FUNCTIONAL SERVICING REPORT

CHICKADEE LANE SUBDIVISION

13935, 13951 AND 13999 CHICKADEE LANE, 0 KING STREET

AND

550, 600 AND 615 GLASGOW ROAD

PART OF LOT 10, CONCESSION 5 AND 6

TOWN OF CALEDON

FILE NOS. 21T-20001C AND RZ 2020-0004

PREPARED FOR

ZANCOR HOMES (BOLTON) LTD.

MARCH 26TH 2019

REVISED JANUARY 4TH 2021

REVISED AUGUST 27TH 2021

REVISED APRIL 29TH 2022

CANDEVCON LIMITED
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PROJECT NO. W17003

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REGISTERED PROFESSIONAL ENGINEER
29/04/22
J. K. HORGAN
PROVINCE OF ONTARIO

MARCH 26TH 2019

REVISED JANUARY 4TH 2021

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CONTENTS (CONT'D)

APPENDICES (CONT'D)

1. INTRODUCTION

The subject lands are comprised of several land parcels located at the northwest, southwest and southeast corners of Glasgow Road and Chickadee Lane, east of Emil Kolb Parkway in the Town of Caledon. In total, the lands comprises 10.04 ha and are municipally known as 13935, 13951, 13977 and 13999 Chickadee Lane, 0 King Street, and 550, 600 and 615 Glasgow Road, with a legal description of Part of Lot 10, Concessions 5 and 6, Town of Caledon. Figure 1 illustrates the Site Location.

This report has been prepared in support of a request for amendment to the Town of Caledon Official Plan and Zoning By-Law as well as Draft Plan of Subdivision approval on behalf of Zancor Homes (Bolton) Ltd. and addresses sanitary, water and storm drainage servicing and stormwater management.

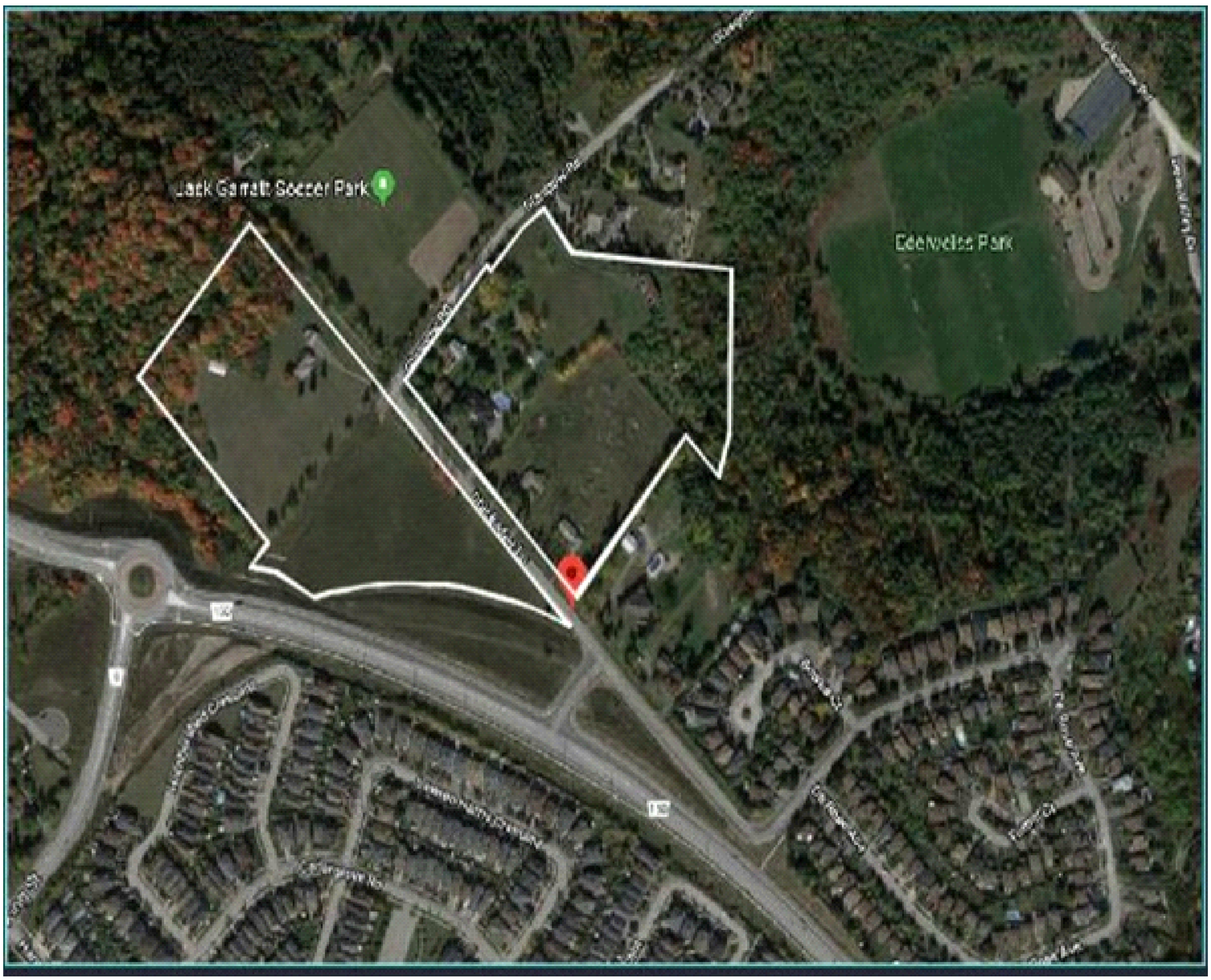

Figure 1

1. INTRODUCTION (CONT'D)

Zancor Homes (Bolton) Ltd. filed an appeal of Region of Peel Official Plan Amendment 30 (ROPA 30). By decision dated October 29th 2020, the Local Planning Appeal Tribunal (LPAT) granted approval of the appeal thereby including the subject lands within the Bolton Settlement Area.

This update to the report responds to the comments provided by the the Town of Caledon (Memorandum dated March 25th 2022) and Toronto and Region Conservation Authority (Letter dated March 22nd 2022).

2. PROPOSED DEVELOPMENT PLAN

The proposed Development is shown on the Draft Plan of Subdivision[1] prepared by Humphries Planning Group Inc. and comprises:

- One (1) Lot with existing Single Detached house;
- Two (2) Lots with proposed Single Detached houses;
- Twenty five (25) Blocks with 151 Street Townhouses;
- One (1) Stormwater Management Block;
- Two (2) Environmental Compensation/Restoration Blocks;
- One (1) Vegetation Protection Zone Block;
- Three (3) Open Space Blocks;
- One (1) Road Widening Block;
- One (1) Noise Buffer Block.

Four new roads (Streets A, B, C and D) are proposed; Street C includes a former part of Glasgow Road, between Chickadee Lane and Emil Kolb Parkway (closed when Emil Kolb Parkway was constructed).

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1 Drawing A1, dated March 2nd 2019 Revised April 6th 2022, prepared by Humphries Planning Group Inc.

3. BACKGROUND AND SITE SPECIFIC TECHNICAL STUDIES

3.1 Background Studies

The following Technical Studies which were prepared pursuant to the Bolton Residential Expansion are relevant to the sanitary and water servicing of the subject lands:

- Bolton Residential Expansion Study Infrastructure Report, prepared by Blue Plan Engineering Consultants Limited, dated June 16th 2014.
- Bolton Residential Expansion, Water and Wastewater Servicing Analysis - 2020 Update, Region of Peel Public Works (Water and Wastewater Infrastructure Planning), September 24th 2020.

3.2 Site Specific Studies

The following Studies were completed in support of the subject application:

- Geotechnical Investigation for proposed Residential Development, Chickadee Lane and Glasgow Road, Town of Caledon prepared by Soil Engineers Ltd., dated July 2018, Reference No. 1801-S032

- Supplementary Slope Stability Assessment for proposed Residential Development, Chickadee Lane and Glasgow Road, prepared by Soil Engineers Ltd., dated August 31st 2020, Reference No. 1801-S032

- Chickadee Lane Rounding Out Area ñBò, Comprehensive Environmental Impact Study and Management Plan prepared by Palmer Consulting Group Inc., dated March 21st 2019, Project No. 170163

- Hydrogeological Investigation - Chickadee Lane Rounding Out Area ñBò, Bolton, Ontario prepared by Palmer Environment Consulting Group Inc., dated October 12th 2018, Project No. 170163

- Memorandum dated March 23rd 2021 prepared by Palmer, Project #1701603, Chickadee Lane Stormwater Management Options Assessment Alternatives, Alternative Outlet Evaluation

3. BACKGROUND AND SITE SPECIFIC TECHNICAL STUDIES (CONT'D)

3.1 Background Studies (Cont'd)

- Memorandum dated August 27th 2021 prepared by Palmer, Project #1701603 - Chickadee Lane Erosion Threshold of Humber River Tributaries

- Water Hydraulic Analysis for Chickadee Lane Round Out Area ñBò Subdivision, Town of Caledon, prepared by AECOM dated October 28th 2020, Project No. 60643310

4. EXISTING CONDITIONS

4.1 Land Use

The subject subdivision property, apart from the two residences being retained as part of the Draft Plan, comprise vacant (former rural residential holdings) and Agricultural lands.

