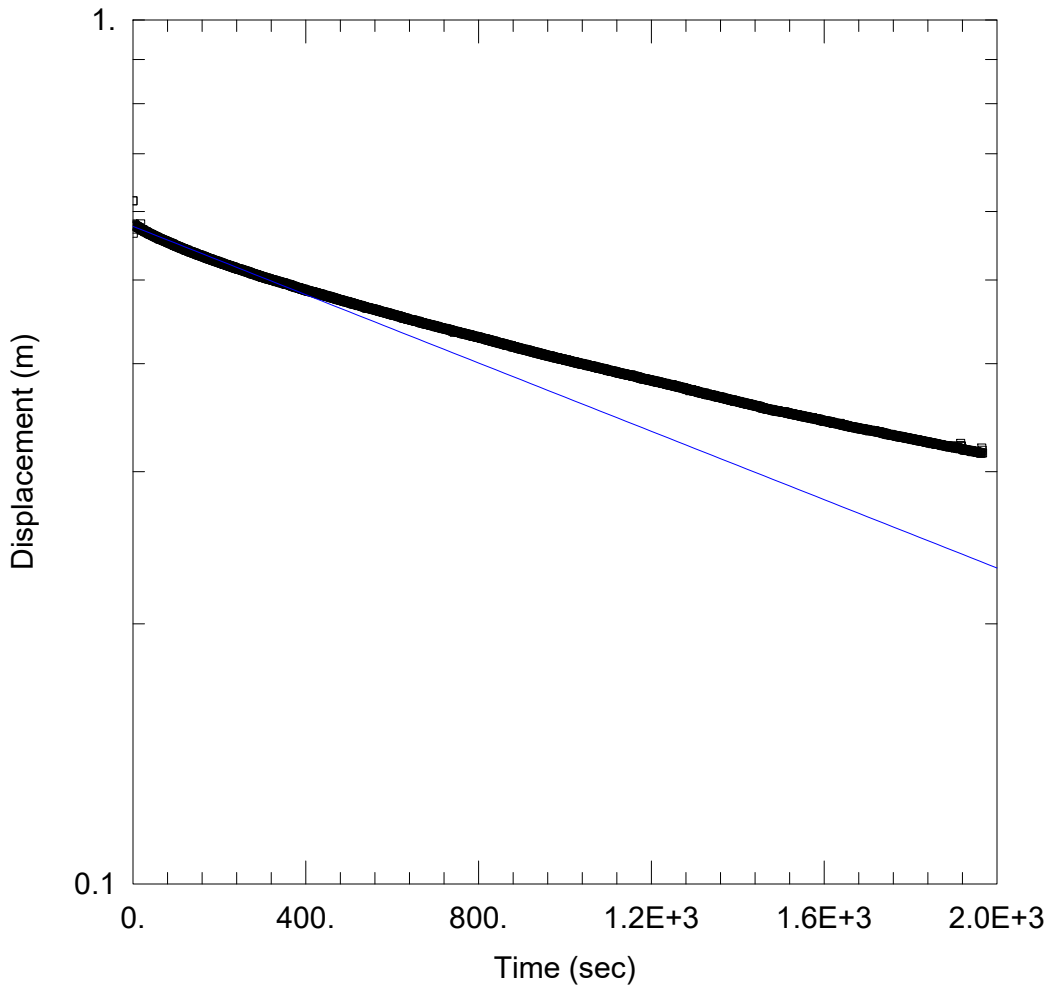
WELL DATA (MW2S)

Initial Displacement: 0.3751 m
Total Well Penetration Depth: 5.84 m
Casing Radius: 0.0254 m
Static Water Column Height: 5.84 m
Screen Length: 1.5 m
Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 6.341E-7 m/sec y0 = 0.2536 m



WELL TEST ANALYSIS

Data Set: C:\...\MW2SF.aqt
Date: 10/12/18 Time: 17:13:47

PROJECT INFORMATION

Company: PECG
Client: Brook Valley Homes
Project: 170163
Location: Bolton
Test Well: MW2S
Test Date: March 19, 2018

AQUIFER DATA

Saturated Thickness: 6.84 m Anisotropy Ratio (Kz/Kr): 0.1

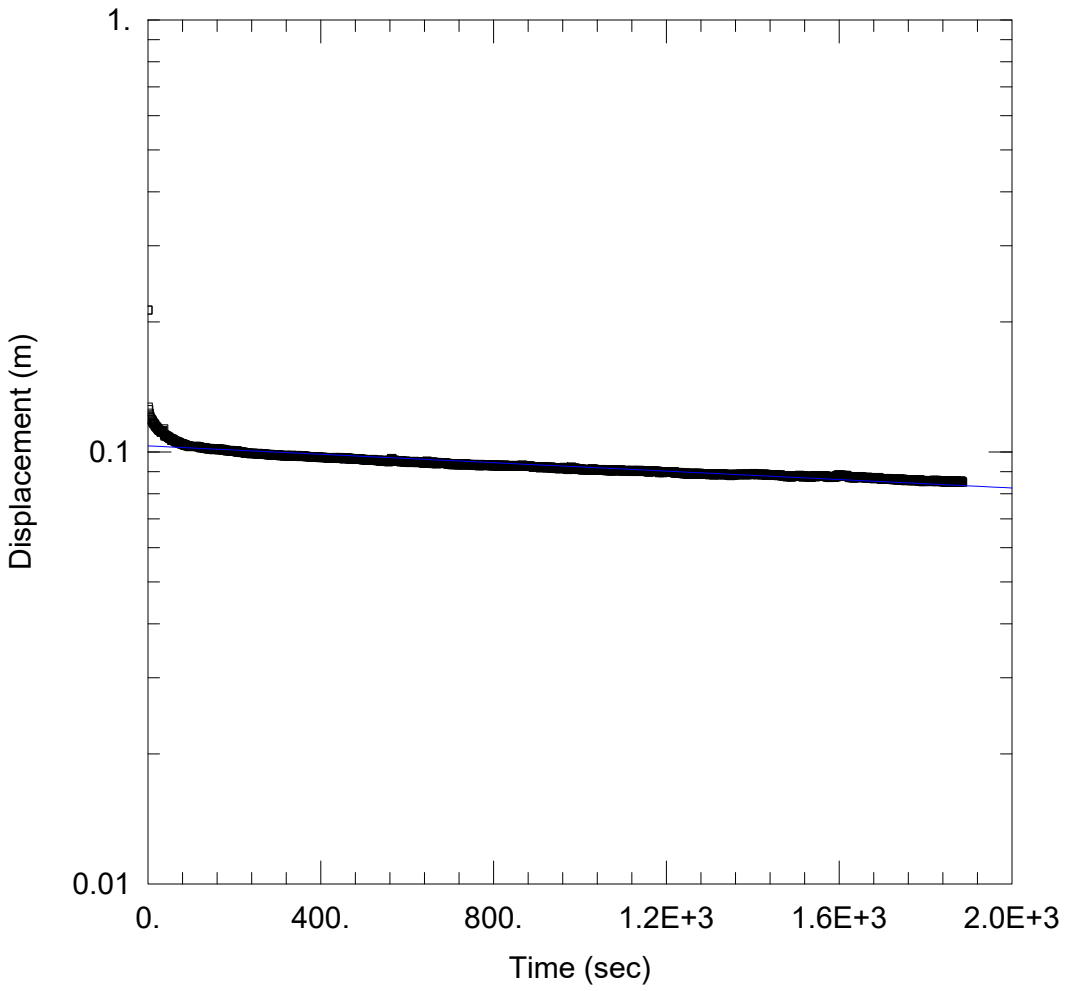
WELL DATA (MW2S)

Initial Displacement: 0.6176 m
Total Well Penetration Depth: 5.84 m
Casing Radius: 0.0254 m
Static Water Column Height: 5.84 m
Screen Length: 1.5 m
Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 5.12E-7 m/sec y0 = 0.5769 m



WELL TEST ANALYSIS

Data Set: C:\...\MW2DR.aqt
Date: 10/12/18 Time: 17:13:27

PROJECT INFORMATION

Company: PECG
Client: Brook Valley Homes
Project: 170163
Location: Bolton
Test Well: MW2D
Test Date: March 19, 2018

AQUIFER DATA

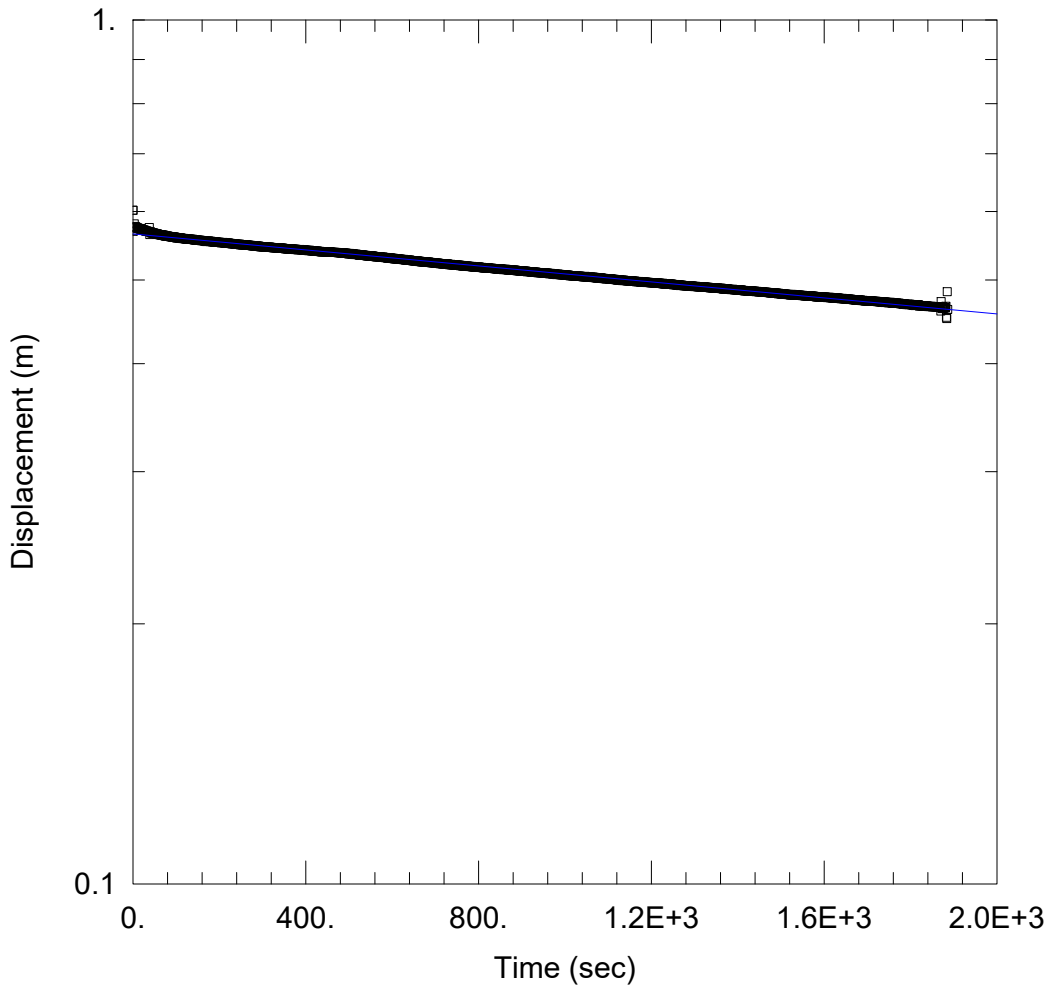
Saturated Thickness: 7.46 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW2D)

Initial Displacement: 0.213 m
Static Water Column Height: 6.46 m
Total Well Penetration Depth: 6.46 m
Screen Length: 1.5 m
Casing Radius: 0.0254 m
Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 1.262E-7 m/sec
y0 = 0.1033 m



WELL TEST ANALYSIS

Data Set: C:\...\MW2DF.aqt
Date: 10/12/18 Time: 17:05:42

PROJECT INFORMATION

Company: PECG
Client: Brook Valley Homes
Project: 170163
Location: Bolton
Test Well: MW2D
Test Date: March 19, 2018