4.2 Topography and Natural Features

The majority of the subject property is relatively flat, with the high point generally located at Chickadee Lane and gentle slopes to the southeast and northwest where there are significant forested valley features associated with the Humber River[2].

4.3 Physiography and Geotechnical Conditions

Geotechnical[3] and Hydrogeological[4] Studies were completed for the subject subdivision. Copies of the reports are included in Appendices ñBò and ñCò respectively.

The Geotechnical Investigation revealed that beneath a veneer of topsoil, the site is generally underlain by silty clay till with sandy silt till deposit at the deeper level.

The level of the water table ranges from 5m to 8m below the ground surface and the ground water flow follows the topography.

The Hydraulic Conductivity (K) values were calculated to range from 3.5×10^{-6} m/s to 4.4×10^{-8} m/s with a geometric mean of 6.1×10^{-7} m/s which is typical of the Halton Till Aquitard.

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2 Refer to Figures 8 and 9 of Comprehensive Environmental Impact Study and Management Plan included in Appendix ñAò

3 Geotechnical Investigation for Proposed Residence Development, Chickadee Lane and Glasgow Road, Town of Caledon by Soil Engineers Ltd., dated July 2018, Reference No. 1801-S032

4 Hydrogeological Investigation, Chickadee Lane Rounding Out Area B, Bolton Ontario, by Palmer Environmental Consulting Group Inc., dated October 12th 2018, Project No. 170163

4. EXISTING CONDITIONS (CONT'D)

4.3 Physiography and Geotechnical Conditions (Cont'd)

Slope Stability Studies[5] were conducted for the valley slopes at the northwest and southeast limits of the subject property and the long term stable slope lines were plotted and are graphically illustrated on the preliminary Servicing Plan (Drawing PS-1).

4.4 Storm Drainage

The subject subdivision property is located in Secondary Subwatershed No. 2 (Palgrave to Bolton) of the Main Humber River Watershed[6]. On a localized basis the property drains overland north westerly and south easterly to the valley systems of the Humber River.

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5 Geotechnical Investigation Report dated July 2018 and Supplementary Slope Assessment Study dated August 31st 2020, included in Appendix ñBò.

6 Refer to Figure 4 Subwatershed Boundary included Appendix ñDò.

5. SANITARY AND WATER SERVICING

5.1 Sanitary

5.1.1 Existing Sanitary Services

As illustrated on the Preliminary Servicing Plan (Drawing PS-1) there are existing sanitary sewers on DeRose Avenue (250mm diameter) and Emil Kolb Parkway (375mm diameter). In consideration of the existing inverts and capacity, the existing 375mm diameter sewer on Emil Kolb Parkway is the preferred outlet. *[Refer to Figure 8 of the Town of Caledon, Bolton Residential Expansion Study, Water and Wastewater Servicing]*[7].

5.1.2 Proposed Sanitary Servicing

The proposed sanitary sewer system is shown on Drawing PS-1; the sewer system also involves the construction of approximately 520m of an external sewer to connect to the existing 375mm diameter sewer on Emil Kolb Parkway. The sewer system is designed in accordance with the Region of Peel Criteria and Standards.

- The population density flow based on street townhouses is 75 persons/ha;
- A sanitary flow based on 302.8 Lpcd (Litres per capita per day);
- A Harmon Peaking Factor calculated based upon the Harmon Peaking Formula ($M = 1+14/(4+p^{0.5})$), where M = ratio of peak flow to average flow and P = the tributary population in thousands;
- An infiltration allowance of 0.2 L/s/ha.

The sanitary drainage areas for the subdivision are shown on Drawing SA-1 and a preliminary Sanitary Sewer Design Sheet is included in Appendix ñFò.

A completed copy of the Region of Peel Connection Multi-Use Demand Table is included in Appendix ñFò.

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7 Included in Appendix ñFò.

5. SANITARY AND WATER SERVICING (CONT'D)

5.2 Water

5.2.1 Existing Water Network

The proposed subdivision is located within the boundaries of Pressure Zone 6. As shown on the attached Figure 5 of the Town of Caledon (Bolton Residential Expansion Study - Water and Wastewater Servicing)[8] and on Drawing PS-1, there is an existing 300mm diameter watermain on Glasgow Road and Chickadee Lane. There is also an existing water system in the subdivision on the west side of Emil Kolb Parkway. An hydrant flow test was conducted on February 2nd 2022 of the existing hydrant on Chickadee Lane (copy included in Appendix ñGò). The flow test indicated a static pressure of 45 psi and a flow of 1088 US GPM at a residual pressure of 40 psi (one hydrant port) and a flow of 1899 US GPM at a residual pressure of 37 psi (two hydrant ports).

5.2.2 Proposed Watermain System

As shown on Drawing PS-1, the proposed watermain system will connect to the existing 300mm diameter watermain on Glasgow Road and Chickadee Lane.

A Water Hydraulic Analysis[9] was carried out to determine the water serviceability of the proposed subdivision under existing and future (2041) conditions and to review the sizing of the proposed watermain system. The analysis concluded that the water supply would be capable of providing adequate water service for the proposed subdivision under Average Day Demand, Maximum Day Demand and Peak Hour Demand.

The fire flow analysis indicated that the water system would provide adequate fire flow.

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8 Included in Appendix ñEò.

9 Water Network Analysis for Chickadee Lane Round Out Area ñBò Subdivision, Town of Caledon, by AECOM dated October 28th 2020, Project No. 60643310

5. SANITARY AND WATER SERVICING (CONT'D)

5.2 Water (Cont'd)

5.2.2 Proposed Watermain System (Cont'd)

A Resiliency Review was also conducted; since the existing water system relies on a single source (300mm watermain on Chickadee Lane) it was noted that the water service for the proposed subdivision would be significantly interrupted if the water supply is out of service. Accordingly, to improve the water supply security a secondary feed from the water system west of Emil Kolb Parkway was recommended. The design details of the secondary feed will be determined as part of the detailed engineering design for the subdivision.

The proposed Subdivision will generate the following estimated water demand as given in Table I.

TABLE I

ESTIMATED WATER DEMAND

Description	Long Term Demand
Total Residential Units (Townhouses and Single Detached)	154
Population (based on 3.20 PPU)	500
Average Consumption Rate (L/cap/day)	280
Total Average Consumption (m^3/day)	140
Peak Day Consumption (based on 2.0 peak day factor) m^3/day	280
Peak Hour Consumption (based on 3.0 peak day factor) m^3/day	420 (4.86 L/s)

A completed copy of the Region of Peel Connection Multi-Use Demand Table is included in Appendix ñGò.

6. STORM DRAINAGE AND STORMWATER MANAGEMENT

6.1 General

In the absence of a Subwatershed Study, the MOE Stormwater Management Manual[10] was used to provide guidance on the design of stormwater management controls for the subject subdivision. The Humber River Hydrology Study Scenario Modelling and Analysis Report conducted by TRCA in 2008[11] determined that future development without stormwater management quantity controls would significantly increase the magnitude of return-period flood flows in downstream areas. It was recommended that a Tributary-Based run off control strategy be implemented to provide detention basins in developments in certain Tributaries to control peak flows to pre-development levels, using unit flow criteria to ensure consistent application in all developing areas. It stated that the results indicated that return period flood flows in watercourses throughout the watershed are generally controlled to existing levels with this approach for all of the future conditions scenarios.

In consideration of the above, it is recommended that the proposed stormwater management is designed to be consistent with the requirements as recommended in the report *Humber River Hydrology Study Scenario Modelling Analysis Report.*

6.2 Storm Sewer System

The proposed storm sewer system is shown on Drawing PS-1. The sewer system will be designed in accordance with the Town of Caledon Standards to accommodate a 10 year storm event and will outlet to the proposed stormwater management pond. The sewer system and pipe sizing will be designed so that the hydraulic grade line in the sewers will be one (1) metre below the basement floor elevations. The storm drainage areas are shown on Drawing ST-1 and the related Storm Sewer Design Sheets are included in Appendix ñHò. Overland flow will be conveyed within the road rights (maximum ponding depth of 0.3m) to the proposed stormwater management pond.

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10 Stormwater Management Planning and Design Manual, Ministry of the Environment, March 2003

11 Humber River Hydrology Study Scenario Modelling and Analysis Report conducted by TRCA in 2008

6. STORM DRAINAGE AND STORMWATER MANAGEMENT (CONT'D)

6.2 Storm Sewer System (Cont'd)

The rear yards will generally drain via swales to rear lot catch basins which will be designed to function with the proposed infiltration trenches. The rear yards and part roofs of Blocks 11, 12 and 13 will drain directly overland to the Environmental Compensation Block 34.

6.3 Stormwater Management

6.3.1 General - Stormwater Management Criteria

Water quality, erosion and quantity control for the subdivision will be provided within the proposed stormwater management pond. As shown on Drawing PS-1 the proposed stormwater management pond will be located in the northwest part of the subdivision. The following summarizes general design criteria for the design of the SWM facility:

- The stormwater management facility is designed as an off-line wet pond with permanent pool within the SWMF to provide "enhanced level protection" as per MOECP (2003) guidelines.
- The erosion control criteria is based on the 48-hour detention of the runoff from a 25mm, 4-hour Chicago storm event.
- Humber River Unit Flow Equation for Sub-Basin 36 is used to determine the Release Rates for 2, 5, 10, 25, 50 and 100-year return period rainfall events.
- Regional storm event (285mm depth, 48-hour Hurricane Hazel).

6. STORM DRAINAGE AND STORMWATER MANAGEMENT (CONT'D)

6.3 Stormwater Management (Cont'd)

6.3.1 General - Stormwater Management Criteria (Cont'd)

TABLE II

PROPOSED STORMWATER MANAGEMENT POND OUTFLOW RATES

Drainage Area	6.98 ha
Enhanced Protection Level	80% TSS Removal
SWM Type	Wet Pond (Off-Line)
Imperviousness	75%
Outflow Rates (L/s)	
25mm Erosion Control	7.4
2-Year	57
5-Year	87
10-Year	107
25-Year	134
50-Year	157
100-Year	177

6.3.2 Stormwater Management Pond Design

The net drainage area to the SWM Pond (including the area of the SWM Pond and external drainage from Glasglow Road and Street C) is 6.98ha. The Visual Otthymo (VO) model was used to determine storm flow calculations and required stormwater quantity control volumes based on required release rates.

6. STORM DRAINAGE AND STORMWATER MANAGEMENT (CONT'D)

6.3 Stormwater Management (Cont'd)

6.3.2 Stormwater Management Pond Design (Cont'd)

Based on the drainage area and release rates identified in Table II, an iterative process was used to calculate the pond's effective stage-storage-discharge relationship, determining the control structure sizing. The ponds have been adequately sized for all storms up to and including Regional event. Table III below provides an overview of the modelling results for the pond operation for 2 to 100-year storm events (AES 6 and 12 hour) and Regional Storm. Design details of the pond are shown on Drawing ST SWM-1. A copy of the related outputs is included in Appendix "H".

TABLE III

STORMWATER MANAGEMENT POND - PRELIMINARY DESIGN STORAGE VOLUME REQUIRED/PROVIDED

Permanent Pool Storage Required (193.33 m^3 ha) =	*1,349 m^3*
Permanent Pool Storage Provided =	1,683 m^3
25mm Erosion Control Storage Required =	*1,271 m^3*
25mm Erosion Control Storage Provided =	1,412 m^3

Description	**Design Storm**						
	2-Year	**5-Year**	**10-Year**	**25-Year**	**50-Year**	**100-Year**	**Regional**
Unit Flow Targets (m^3/s)	0.057	0.087	0.107	0.134	0.157	0.177	---
Peak Flow (m^3/s)	0.300	0.420	0.861	1.041	1.177	1.309	0.994
Outflow (m^3/s)	0.034	0.074	0.102	0.128	0.144	0.159	0.987
Pond W.L. (m)	255.78	255.85	255.94	256.10	256.27	256.42	256.55
Max. Storage Used (m^3)	1,765	2,224	2,558	3,040	3,417	3,791	4,760
Storage at Pond W.L (m^3)	2,086	2,312	2,611	3,161	3,775	4,341	4,851

6. STORM DRAINAGE AND STORMWATER MANAGEMENT (CONT'D)

6.3 Stormwater Management (Cont'd)

6.3.2 Stormwater Management Pond Design (Cont'd)

An orifice will be used for erosion control outflow, and a broad-crested weir and orifice are proposed to control the outflows for the 2-year and up to the Regional storm events. The Control Structure stage-storage-discharge curve is provided Table IV below.

TABLE IV

PROVIDED STAGE STORAGE DISCHARGE RELATIONSHIP

Stage (m)	Storage (m^3)	Outflow (m^3/s)
255.78	2,086	0.056
255.85	2,312	0.086
255.94	2,611	0.106
256.10	3,161	0.134
256.27	3,775	0.158
256.42	4,341	0.177
256.55	4,851	1.169

The following summarizes the outlet controls:

- 25mm Erosion Control: 75mm diameter orifice plate.
- 2 to 100 Year and Regional Storm Release: combination of 75mm diameter orifice plate and 0.36m wide x 0.19m high weir.
- A 10m wide emergency spillway is sized to safely convey the uncontrolled peak flow (1.309m3/s). The crest elevation of the emergency spillway is set at an elevation of 256.42m.

The event storage conditions of the wet pond, supporting stage storage and discharge calculations are included in Appendix "H".

6. STORM DRAINAGE AND STORMWATER MANAGEMENT (CONT'D)

6.3 Stormwater Management (Cont'd)

6.3.2 Stormwater Management Pond Design (Cont'd)

Preliminary design details of the proposed Stormwater Management Pond are illustrated on Drawing SWM-1 taking proposed sewer inverts and preliminary grading into consideration. It is noted that the configurations of the pond and related structures will be finalized as part of the final Engineering Design of the facility. A ñBottom Drainò outlet is proposed from the pond to minimize temperature impacts on the Humber River.

6.3.3 Sediment Loading and Drying Area

The estimated annual sediment loading based on 75% catchment imperviousness is 3.13 m^3/ha[12]. Based on the SWM pond drainage area of 6.98 ha the annual sediment generation is 21.85m^3. Assuming that the sediment is removed from the SWM pond on a ten (10) year interval the total sediment generated is 218.5m^3. To avoid dispersion of the sediment to the surrounding area it is recommended that the protocol for storing the sediment to allow it to dry is to enclose the sediment storage area with interlocking plastic barriers (New Jersey barrier style) lined with Terrafix 270R Geotextile. This will facilitate the water to drain from the sediment. On the basis of a 1.2m storage height a minimum footprint area of 182m^2± is required. As shown on Drawing SWM-1 a sediment drying area is proposed adjacent to the forebay and maintenance access. The area of the sediment storage area is 195m^2.

[12] Ministry of the Environment, Stormwater Management Planning and Design Manual, March 2003

6.4 Water Balance

The Hydrogeological Study[13] completed for the subject subdivision concluded that the development of the subject subdivision will result in an infiltration loss of 5,171 m^3/year (i.e. pre to post development). In addition, TRCA advised that to reduce the potential for erosion in the receiving feature, 15mm of runoff from the site be accommodated in the infiltration trenches or other LID measures in lieu of continuous modelling.

Accordingly, it is proposed that the runoff from the rear half of the roof surfaces and the rear yards be infiltrated where feasible.

To assist in the infiltration of stormwater it is proposed that in the locations of the proposed infiltration trenches the native subsoil is replaced with topsoil for a depth of 2m to 3m. The topsoil mass will facilitate the surface infiltration of stormwater (in the rear yard swales) and will also provide storage and an increased surface area of infiltration of stormwater into the surrounding subsoil.