AQUIFER DATA

Saturated Thickness: 7.46 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW2D)

Initial Displacement: 0.6021 m
Static Water Column Height: 6.46 m
Total Well Penetration Depth: 6.46 m
Screen Length: 1.5 m
Casing Radius: 0.0254 m
Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 1.199E-7 m/sec
y0 = 0.5652 m

Appendix D

Groundwater Chemistry Certificate of Analysis

Appendix D

Groundwater Chemistry Certificate of Analysis

PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
ATTN: Ryan Polick
74 Berkeley Street
Toronto ON M5V 2W7

Date Received: 15-MAR-18
Report Date: 23-MAR-18 10:45 (MT)
Version: FINAL

Client Phone: 647-795-8153

Certificate of Analysis

Lab Work Order #: L2068971

Project P.O. #: NOT SUBMITTED
Job Reference: 170163 CHICKADEE LANE
C of C Numbers: 17-622480
Legal Site Desc:

Amanda Fazekas
Account Manager

170163 CHICKADEE LANE

Sample Details Grouping	Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	Guideline Limits #2
L2068971-1	MW6							
Sampled By:	CLIENT on 15-MAR-18 @ 15:45							
Matrix:	WATER							
Physical Tests								
	Colour, Apparent	30.9		2.0	CU	17-MAR-18		*5
	Conductivity	941		3.0	umhos/cm	17-MAR-18		
	Hardness (as CaCO3)	461	HTC	10	mg/L	20-MAR-18		*80-100
	pH	7.88		0.10	pH units	17-MAR-18		6.5-8.5
	Redox Potential	317	PEHR	-1000	mV	20-MAR-18		
	Total Dissolved Solids	560	DLDS	20	mg/L	18-MAR-18		*500
	Turbidity	72.0		0.10	NTU	17-MAR-18		*5
Anions and Nutrients								
	Acidity (as CaCO3)	30.0		5.0	mg/L	21-MAR-18		
	Alkalinity, Total (as CaCO3)	387		10	mg/L	19-MAR-18		30-500
	Ammonia, Total (as N)	0.022		0.020	mg/L	19-MAR-18		
	Bromide (Br)	<0.10		0.10	mg/L	19-MAR-18		
	Chloride (Cl)	55.8		0.50	mg/L	19-MAR-18		250
	Fluoride (F)	0.226		0.020	mg/L	19-MAR-18	1.5	
	Nitrate (as N)	<0.020		0.020	mg/L	19-MAR-18	10	
	Nitrite (as N)	<0.010		0.010	mg/L	19-MAR-18	1	
	Orthophosphate-Dissolved (as P)	<0.0030		0.0030	mg/L	19-MAR-18		
	Phosphorus, Total	0.0560		0.0030	mg/L	20-MAR-18		
	Sulfate (SO4)	77.1		0.30	mg/L	19-MAR-18		500
Bacteriological Tests								
	Escherichia Coli	0		0	MPN/100mL	18-MAR-18	0	
	Total Coliforms	>201		0	MPN/100mL	18-MAR-18	*0	
Total Metals								
	Aluminum (Al)-Total	1.24		0.0050	mg/L	20-MAR-18		*0.1
	Antimony (Sb)-Total	0.00017		0.00010	mg/L	20-MAR-18	0.006	
	Arsenic (As)-Total	0.00126		0.00010	mg/L	20-MAR-18	0.0100	
	Barium (Ba)-Total	0.0943		0.00020	mg/L	20-MAR-18	1	
	Beryllium (Be)-Total	<0.00010		0.00010	mg/L	20-MAR-18		
	Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	20-MAR-18		
	Boron (B)-Total	0.027		0.010	mg/L	20-MAR-18	5	
	Cadmium (Cd)-Total	0.0000197		0.0000050	mg/L	20-MAR-18	0.005	
	Calcium (Ca)-Total	108		0.50	mg/L	20-MAR-18		
	Cesium (Cs)-Total	0.000180		0.000010	mg/L	20-MAR-18		
	Chromium (Cr)-Total	0.00296		0.00050	mg/L	20-MAR-18	0.05	
	Cobalt (Co)-Total	0.00168		0.00010	mg/L	20-MAR-18		
	Copper (Cu)-Total	0.0026		0.0010	mg/L	20-MAR-18		1
	Iron (Fe)-Total	2.07		0.050	mg/L	20-MAR-18		*0.3
	Lead (Pb)-Total	0.00144		0.000050	mg/L	20-MAR-18	0.01	
	Lithium (Li)-Total	0.0275		0.0010	mg/L	20-MAR-18		
	Magnesium (Mg)-Total	46.3		0.050	mg/L	20-MAR-18		
	Manganese (Mn)-Total	0.114		0.00050	mg/L	20-MAR-18		*0.05
	Molybdenum (Mo)-Total	0.00215		0.000050	mg/L	20-MAR-18		
	Nickel (Ni)-Total	0.00366		0.00050	mg/L	20-MAR-18		
	Phosphorus (P)-Total	0.083		0.050	mg/L	20-MAR-18		

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

Ontario Drinking Water Regulation (ODWQS) JAN.1,2017 = [Suite] - ON-DW-STANDARD+GUIDELINES

#1: Schedule 1 (Microbiological) and 2 (Chemical) Standards (JAN,2017) **#2: Ontario DW Aesthetic and Operational Guidelines**