The requirement to retain the first 15mm of runoff on-site was reviewed and the related calculations are as follows:

Subdivision Area = 6.98 ha (excluding Open Space and Restoration/VPZ areas)

% Imperviousness taken as 75%

Impervious Area = 0.75 (6.97 ha) = 5.235 ha

15mm Rainfall = 785.25m^3

Infiltration Trench = 2.0m wide x 1.5m deep

Storage Volume @ 40% void ratio = 1.2m^3/m

Total Length of Trench required = 654m

Length of Trench provided = 765m

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13 Included in Appendix ñCò

7. SEDIMENT AND EROSION CONTROL

Erosion and sedimentation are naturally occurring processes that involve particle detachment, sediment transport and deposition of soil particles. Construction activities commonly alter the landscapes where they are located, exacerbating these natural processes. One of the most significant alterations encountered during construction is the removal of the vegetation that stabilizes the subsoil. In the absence of the vegetation, the underlying soils are fully or partially exposed to various natural forces such as rain, flowing water, wind, and gravity[14].

The discharge of high sediment loads to natural watercourses has significant impacts on receiving waters and aquatic habitat. Some specific examples include:

- Degradation of water quality;
- Damage or destruction of fish habitat;
- Increased flooding.

In consideration of the above, it is necessary as part of the Final Design and implementation of infrastructure and development servicing to incorporate a comprehensive Erosion and Sediment Control Plan. The objectives are:

(i) Minimize wherever possible the extent of vegetation removal;
(ii) Provide appropriate sediment control measures to minimize the off-site transport of sediment;
(iii) Minimize the extent of time that sites are devoid of stabilizing vegetation;
(iv) Provide interim erosion control measures where permanent restoration is not feasible.
(v) Provide permanent restoration to eliminate future erosion.

14 *Erosion and Sediment Control Guidelines for Urban Construction,* December 2006, Greater Horseshoe Conservation Authorities.

7. SEDIMENT AND EROSION CONTROL (CONT'D)

The Erosion and Sediment Control Plan should consider the specific characteristics of each development site and address the requirements relating to the following typical construction stages:

- Topsoil Stripping and Site Pre-Grading
- Infrastructure Servicing
- Building Construction

A ñtreatment trainò approach is recommended in the development of an appropriate Erosion and Sediment Control Plan in compliance with the *Erosion and Sediment Control Guidelines for Urban Construction.* Typical sediment control measures include:

- Installation of double silt fencing along the boundary of work areas adjacent to the NHS;
- Construction of vegetated cut off swales including sediment traps and rock check dams;
- Stabilization of temporary sediment traps and provision of vegetated filter strips adjacent to the NHS;
- Provision of catch basin sediment controls.

Inherent in the Erosion and Sediment Control Plan is a monitoring program with an Action Plan to implement remedial measures in a timely manner where required.

It is recommended that the Erosion and Sediment Control Plan be submitted at the Final Design Stage.

8. CONCLUSIONS

This Functional Servicing Report was prepared as a technical document in support of the request for an Amendment to the Town of Caledon Official Plan and Zoning By Law as well as the Draft Plan of Subdivision. The report addresses sanitary, water and storm drainage servicing and stormwater management.

The Report outlines a proposed servicing strategy for the proposed subdivision development and provides preliminary engineering design for sanitary, water, storm drainage and stormwater management in accordance with the technical requirements of the Region of Peel, Town of Caledon, Toronto and Region Conservation and MECP.

The report concludes that:

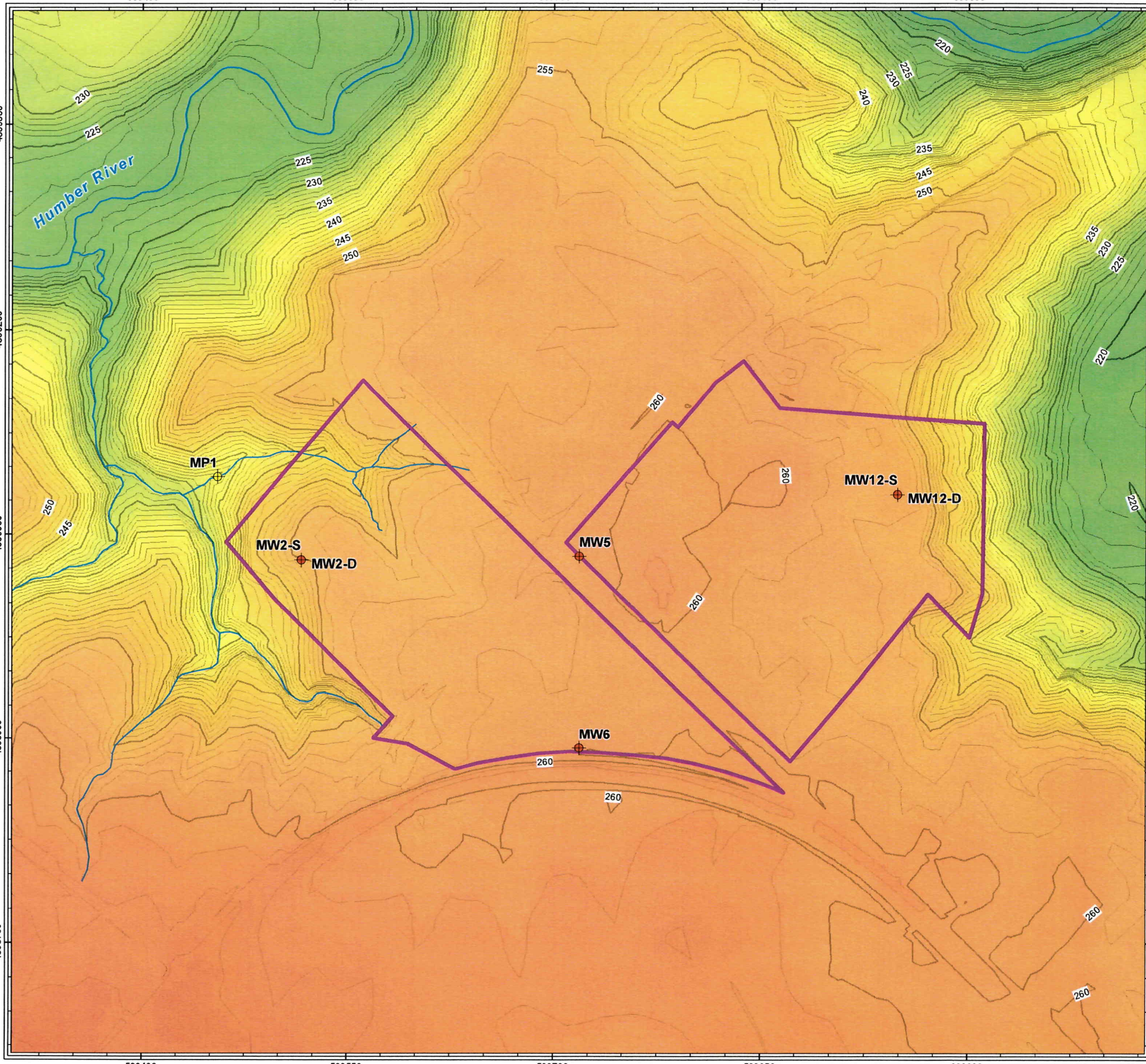
- a suitable outlet is available for the proposed sanitary sewer system;
- the existing water system (Pressure Zone 6) has adequate capacity to service the subdivision; in order to provide increased resiliency a second supply is recommended;
- the proposed stormwater management pond provides adequate capacity to restrict outflows for all storm events (up to and including the Regional storm) to pre-development conditions and to provide an enhanced level of water quality protection;
- the subdivision can be serviced without impacting any of the adjacent properties.

APPENDIX "A"

Excerpts from Comprehensive Environmental Impact Study and Management Plan, Palmer Environmental Consulting Group Inc. dated December 29th 2020 (Project No. 170163)

Palmer Memorandum dated March 23rd 2021, Chickadee Lane Stormwater Management Options assessment, Alternative Outlet Evaluation

Palmer Memorandum dated August 27th 2021, Chickadee Lane Erosion Threshold of Humber River Tributaries



DRAWN: B. Elder
CHECKED: R. Rolick
PROJECT: 1701603
DATE: Dec 23, 2020

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 8

Document Path: G:\Shared drives\Projects 2017\17016 - Brook Valley Homes\1701603 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\2020\1701603_Figure8_Topography.mxd

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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

DRAWN: B. Elder
CHECKED: R. Rolick
PROJECT: 170163
DATE: Dec 23, 2020

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

Pre-development Landuse

FIGURE 9

Document Path: G:\Shared drives\Projects 2017\17016 - Brook Valley Homes\1701603 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\2020\1701603_Figure9_Landuse.mxd

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74 Berkeley Street, Toronto, ON M5A 2W7
Tel: 647-795-8153 | www.pecg.ca

Memorandum

Date: March 23, 2021

Project #: 1701603

To: Frank Filippo, Zancor Homes

From: Michael Brierley, M.Sc., and Robin McKillop, M.Sc., P.Geo., CAN-CISEC, Austin Adams, M.Sc., E.P

cc: Jason Cole, M.Sc., P.Geo., Diarmuid Horgan, P.Eng.