Sample Details Grouping	Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	#2		
L2068971-1	MW6									
Sampled By:	CLIENT on 15-MAR-18 @ 15:45									
Matrix:	WATER									
Total Metals										
	Potassium (K)-Total	3.57		0.050	mg/L	20-MAR-18				
	Rubidium (Rb)-Total	0.00324		0.00020	mg/L	20-MAR-18				
	Selenium (Se)-Total	0.000282		0.000050	mg/L	20-MAR-18	0.01			
	Silicon (Si)-Total	8.78		0.10	mg/L	20-MAR-18				
	Silver (Ag)-Total	<0.000050		0.000050	mg/L	20-MAR-18				
	Sodium (Na)-Total	39.0		0.50	mg/L	20-MAR-18	*20	200		
	Strontium (Sr)-Total	0.431		0.0010	mg/L	20-MAR-18				
	Sulfur (S)-Total	27.3		0.50	mg/L	20-MAR-18				
	Tellurium (Te)-Total	<0.00020		0.00020	mg/L	20-MAR-18				
	Thallium (Tl)-Total	0.000028		0.000010	mg/L	20-MAR-18				
	Thorium (Th)-Total	0.00039		0.00010	mg/L	20-MAR-18				
	Tin (Sn)-Total	0.00156		0.00010	mg/L	20-MAR-18				
	Titanium (Ti)-Total	0.0342		0.00030	mg/L	20-MAR-18				
	Tungsten (W)-Total	<0.00010		0.00010	mg/L	20-MAR-18				
	Uranium (U)-Total	0.00481		0.000010	mg/L	20-MAR-18	0.02			
	Vanadium (V)-Total	0.00305		0.00050	mg/L	20-MAR-18				
	Zinc (Zn)-Total	0.0071		0.0030	mg/L	20-MAR-18		5		
	Zirconium (Zr)-Total	0.00054		0.00030	mg/L	20-MAR-18				

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

Ontario Drinking Water Regulation (ODWQS) JAN.1,2017 = [Suite] - ON-DW-STANDARD+GUIDELINES

#1: Schedule 1 (Microbiological) and 2 (Chemical) Standards (JAN,2017) **#2: Ontario DW Aesthetic and Operational Guidelines**

Reference Information

Sample Parameter Qualifier key listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
PEHR	Parameter Exceeded Recommended Holding Time On Receipt: Proceed With Analysis As Requested.
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference***
ACIDITY-ED	Water	Acidity (as CaCO3)	APHA 2310 B - Potentiometric Titration

Acidity is the capacity of a water sample to react with strong base. It can be measured by titration with a strong base to a designated pH endpoint, usually 8.3. If the sample is colorless and clear, titration with base to the phenolphthalein endpoint is used. For dark or turbid samples, potentiometric titration to pH 8.3 is performed.

ALK-WT	Water	Alkalinity, Total (as CaCO3)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

BR-IC-N-WT	Water	Bromide in Water by IC	EPA 300.1 (mod)

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

CL-IC-N-WT	Water	Chloride by IC	EPA 300.1 (mod)

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

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

COLOUR-APPARENT-WT	Water	Colour	APHA 2120

Apparent Colour is measured spectrophotometrically by comparison to platinum-cobalt standards using the single wavelength method after sample decanting. Colour measurements can be highly pH dependent, and apply to the pH of the sample as received (at time of testing), without pH adjustment. Concurrent measurement of sample pH is recommended.

EC-WT	Water	Conductivity	APHA 2510 B

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

F-IC-N-WT	Water	Fluoride in Water by IC	EPA 300.1 (mod)

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

HARDNESS-CALC-WT	Water	Hardness	APHA 2340 B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

MET-T-CCMS-WT	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

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

NH3-WT	Water	Ammonia, Total as N	EPA 350.1

Sample is measured colorimetrically. When sample is turbid a distillation step is required, sample is distilled into a solution of boric acid and measured colorimetrically.

NO2-IC-WT	Water	Nitrite in Water by IC	EPA 300.1 (mod)

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

NO3-IC-WT	Water	Nitrate in Water by IC	EPA 300.1 (mod)

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

P-T-COL-WT	Water	Total P in Water by Colour	APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is deteremined colourimetrically after persulphate digestion of the sample.

PH-WT	Water	pH	APHA 4500 H-Electrode

Water samples are analyzed directly by a calibrated pH meter.

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

Reference Information

PO4-DO-COL-WT	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

REDOX-POTENTIAL-WT	Water	Redox Potential	APHA 2580

This analysis is carried out in accordance with the procedure described in the "APHA" method 2580 "Oxidation-Reduction Potential" 2012. Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

It is recommended that this analysis be conducted in the field.

SO4-IC-N-WT	Water	Sulfate in Water by IC	EPA 300.1 (mod)

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

SOLIDS-TDS-WT	Water	Total Dissolved Solids	APHA 2540C

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TC,EC-QT51-WT	Water	Total Coliform and E. Coli	APHA 9223B

This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture of hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is obtained by comparing the positive responses to a probability table.

TURBIDITY-WT	Water	Turbidity	APHA 2130 B

Sample result is based on a comparison of the intensity of the light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. Sample readings are obtained from a Nephelometer.

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

Chain of Custody numbers:

17-622480

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

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

GLOSSARY OF REPORT TERMS

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

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

Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to fitness for a particular purpose, or non-infringement. ALS assumes no responsibility for errors or omissions in the information.

Quality Control Report

Workorder: L2068971 Report Date: 23-MAR-18

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto ON M5V 2W7
Contact: Ryan Polick

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ACIDITY-ED	**Water**							
Batch R3993322								
WG2737212-3 DUP		**L2068891-1**						
Acidity (as CaCO3)		42.0	43.0		mg/L	2.4	20	21-MAR-18
WG2737212-2 LCS								
Acidity (as CaCO3)			106.0		%		85-115	21-MAR-18
WG2737212-1 MB								
Acidity (as CaCO3)			<5.0		mg/L		5	21-MAR-18
ALK-WT	**Water**							
Batch R3989453								
WG2735349-3 CRM		**WT-ALK-CRM**						
Alkalinity, Total (as CaCO3)			94.5		%		80-120	19-MAR-18
WG2735349-4 DUP		**L2068981-4**						
Alkalinity, Total (as CaCO3)		44	42		mg/L	4.6	20	19-MAR-18
WG2735349-2 LCS								
Alkalinity, Total (as CaCO3)			97.8		%		85-115	19-MAR-18
WG2735349-1 MB								
Alkalinity, Total (as CaCO3)			<10		mg/L		10	19-MAR-18
BR-IC-N-WT	**Water**							
Batch R3990051								
WG2735070-14 DUP		**WG2735070-13**						
Bromide (Br)		<0.10	<0.10	RPD-NA	mg/L	N/A	20	19-MAR-18
WG2735070-12 LCS								
Bromide (Br)			99.0		%		85-115	19-MAR-18
WG2735070-11 MB								
Bromide (Br)			<0.10		mg/L		0.1	19-MAR-18
WG2735070-15 MS		**WG2735070-13**						
Bromide (Br)			99.1		%		75-125	19-MAR-18
CL-IC-N-WT	**Water**							
Batch R3990051								
WG2735070-14 DUP		**WG2735070-13**						
Chloride (Cl)		33.3	33.3		mg/L	0.0	20	19-MAR-18
WG2735070-12 LCS								
Chloride (Cl)			99.9		%		90-110	19-MAR-18
WG2735070-11 MB								
Chloride (Cl)			<0.50		mg/L		0.5	19-MAR-18
WG2735070-15 MS		**WG2735070-13**						
Chloride (Cl)			98.6		%		75-125	19-MAR-18
COLOUR-APPARENT-WT	**Water**							

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto ON M5V 2W7
Contact: Ryan Polick

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
COLOUR-APPARENT-WT	**Water**							
Batch R3987300								
WG2734505-3 DUP		**L2068994-1**						
Colour, Apparent		9.1	8.7		CU	4.3	20	17-MAR-18
WG2734505-2 LCS								
Colour, Apparent			102.3		%		85-115	17-MAR-18
WG2734505-1 MB								
Colour, Apparent			<2.0		CU		2	17-MAR-18
EC-WT	**Water**							
Batch R3989048								
WG2734455-4 DUP		**WG2734455-3**						
Conductivity		3510	3480		umhos/cm	0.9	10	17-MAR-18
WG2734455-2 LCS								
Conductivity			100.5		%		90-110	17-MAR-18
WG2734455-1 MB								
Conductivity			<3.0		umhos/cm		3	17-MAR-18
F-IC-N-WT	**Water**							
Batch R3990051								
WG2735070-14 DUP		**WG2735070-13**						
Fluoride (F)		0.042	0.042		mg/L	0.9	20	19-MAR-18
WG2735070-12 LCS								
Fluoride (F)			101.5		%		90-110	19-MAR-18
WG2735070-11 MB								
Fluoride (F)			<0.020		mg/L		0.02	19-MAR-18
WG2735070-15 MS		**WG2735070-13**						
Fluoride (F)			101.1		%		75-125	19-MAR-18
MET-T-CCMS-WT	**Water**							
Batch R3987814								
WG2734886-4 DUP		**WG2734886-3**						
Aluminum (Al)-Total		0.172	0.169		mg/L	1.5	20	19-MAR-18
Antimony (Sb)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	19-MAR-18
Arsenic (As)-Total		0.00056	0.00058		mg/L	3.4	20	19-MAR-18
Barium (Ba)-Total		0.0431	0.0428		mg/L	0.8	20	19-MAR-18
Beryllium (Be)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	19-MAR-18
Bismuth (Bi)-Total		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	19-MAR-18
Boron (B)-Total		0.031	0.031		mg/L	1.6	20	19-MAR-18
Cadmium (Cd)-Total		0.0000067	0.0000090	J	mg/L	0.0000023	0.00001	19-MAR-18
Calcium (Ca)-Total		87.1	87.9		mg/L	0.9	20	19-MAR-18

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto ON M5V 2W7
Contact: Ryan Polick

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WT	**Water**							
Batch R3987814								
WG2734886-4 DUP		**WG2734886-3**						
Chromium (Cr)-Total		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	19-MAR-18
Cesium (Cs)-Total		0.000017	0.000015		mg/L	14	20	19-MAR-18
Cobalt (Co)-Total		0.00019	0.00018		mg/L	2.0	20	19-MAR-18
Copper (Cu)-Total		0.0010	0.0010		mg/L	0.6	20	19-MAR-18
Iron (Fe)-Total		0.384	0.387		mg/L	0.8	20	19-MAR-18
Lead (Pb)-Total		0.000202	0.000204		mg/L	1.3	20	19-MAR-18
Lithium (Li)-Total		0.0016	0.0015		mg/L	1.1	20	19-MAR-18
Magnesium (Mg)-Total		17.0	16.7		mg/L	2.1	20	19-MAR-18
Manganese (Mn)-Total		0.0822	0.0816		mg/L	0.8	20	19-MAR-18
Molybdenum (Mo)-Total		0.00186	0.00184		mg/L	1.4	20	19-MAR-18
Nickel (Ni)-Total		0.00065	0.00061		mg/L	7.1	20	19-MAR-18
Phosphorus (P)-Total		<0.050	<0.050	RPD-NA	mg/L	N/A	20	19-MAR-18
Potassium (K)-Total		3.08	3.05		mg/L	0.9	20	19-MAR-18
Rubidium (Rb)-Total		0.00067	0.00068		mg/L	1.8	20	19-MAR-18
Selenium (Se)-Total		0.000137	0.000124		mg/L	9.5	20	19-MAR-18
Silicon (Si)-Total		2.92	2.94		mg/L	0.5	20	19-MAR-18
Silver (Ag)-Total		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	19-MAR-18
Sodium (Na)-Total		26.6	26.1		mg/L	1.8	20	19-MAR-18
Strontium (Sr)-Total		0.267	0.274		mg/L	2.7	20	19-MAR-18
Sulfur (S)-Total		15.4	15.5		mg/L	0.4	25	19-MAR-18
Thallium (Tl)-Total		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	19-MAR-18
Tellurium (Te)-Total		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	19-MAR-18
Thorium (Th)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	25	19-MAR-18
Tin (Sn)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	19-MAR-18
Titanium (Ti)-Total		0.00441	0.00444		mg/L	0.5	20	19-MAR-18
Tungsten (W)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	19-MAR-18
Uranium (U)-Total		0.00109	0.00112		mg/L	3.2	20	19-MAR-18
Vanadium (V)-Total		0.00061	0.00061		mg/L	0.0	20	19-MAR-18
Zinc (Zn)-Total		<0.0030	<0.0030	RPD-NA	mg/L	N/A	20	19-MAR-18
Zirconium (Zr)-Total		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	19-MAR-18
WG2734886-2 LCS								
Aluminum (Al)-Total			101.0		%		80-120	19-MAR-18
Antimony (Sb)-Total			107.4		%		80-120	19-MAR-18

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto ON M5V 2W7
Contact: Ryan Polick