Re: Chickadee Lane Stormwater Management Options Assessment
Alternative Outlet Evaluation

1. Introduction

Palmer is pleased to provide Brookvalley Project Management Inc. (Brookvalley), on behalf of Zancor Homes Inc. (Zancor), the results of our assessment of three options for outlets from the proposed stormwater management (SWM) pond to the receiving watercourse and documentation of the feasibility of each option from fluvial geomorphological, ecological and engineering perspectives. There are a number of defined gullies and channels that descend into the Humber River Valley and drain the northwest corner of the subject property at the intersection of Chickadee Lane and Glasgow Road, in Bolton. This technical memorandum provides an overview of existing conditions near each proposed outlet location, a brief description of the alternatives and their evaluation.

1.1 Background

Palmer (2019) previously submitted the *Chickadee Lane Rounding Out Area B Comprehensive Environmental Impact Study and Management Plan (CEISMP)*. In comments received May 15, 2020, Toronto and Region Conservation Authority (TRCA) expressed concern that reaches downstream of the proposed SWM pond may be susceptible to excessive erosion due to the proposed development of the subject property as well as recent urban development south of Emil Kolb Parkway. Accordingly, Palmer's Senior Fluvial Geomorphologist, Candevcon Ltd. and Brookvalley carried out a site assessment of the subject property on May 26, 2020, to review potential SWM pond outlet alternatives. Two additional outlet alternatives were identified during the site meeting, in addition to the originally proposed outlet location. Each of the outlet alternatives was surveyed on June 15, 2020, by KRCMAR Surveyors Ltd. In addition, the feasibility of tying into existing municipal infrastructure was explored by Candevcon Ltd. It was determined that drainage from the proposed development could not discharge into exiting infrastructure or drainage pathways along Emil Kolb Parkway without exacerbating existing erosion along Reach B observed during

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the existing conditions assessment. Palmer's Fluvial Processes Specialists assessed existing conditions along the entire headwater tributary drainage network (Reaches A, B, C, and D) west of the subject property on June 30, 2020, to document erosional processes and inform appropriate pond outlet locations (Palmer, 2020). The existing conditions assessment confirmed the following:

- Nearly all the reaches along the gullies and channels comprising the headwater tributary network, which drains the western and northern portions of the subject property, exhibit at least local erosion.
- Tributary A exhibits the least amount of erosion. As such, consideration could be given to outletting stormwater along one or more of Reaches A1, A2, A3 and/or A5. Reach A4 is unstable and unsuitable for a stormwater outlet.
- Tributary D has rapidly down-cut and incised through its alluvial floodplain as the channel has adjusted to unnaturally deep and fast flows resulting from watershed urbanization.

2. Outlet Alternatives

Three outlet alternatives were identified during a field investigation on May 26, 2020 (**Figure 1**). Two of the outlet alternatives are proposed to discharge into Tributary A catchment, located at the northeast corner of the subject property. The third alternative is proposed to discharge into Tributary D, located west of the property boundary. An overview of the proposed outlet alternatives and the existing gully and channel conditions is provided below.

2.1 Alternative 1

Drainage alternative 1, originally proposed as part of Palmer's CEISMP submission, outlets directly into a V-shaped gully (Reach A4; Palmer 2020), which drains into Reach A5 approximately 60 m downstream. The gully exhibits signs of active erosion along its steep sidewalls. The gully has a high gradient (14%) and an irregular, stepped bed profile. The steep energy gradient increases velocity and shear stress along the gully bottom and walls. The banks are scoured and slightly undercut, exposing roots. All flows are confined to the V-shaped gully bottom without any floodplain available to attenuate floods. The bed and bank material consist of sandy silty-clay till, locally overlain by organic matter, sand, small gravels with cobbles and anthropogenic debris (i.e. concrete rubble). Also, woody debris and exposed tree roots impart structure and roughness along the bed. Alternative 1 would require the least amount of piping and terrestrial disturbance compared to Alternatives 2 and 3. However, the existing conditions assessment (Palmer, 2020) determined that this reach would not be suitable for stormwater discharge due to increased erosion potential within the gully. It is estimated that additional flows at this location would also exacerbate the uprooting or trees along the gully..

2.2 Alternative 2

Drainage alternative 2 would be piped from the proposed SWM pond[1] and discharge into Reach A5. The proposed alignment of the pond outlet sewer is located along a naturally cleared corridor along the forested

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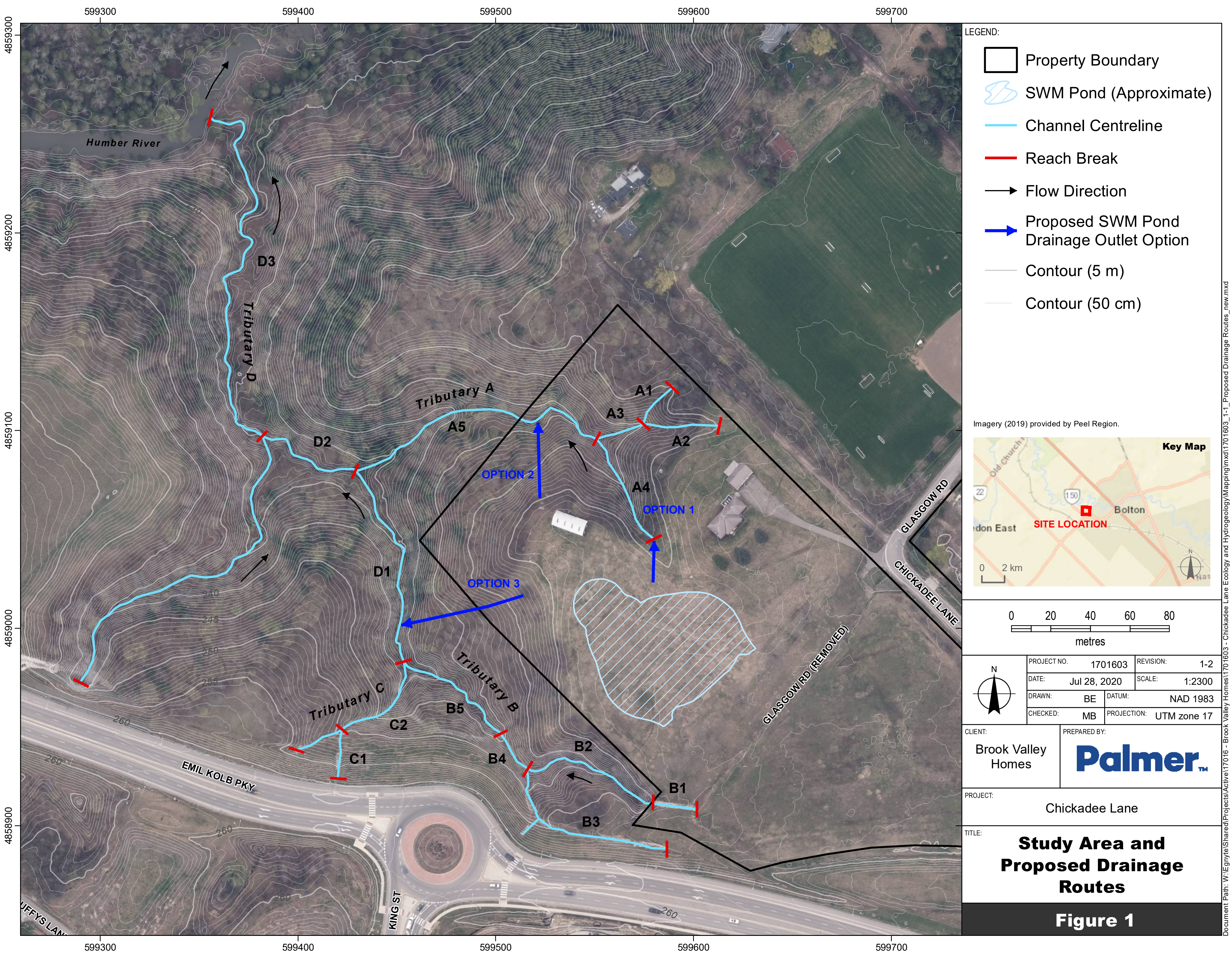
[1] Following correspondence from TRCA on 15 May 2020, the proposed SWM pond will need to be relocated outside of the delineated Long-Term Stable Top of Slope (LTSTOS) and associated allowances, which represents the limit of the Significant Valleyland as a KNHF under the Greenbelt Plan 15 m development buffer established based on habitat delineation.

valley wall, requiring less vegetation removal and tree clearing than Alternative 1. The wall at this location has a gentler gradient relative to slopes 50 m to the east and west of the proposed alignment. The pond will discharge into a reach that is transitional in its genesis and characteristics, exhibiting more influence from fluvial characteristics than solely gully processes. The channel exhibits little sign of active erosion along the sidewalls and no mass movement failures. The channel has a sinuous planform that reflects valley morphology as opposed to lateral erosion or meandering processes. The gully has a moderate-high gradient (9.5%). The bed and bank material consist of sandy silty-clay till overlain by silts and sands with discontinuous cobbles and boulders. Woody debris and exposed tree roots impart structure and roughness along the bed. Coarsening of the bed material moderates erosion and limits scour along the toe of the valley wall, thereby contributing to the relative stability of this reach.

2.3 Alternative 3

Drainage alternative 3 would be piped from the western side of the proposed SWM pond and outlet at the upstream extent of Reach D1. The proposed alignment follows an anthropogenically cleared corridor for approx. 75 m before continuing through a treed section of valley for the final 15 m. The valley slopes gently to a small plateau before descending more steeply toward the channel. The toe of the valley wall has eroded leaving a nearly 4 m-high vertical face separating the channel and the crest of the treed slope. The proposed pond outlet would discharge into upstream extent of Reach D1, which is transitional in its characteristics, exhibiting more influence from fluvial characteristics than solely gully processes. The channel is confined on both sides by prominent valley walls. The channel has incised below its floodplain and is adjusting to unnaturally deep and fast flows resulting from watershed urbanization west of Emil Kolb Parkway. The channel entrenchment has concentrated tractive forces along the channel bed and banks, which, in turn, has led to further degradation and instability. Higher peak flows from increased stormwater entering the channel have eroded the channel banks and the toe of the valley wall, enlarging the channel cross-section. The average bed gradient along the reach is 5%. Bed morphology is poorly defined due to active degradation. Bed materials are dominated by gravels and cobbles overlain by deposited sand. Bed material is readily entrained due to the high energy gradient along the reach. Till is exposed locally along the bed, mostly along the thalweg position, and extensively along the lower banks. The entire length of Tributary D is susceptible to scour and erosion resulting from historical changes to its hydrologic and hydraulic regimes.



599300
599400
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Humber River
D3
Tributary D
Tributary A
A1
A2
A3
A4
A5
D2
D1
OPTION 1
OPTION 2
OPTION 3
Tributary B
Tributary C
B1
B2
B3
B4
B5
C1
C2
EMIL KOLB PKY
KING ST
GLASGOW RD
CHICKADEE LANE
GLASGOW RD (REMOVED)
LEGEND:
Property Boundary
SWM Pond (Approximate)
Channel Centreline
Reach Break
Flow Direction
Proposed SWM Pond Drainage Outlet Option
Contour (5 m)
Contour (50 cm)
Imagery (2019) provided by Peel Region.
Key Map
Bolton
SITE LOCATION
0 2 km
0 20 40 60 80
metres
PROJECT NO. 1701603
REVISION: 1-2
DATE: Jul 28, 2020
SCALE: 1:2300
DRAWN: BE
DATUM: NAD 1983
CHECKED: MB
PROJECTION: UTM zone 17
CLIENT: Brook Valley Homes
PREPARED BY: Palmer
PROJECT: Chickadee Lane
TITLE: Study Area and Proposed Drainage Routes
Document Path: W:\Egnyte\Shared\Projects\Active\17016 - Brook Valley Homes\1701603 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\1701603_1-1_Proposed Drainage Routes_new.mxd

Figure 1

3. Evaluation of Alternatives

Outlet alternatives are evaluated from an erosion, ecology, slope stability, civil engineering, and cost perspective (**Table 1**) to determine the preferred alignment and outlet location.

Table 1. Evaluation of proposed drainage alternatives

Discipline	Proposed Alternative		
	Alternative 1	**Alternative 2**	**Alternative 3**
Fluvial Geomorphology	Expansion of the gully's catchment area and regulation of its hydrological regime have the potential to exacerbate erosion through a positive feedback mechanism. The steepness and confinement of the gully bottom yield a naturally erosive environment. Discharging into this steep gully is not suitable from a fluvial geomorphological perspective.	Expansion of Reach A5's catchment area and regulation of its hydrological regime have the potential to exacerbate erosion along this reach. This section of channel, however, is relatively stable with till underlain by cobbles, boulders and woody debris along the bed. It also exhibits no obvious valley wall instability.	Additional discharge entering the channel from the proposed pond has the potential to exacerbate erosion along this unstable reach. The steepness and confinement of the channel bottom yield a naturally erosive environment.
Score	**1**	**5**	**3**
Aquatic Ecology	Approx. 2 m wide in this section. 0-5 cm deep, slow trickle of flowing water. Sand bottom with some gravels and cobbles present. Steep and unlikely suitable for fish species. Limited groundwater influence along this section	Approx. 2 m wide in this section. 0-3 cm deep, slight trickle of water along the channel. Silty/clay bottom, some large rocks. Steep and unlikely suitable for fish species. Groundwater upwelling observed along this section.	Approx. 0.5 wide in this section. 1-6 cm deep, slow flow (with sinks) flowing north. Silty/clay bottom with wood debris and localized boulders. Gully-spanning tree roots. Steep and unlikely suitable for fish species. No groundwater influence along this section.
Score	**3**	**3**	**3**
Terrestrial Ecology	This section would represent the least native tree removal, as it is primarily dominated by European Buckthorn (highly invasive, non-native), and Ash populations here have already declined due to EAB, with few live trees left. Clearing of this area would not fragment the forest due to its position at the woodland edge. However, it is estimated that additional flows at this location may exacerbate the observed uprooting of trees along this route.	The area provides a potentially suitable habitat for bats and salamanders. Large, tall deciduous trees provide canopy cover of >60% with occasional gaps, including a naturally cleared corridor along the forested valley wall. The woodlands also provide confirmed habitat for Wood Thrush and Eastern Wood-pewee, both Species at Risk birds in Ontario. There are no specific issues related to outlet placement.	The area provides a potentially suitable habitat for bats and salamanders. Large, tall deciduous trees provide canopy cover of >60% with occasional gaps. The woodlands also provide confirmed habitat for Wood Thrush and Eastern Wood-pewee, both Species at Risk birds in Ontario. There are no specific issues related to outlet placement.
Regulatory Agency Acceptance (Satisfy TRCA, DFO and MNRF Mandates)	Identified as significant valley land under the Greenbelt Plan with potential for species at risk present, so would require approvals from TRCA and MNRF.		
Score	**3**	**3**	**3**
Slope Stability[1]	The gully exhibits little sign of active erosion along gully walls and no mass movement failures. No headward cut or seepage areas were observed. The gully sidewalls appear to be relatively stable; however, continued incision along the gully bottom highlights the potential for future sidewall instability.	The valley wall exhibits little sign of active erosion along valley wall and no mass movement failures. The toes of the valley walls are slightly undercut, exposing roots and silty till; however, no instability was noted.	Signs of active erosion with mass movement failures and seepage areas (resulting from the presence of a perched water table (Palmer 2019)) were present along the valley wall. Severe erosion along the bed and banks of the channel has further contributed to valley wall instability
Score	**3**	**5**	**1**
Engineering	This alternative requires the shortest outlet pipe and least construction cost.	This Alternative requires the longest outlet pipe, with manhole drop structures, and the highest construction cost. The advantage is that the energy is dissipated within the sewer system as opposed to along a channel as in Alternative 1.	This alternative is slightly less costly to construct, but the risk to valley wall stability is high.
Score	**5**	**3**	**1**
Score	**15**	**19**	**11**
Overview	Although alternative 1 would result in the least amount of direct construction disturbance, the receiving reach (A4) would be unable to accommodate additional discharge without adverse effects due to its inherent instability and erosive characteristics.	Alternative 2 is the preferred options as it best balances long-term stability of the reaches downstream of the proposed outlet.	Alternative 3 would outlet into a geomorphologically sensitive reach due to watershed urbanization resulting in instability along the channel bed and valley walls.