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WT	**Water**							
Batch R3987814								
WG2734886-2 LCS								
Arsenic (As)-Total			101.8		%		80-120	19-MAR-18
Barium (Ba)-Total			101.7		%		80-120	19-MAR-18
Beryllium (Be)-Total			99.5		%		80-120	19-MAR-18
Bismuth (Bi)-Total			99.7		%		80-120	19-MAR-18
Boron (B)-Total			98.4		%		80-120	19-MAR-18
Cadmium (Cd)-Total			102.5		%		80-120	19-MAR-18
Calcium (Ca)-Total			100.3		%		80-120	19-MAR-18
Chromium (Cr)-Total			102.6		%		80-120	19-MAR-18
Cesium (Cs)-Total			104.4		%		80-120	19-MAR-18
Cobalt (Co)-Total			99.8		%		80-120	19-MAR-18
Copper (Cu)-Total			99.2		%		80-120	19-MAR-18
Iron (Fe)-Total			98.5		%		80-120	19-MAR-18
Lead (Pb)-Total			102.5		%		80-120	19-MAR-18
Lithium (Li)-Total			98.0		%		80-120	19-MAR-18
Magnesium (Mg)-Total			103.1		%		80-120	19-MAR-18
Manganese (Mn)-Total			102.9		%		80-120	19-MAR-18
Molybdenum (Mo)-Total			101.1		%		80-120	19-MAR-18
Nickel (Ni)-Total			100.2		%		80-120	19-MAR-18
Phosphorus (P)-Total			102.0		%		70-130	19-MAR-18
Potassium (K)-Total			102.0		%		80-120	19-MAR-18
Rubidium (Rb)-Total			102.5		%		80-120	19-MAR-18
Selenium (Se)-Total			102.7		%		80-120	19-MAR-18
Silicon (Si)-Total			117.4		%		60-140	19-MAR-18
Silver (Ag)-Total			105.0		%		80-120	19-MAR-18
Sodium (Na)-Total			103.7		%		80-120	19-MAR-18
Strontium (Sr)-Total			99.7		%		80-120	19-MAR-18
Sulfur (S)-Total			98.0		%		80-120	19-MAR-18
Thallium (Tl)-Total			99.8		%		80-120	19-MAR-18
Tellurium (Te)-Total			107.1		%		80-120	19-MAR-18
Thorium (Th)-Total			101.4		%		70-130	19-MAR-18
Tin (Sn)-Total			103.1		%		80-120	19-MAR-18
Titanium (Ti)-Total			98.3		%		80-120	19-MAR-18
Tungsten (W)-Total			99.5		%		80-120	19-MAR-18

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto ON M5V 2W7
Contact: Ryan Polick

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WT	**Water**							
Batch R3987814								
WG2734886-2 LCS								
Uranium (U)-Total			104.2		%		80-120	19-MAR-18
Vanadium (V)-Total			101.7		%		80-120	19-MAR-18
Zinc (Zn)-Total			97.6		%		80-120	19-MAR-18
Zirconium (Zr)-Total			95.4		%		80-120	19-MAR-18
WG2734886-1 MB								
Aluminum (Al)-Total			<0.0050		mg/L		0.005	19-MAR-18
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	19-MAR-18
Arsenic (As)-Total			<0.00010		mg/L		0.0001	19-MAR-18
Barium (Ba)-Total			<0.00020		mg/L		0.0002	19-MAR-18
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	19-MAR-18
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	19-MAR-18
Boron (B)-Total			<0.010		mg/L		0.01	19-MAR-18
Cadmium (Cd)-Total			<0.000005(		mg/L		0.000005	19-MAR-18
Calcium (Ca)-Total			<0.50		mg/L		0.5	19-MAR-18
Chromium (Cr)-Total			<0.00050		mg/L		0.0005	19-MAR-18
Cesium (Cs)-Total			<0.000010		mg/L		0.00001	19-MAR-18
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	19-MAR-18
Copper (Cu)-Total			<0.0010		mg/L		0.001	19-MAR-18
Iron (Fe)-Total			<0.050		mg/L		0.05	19-MAR-18
Lead (Pb)-Total			<0.000050		mg/L		0.00005	19-MAR-18
Lithium (Li)-Total			<0.0010		mg/L		0.001	19-MAR-18
Magnesium (Mg)-Total			<0.050		mg/L		0.05	19-MAR-18
Manganese (Mn)-Total			<0.00050		mg/L		0.0005	19-MAR-18
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	19-MAR-18
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	19-MAR-18
Phosphorus (P)-Total			<0.050		mg/L		0.05	19-MAR-18
Potassium (K)-Total			<0.050		mg/L		0.05	19-MAR-18
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	19-MAR-18
Selenium (Se)-Total			<0.000050		mg/L		0.00005	19-MAR-18
Silicon (Si)-Total			<0.10		mg/L		0.1	19-MAR-18
Silver (Ag)-Total			<0.000050		mg/L		0.00005	19-MAR-18
Sodium (Na)-Total			<0.50		mg/L		0.5	19-MAR-18
Strontium (Sr)-Total			<0.0010		mg/L		0.001	19-MAR-18
Sulfur (S)-Total			<0.50		mg/L		0.5	19-MAR-18

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto ON M5V 2W7
Contact: Ryan Polick