[1] *A long-term slope stability assessment has not been completed along the proposed drainage alternative alignments. Slope stability was evaluated based on the composition of table land and observed mass wasting or seepage areas in proximity to the proposed alignments.*

4. Conclusion and Recommendations

The options assessment identified that Alternative 2 would be the most appropriate outlet location from geomorphological, ecological, and engineering perspectives. Alternative 2 would result in the proposed SWM pond discharging into Reach A5. Reach A5 is transitional in its genesis and characteristics, exhibiting more influence from fluvial characteristics than solely gully processes. Reach D2, which is immediately downstream of Reach A5, would also receive SWM pond discharge. It is rapidly responding to an altered flow regime due to urban development south of Emil Kolb Parkway and, thus, is very sensitive to changes in flow regime. Positioning a SWM pond outlet along the bottom of steep channels and narrow-bottomed valleys without exacerbating erosion will be challenging without at least localized mitigative measures along the channel.

To ensure that the preferred outlet locations do not negatively impact long-term stability and/or terrestrial ecology, the following studies are recommended:

- Complete an erosion threshold assessment along the most sensitive reaches downstream of the preferred stormwater outlet alternative to inform release rates from the proposed SWM pond.
- Update discharge rates from the SWM pond to ensure that the receiving watercourse can accommodate more frequent, smaller discharge events from the pond without exceeding the erosion threshold.
- A tree survey is recommended along the proposed alignment to ensure future designs can avoid impact to any sensitive species.

5. Certification

This memorandum was prepared and reviewed by the undersigned:

Prepared By:

Michael Brierley, M.Sc.
Fluvial Processes Specialist

Reviewed By:

Robin McKillop, M.Sc., P.Geo., CAN-CISEC
Principal, Fluvial Geomorphologist

References

Palmer, 2019. Hydrogeological Investigation – Chickadee Lane Rounding Out Area B

Palmer, 2020. Chickadee Lane Existing Conditions – Fluvial Geomorphological Assessment of Humber River Tributary.

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Memorandum

Date: August 27, 2021

Project #: 1701603

File #:

To: Frank Filippo (Zancor Homes (Bolton) Inc.)

From: Michael Brierley M.Sc., Dan McParland P.Geo., and Robin McKillop P.Geo.

cc: Jason Cole P.Geo.

Re: Chickadee Lane Erosion Threshold of Humber River Tributaries

1. Introduction

Palmer is pleased to provide Brookvalley Project Management Inc. (Brookvalley), on behalf of Zancor Homes Inc. (Zancor), the results of our erosion threshold assessment of two reaches (A5 and D2) of Humber River downstream of a proposed stormwater management (SWM) pond outlet that descend into the Humber River Valley and drain the northwest corner of the subject property at the intersection of Chickadee Lane and Glasgow Road, in Bolton.

1.1 Background

Initial geomorphological field reconnaissance was completed on February 5, 2019, to examine the conditions and erosional processes along a headwater gully system downstream of the proposed stormwater management (SWM) pond (**Figure 1; Palmer 2020a**). TRCA, in comments received May 15, 2020, expressed concern that reaches downstream of the proposed SWM pond may be susceptible to excessive erosion due to the proposed development of the subject property as well as recent urban development south of Emil Kolb Parkway. Accordingly, Palmer's Fluvial Processes Specialists assessed existing conditions along the entire headwater tributary drainage network (Reaches A, B, C, and D) west of the subject property on June 30, 2020, to document erosional processes and inform appropriate pond outlet locations (Palmer, 2020a).

Following the existing conditions assessment (Palmer, 2020a), an options assessment for the pond outlet was completed (Palmer, 2020b). The options assessment identified that Option 2 would be the most appropriate outlet location from a geomorphological perspective (**Figure 1; Palmer 2020a**). Option 2 would result in the proposed SWM pond[1] discharging into Reach A5. Reach A5 is transitional in its genesis and

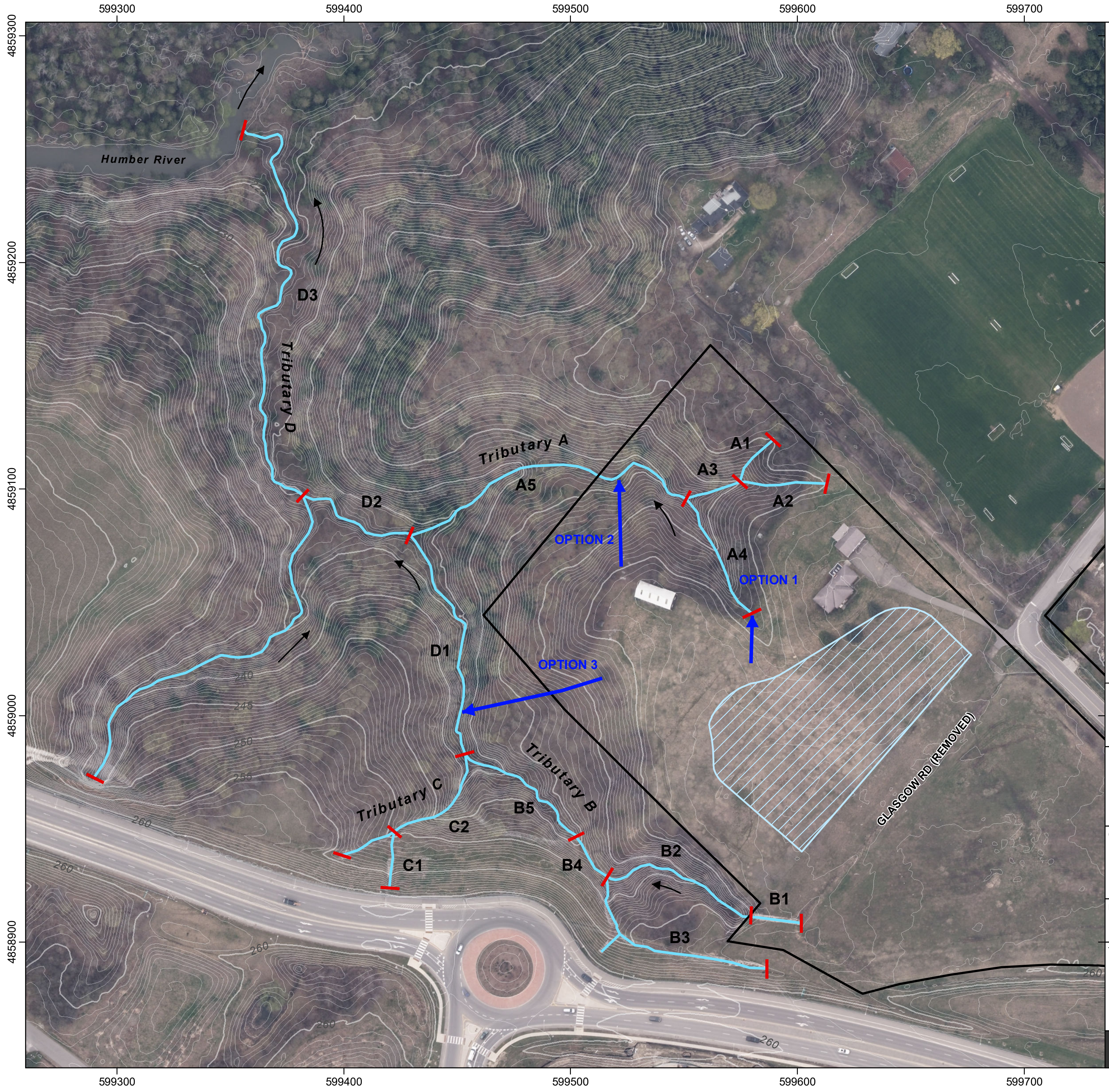
[1] *Following correspondence from TRCA on 15 May 2020, the proposed SWM pond will need to be relocated outside of the delineated Long-Term Stable Top of Slope (LTSTOS) and associated allowances, which represents the limit of the Significant Valleyland as a KNHF under the Greenbelt Plan 15 m development buffer established based on habitat delineation.*

characteristics, exhibiting more influence from fluvial characteristics. Between the proposed SWM pond and the Option 2 outlet, the valley wall has a gentler gradient relative to slopes 50 m to the east and west along and reduced mature vegetation cover along the proposed alignment.