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WT	**Water**							
Batch R3987814								
WG2734886-1 MB								
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	19-MAR-18
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	19-MAR-18
Thorium (Th)-Total			<0.00010		mg/L		0.0001	19-MAR-18
Tin (Sn)-Total			<0.00010		mg/L		0.0001	19-MAR-18
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	19-MAR-18
Tungsten (W)-Total			<0.00010		mg/L		0.0001	19-MAR-18
Uranium (U)-Total			<0.000010		mg/L		0.00001	19-MAR-18
Vanadium (V)-Total			<0.00050		mg/L		0.0005	19-MAR-18
Zinc (Zn)-Total			<0.0030		mg/L		0.003	19-MAR-18
Zirconium (Zr)-Total			<0.00030		mg/L		0.0003	19-MAR-18
WG2734886-5 MS		**WG2734886-6**						
Aluminum (Al)-Total			96.6		%		70-130	19-MAR-18
Antimony (Sb)-Total			102.5		%		70-130	19-MAR-18
Arsenic (As)-Total			103.9		%		70-130	19-MAR-18
Barium (Ba)-Total			98.3		%		70-130	19-MAR-18
Beryllium (Be)-Total			98.7		%		70-130	19-MAR-18
Bismuth (Bi)-Total			99.2		%		70-130	19-MAR-18
Boron (B)-Total			N/A	MS-B	%		-	19-MAR-18
Cadmium (Cd)-Total			100.8		%		70-130	19-MAR-18
Calcium (Ca)-Total			N/A	MS-B	%		-	19-MAR-18
Chromium (Cr)-Total			102.3		%		70-130	19-MAR-18
Cesium (Cs)-Total			99.7		%		70-130	19-MAR-18
Cobalt (Co)-Total			99.7		%		70-130	19-MAR-18
Copper (Cu)-Total			97.3		%		70-130	19-MAR-18
Iron (Fe)-Total			N/A	MS-B	%		-	19-MAR-18
Lead (Pb)-Total			99.2		%		70-130	19-MAR-18
Lithium (Li)-Total			N/A	MS-B	%		-	19-MAR-18
Magnesium (Mg)-Total			N/A	MS-B	%		-	19-MAR-18
Manganese (Mn)-Total			N/A	MS-B	%		-	19-MAR-18
Molybdenum (Mo)-Total			100.6		%		70-130	19-MAR-18
Nickel (Ni)-Total			97.9		%		70-130	19-MAR-18
Phosphorus (P)-Total			110.4		%		70-130	19-MAR-18
Potassium (K)-Total			107.6		%		70-130	19-MAR-18
Rubidium (Rb)-Total			98.1		%		70-130	19-MAR-18

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto ON M5V 2W7
Contact: Ryan Polick

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WT	**Water**							
Batch R3987814								
WG2734886-5 MS		**WG2734886-6**						
Selenium (Se)-Total			82.5		%		70-130	19-MAR-18
Silicon (Si)-Total			N/A	MS-B	%		-	19-MAR-18
Silver (Ag)-Total			94.3		%		70-130	19-MAR-18
Sodium (Na)-Total			N/A	MS-B	%		-	19-MAR-18
Strontium (Sr)-Total			N/A	MS-B	%		-	19-MAR-18
Sulfur (S)-Total			N/A	MS-B	%		-	19-MAR-18
Thallium (Tl)-Total			99.2		%		70-130	19-MAR-18
Tellurium (Te)-Total			94.0		%		70-130	19-MAR-18
Thorium (Th)-Total			105.6		%		70-130	19-MAR-18
Tin (Sn)-Total			101.2		%		70-130	19-MAR-18
Titanium (Ti)-Total			104.9		%		70-130	19-MAR-18
Tungsten (W)-Total			104.1		%		70-130	19-MAR-18
Uranium (U)-Total			107.9		%		70-130	19-MAR-18
Vanadium (V)-Total			105.6		%		70-130	19-MAR-18
Zinc (Zn)-Total			95.7		%		70-130	19-MAR-18
Zirconium (Zr)-Total			103.0		%		70-130	19-MAR-18
NH3-WT	**Water**							
Batch R3989708								
WG2735508-7 DUP		**L2068981-4**						
Ammonia, Total (as N)		<0.020	<0.020	RPD-NA	mg/L	N/A	20	19-MAR-18
WG2735508-6 LCS								
Ammonia, Total (as N)			103.9		%		85-115	19-MAR-18
WG2735508-5 MB								
Ammonia, Total (as N)			<0.020		mg/L		0.02	19-MAR-18
WG2735508-8 MS		**L2068981-4**						
Ammonia, Total (as N)			94.3		%		75-125	19-MAR-18
NO2-IC-WT	**Water**							
Batch R3990051								
WG2735070-14 DUP		**WG2735070-13**						
Nitrite (as N)		<0.010	<0.010	RPD-NA	mg/L	N/A	25	19-MAR-18
WG2735070-12 LCS								
Nitrite (as N)			98.9		%		70-130	19-MAR-18
WG2735070-11 MB								
Nitrite (as N)			<0.010		mg/L		0.01	19-MAR-18
WG2735070-15 MS		**WG2735070-13**						

Quality Control Report

Workorder: L2068971 Report Date: 23-MAR-18

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto ON M5V 2W7
Contact: Ryan Polick

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-IC-WT	**Water**							
Batch R3990051								
WG2735070-15 MS		**WG2735070-13**						
Nitrite (as N)			93.0		%		70-130	19-MAR-18
NO3-IC-WT	**Water**							
Batch R3990051								
WG2735070-14 DUP		**WG2735070-13**						
Nitrate (as N)		4.99	4.98		mg/L	0.1	25	19-MAR-18
WG2735070-12 LCS								
Nitrate (as N)			99.3		%		70-130	19-MAR-18
WG2735070-11 MB								
Nitrate (as N)			<0.020		mg/L		0.02	19-MAR-18
WG2735070-15 MS		**WG2735070-13**						
Nitrate (as N)			N/A	MS-B	%		-	19-MAR-18
P-T-COL-WT	**Water**							
Batch R3988985								
WG2735183-3 DUP		**L2068891-1**						
Phosphorus, Total		1.56	1.52		mg/L	2.9	20	20-MAR-18
WG2735183-2 LCS								
Phosphorus, Total			91.0		%		80-120	20-MAR-18
WG2735183-1 MB								
Phosphorus, Total			<0.0030		mg/L		0.003	20-MAR-18
WG2735183-4 MS		**L2068891-1**						
Phosphorus, Total			N/A	MS-B	%		-	20-MAR-18
PH-WT	**Water**							
Batch R3989048								
WG2734455-4 DUP		**WG2734455-3**						
pH		7.60	7.62	J	pH units	0.02	0.2	17-MAR-18
WG2734455-2 LCS								
pH			6.97		pH units		6.9-7.1	17-MAR-18
PO4-DO-COL-WT	**Water**							
Batch R3987616								
WG2735008-3 DUP		**L2068487-1**						
Orthophosphate-Dissolved (as P)		0.0176	0.0151		mg/L	15	30	19-MAR-18
WG2735008-2 LCS								
Orthophosphate-Dissolved (as P)			100.2		%		70-130	19-MAR-18
WG2735008-1 MB								
Orthophosphate-Dissolved (as P)			<0.0030		mg/L		0.003	19-MAR-18

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto ON M5V 2W7
Contact: Ryan Polick

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PO4-DO-COL-WT	**Water**							
Batch R3987616								
WG2735008-4 MS		**L2068487-1**						
Orthophosphate-Dissolved (as P)			101.9		%		70-130	19-MAR-18
REDOX-POTENTIAL-WT	**Water**							
Batch R3991168								
WG2735834-1 DUP		**L2068891-1**						
Redox Potential		336	333		mV	0.9	25	20-MAR-18
SO4-IC-N-WT	**Water**							
Batch R3990051								
WG2735070-14 DUP		**WG2735070-13**						
Sulfate (SO4)		15.5	15.4		mg/L	0.8	20	19-MAR-18
WG2735070-12 LCS								
Sulfate (SO4)			100.8		%		90-110	19-MAR-18
WG2735070-11 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	19-MAR-18
WG2735070-15 MS		**WG2735070-13**						
Sulfate (SO4)			100.8		%		75-125	19-MAR-18
SOLIDS-TDS-WT	**Water**							
Batch R3988269								
WG2734727-3 DUP		**L2068327-2**						
Total Dissolved Solids		635	638		mg/L	0.4	20	18-MAR-18
WG2734727-2 LCS								
Total Dissolved Solids			97.9		%		85-115	18-MAR-18
WG2734727-1 MB								
Total Dissolved Solids			<10		mg/L		10	18-MAR-18
TC,EC-QT51-WT	**Water**							
Batch R3987530								
WG2734483-2 DUP		**L2068440-1**						
Total Coliforms		0	0		MPN/100mL	0.0	65	18-MAR-18
Escherichia Coli		0	0		MPN/100mL	0.0	65	18-MAR-18
WG2734483-1 MB								
Total Coliforms			0		MPN/100mL		1	18-MAR-18
Escherichia Coli			0		MPN/100mL		1	18-MAR-18
TURBIDITY-WT	**Water**							

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto ON M5V 2W7
Contact: Ryan Polick

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TURBIDITY-WT	**Water**							
Batch R3987229								
WG2734457-3 DUP		**L2068994-1**						
Turbidity		1.39	1.34		NTU	3.7	15	17-MAR-18
WG2734457-2 LCS								
Turbidity			104.0		%		85-115	17-MAR-18
WG2734457-1 MB								
Turbidity			<0.10		NTU		0.1	17-MAR-18

Quality Control Report

Workorder: L2068971 Report Date: 23-MAR-18

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto ON M5V 2W7
Contact: Ryan Polick

Legend:

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

Sample Parameter Qualifier Definitions:

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

Quality Control Report

Workorder: L2068971 Report Date: 23-MAR-18

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto ON M5V 2W7
Contact: Ryan Polick

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
Redox Potential							
	1	15-MAR-18 15:45	20-MAR-18 21:00	0.25	125	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM: Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR: Exceeded ALS recommended hold time prior to sample receipt.
EHTL: Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT: Exceeded ALS recommended hold time prior to analysis.
Rec. HT: ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2068971 were received on 15-MAR-18 17:00.

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

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

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

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2068971-COFC

COC Number: 17 - 622480

Page of

Report To	Contact and company name below will appear on the final report	Report Format / Distribution	Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)
Company:	PECG - PALMER ENVIRONMENTAL	Select Report Format: [X] PDF [X] EXCEL [ ] EDD (DIGITAL)	Regular [R] [X] Standard TAT if received by 3 pm - business days - no surcharges apply
Contact:	Ryan@pecg.ca	Quality Control (QC) Report with Report [X] YES [ ] NO	PRIORITY (Business Days): 4 day [P4-20%] [ ]; 3 day [P3-25%] [ ]; 2 day [P2-50%] [ ]
Phone:	604-790-6051	[X] Compare Results to Criteria on Report - provide details below if box checked	EMERGENCY: 1 Business day [E-100%] [ ]; Same Day, Weekend or Statutory holiday [E2-200% (Laboratory opening fees may apply)] [ ]
	Company address below will appear on the final report	Select Distribution: [X] EMAIL [ ] MAIL [ ] FAX	Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm
Street:	74 Berkeley St	Email 1 or Fax: Ryan@pecg.ca	For tests that can not be performed according to the service level selected, you will be contacted.
City/Province:	Toronto Ontario	Email 2: Corinne@pecg.ca	
Postal Code:	M5A 2W7	Email 3: Jason@pecg.ca	
Invoice To	Same as Report To [X] YES [ ] NO	**Invoice Distribution**	
	Copy of Invoice with Report [X] YES [ ] NO	Select Invoice Distribution: [X] EMAIL [ ] MAIL [ ] FAX	
Company:		Email 1 or Fax: Jason@pecg.ca	
Contact:		Email 2:	

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:		AFE/Cost Center:	PO#:
Job #:	170163 Chickadee Lane	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only):	L2068971 16B	ALS Contact:	Sampler:

Analysis Request

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

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Anions	Total Metals, Hardness	TC, EC	Acidity	Alk, Color, EC, pH, Redox, TDS, Turb	NH_3, TP	SAMPLES ON HOLD	Sample is hazardous (please provide further details)	NUMBER OF CONTAINERS
1	MW6	15-Mar-18	15:45	Grab Water	X	X	X	X	X	X			6

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? [ ] YES [X] NO	Compare with Ontario drinking water standards
Are samples for human consumption/ use? [ ] YES [ ] NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen [ ]		SIF Observations	Yes [ ]	No [ ]	
Ice Packs [X]	Ice Cubes [ ]	Custody seal intact	Yes [ ]	No [ ]	
Cooling Initiated [ ]					
INITIAL COOLER TEMPERATURES °C: 4.5		FINAL COOLER TEMPERATURES °C: 2.8			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Ryan Rolick	Date: March 15, 2018	Time: 17:00	Received by: MEL	Date: Mar. 15 2018	Time: 17:00	Received by:	Date: Mar. 16/18	Time: 15:00

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JULY 2017 FRONT

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

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