To inform release rates from the proposed SWM Pond, Palmer's Fluvial Processes Specialists completed erosion threshold analyses in both Reach A5 and Reach D2 (**Figure 1; Palmer 2020a**). Reach D2, which is immediately downstream of Reach A5, was assessed because it is rapidly responding to an altered flow regime due to urban development south of Emil Kolb Parkway and, thus, very sensitive to changes in flow regime. Reach A5 and Reach D2 are both downstream of Option 1 outlet. Reach D2 is downstream of the Option 3 outlet.

2. Physical Setting

In the vicinity of the subject property, Humber River has incised through thick deposits of clay- to silt-textured till at least partly derived from erosion of glaciolacustrine deposits. Borehole logs from drilling completed within the subject property generally confirm that a veneer of topsoil and earth fill overlie silty clay till and compact to very dense sandy silt till at greater depths (Soil Engineers Ltd., 2018). Borehole 2 (BH2), which is located closest to the proposed SWM pond and the edge of the valley, corroborates field observation that the walls of the gully features that descend into the Humber River valley comprise silty clay till, with traces of gravel, sand seams, cobbles and boulders (Soil Engineers Ltd., 2018). The till helps maintain morphological form in the steep headwater tributaries and supplies sediment to downstream reaches.



LEGEND:

- Property Boundary
- SWM Pond
- Channel Centreline
- Reach Break
- Flow Direction
- Proposed SWM Pond Drainage Outlet Option
- Contour (5 m)
- Contour (50 cm)

Imagery (2019) provided by Peel Region.

0 20 40 60 80
metres

PROJECT NO.	1701603	REVISION:	1-2
DATE:	Aug 27, 2021	SCALE:	1:2300
DRAWN:	BE	DATUM:	NAD 1983
CHECKED:	MB	PROJECTION:	UTM zone 17

CLIENT:
Brook Valley Homes

PREPARED BY:
Palmer

PROJECT:
Chickadee Lane

TITLE:
Study Area and Proposed Drainage Routes

Figure 1

Document Path: G:\Shared drives\Projects 2017\17016 - Brook Valley Homes\1701603 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\2021\1701603_Figure1-1_Proposed Drainage Routes.mxd

3. Methods

The erosion threshold assessment was completed in accordance with TRCA's detailed procedural documents (2008). Field data collection occurred on December 9, 2020, by Palmer's Fluvial Process Specialists. Site-specific data collection included four bankfull cross-sections along each reach (locations shown in **Figure 1**); a local longitudinal bed survey (rod and level); substrate characteristics, including grain size distribution estimates based on modified Wolman (1954) pebble counts at each cross-section along Reach D2 and a single representative sample for Reach A5; and description of bank structure and composition. Fine-grained bed material was characterized by grain size range class (e.g. silt, fine sand) by visual examination and hand texturing, with confirmatory reference to nearby borehole logs and associated grain size analysis records. Bankfull dimensions were based on field indicators defining the principal limit of scour, including abrupt changes in bank vegetation, material, and steepness (Harrelson et al., 1994), which is assumed to correspond to the 'channel-forming' discharge. Irregular and unstable morphology complicates the identification of bankfull indicators along Reach D2 (Palmer, 2020a).

Although cohesive till substrate was locally observed along both reaches, channel morphology of Reach A5 and Reach D2 is largely controlled by cohesionless alluvial material present along the bed and banks. Furthermore, in Reach A5 the range of bed grain sizes is broad and channel morphology is controlled by both silts and sands present along channel periphery and interstitial spaces of coarser-grained materials as well as coarse gravels and cobbles unevenly distributed along the bed. In Reach D2, the gravel bed material is more consistent along the reach. For observed coarse-grained material (gravels and cobbles) in Reach D2 and Reach A5, erosion threshold and critical discharge analyses were completed based on a Shields (1936) approach as outlined by Church (2006), as it is a semi-empirical approach (as opposed to completely empirical). The median grain size (D_{50}) was used for the erosion threshold calculations. Erosion thresholds were compared to hydraulic conditions at bankfull flows (established from the field survey) to better understand the propensity for entrainment.

To determine the erosion threshold for the fine-grained material (silt and sand) in Reach A5 a representative silt grain size (0.05 mm) was compared to entrainment thresholds established by Hjulström (1935). The Hjulström (1935) approach better represents the entrainment of fine-grained material relative to Shields (1936). Silts were more readily observed than sand during hand texturing at Reach A5 and more susceptible to erosion compared to cohesive tills documented in borehole logs (Soil Engineers Ltd., 2018). Cohesive material is bound together by electrochemical forces in such a way that resists entrainment. As such, cohesive material entrainment is not a function of particle size (Knighton, 1998). Therefore, the establishment of an erosion threshold based on the silt fraction is considered a conservative approach.

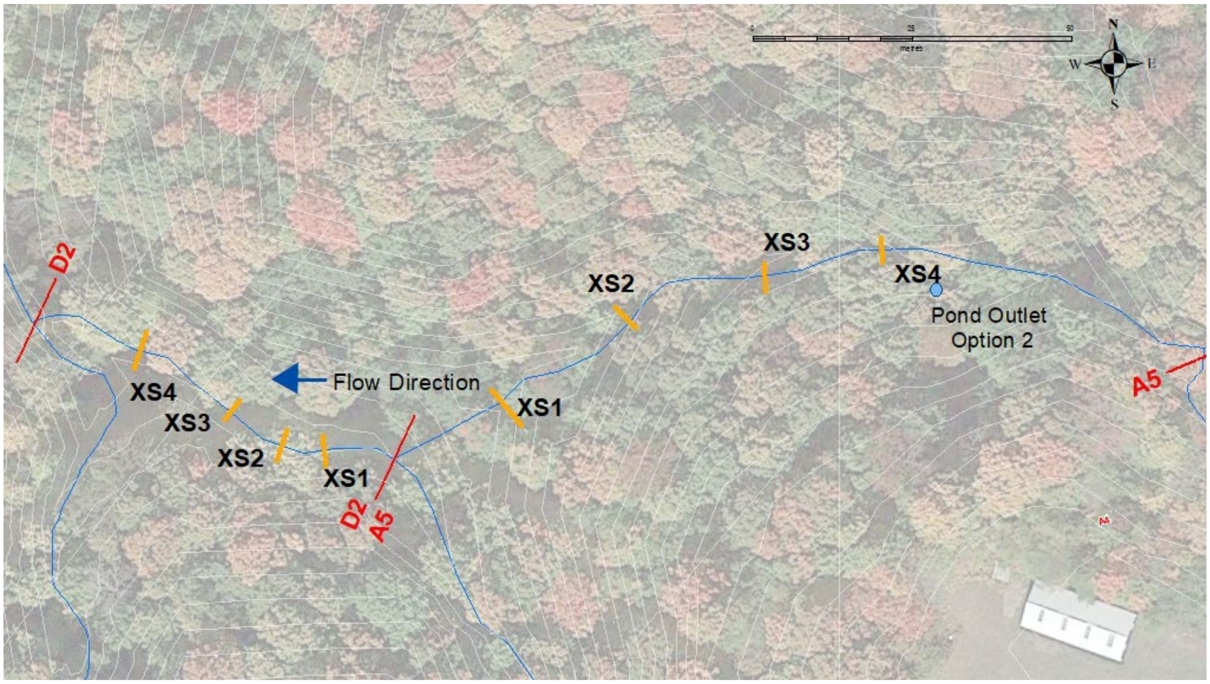


Figure 2. Reach breaks, preferred stormwater management discharge location (Option 2), and surveyed cross-section locations.

4. Description of Channel Morphology of Reach A5 and Reach D2

The planned SWM pond is proposed to discharge into the Humber River Valley (**Figure 1**). Three outlet alternatives were identified during a field investigation on May 26, 2020 (**Figure 1**). Two of the outlet alternatives are proposed to discharge into Tributary A catchment, located at the northeast corner of the subject property. The third alternative is proposed to discharge into Tributary D, located west of the property boundary.

4.1 Reach A5

Reach A5 exhibits little sign of active erosion along sidewalls and no mass movement failures. The channel has a sinuous planform; however, it is not a function of lateral erosion but forced by valley topography. The gully has a moderate-high gradient (9.54%). The bed and bank material consist of sand and silts as well as localized till exposure, overlain by cobbles and boulders (**Photo 1**). Sand and small gravels are temporarily deposited upstream of boulder clusters and woody debris. Woody debris and exposed tree roots impart structure and roughness along the bed (**Photo 2**). High organic matter (i.e. fallen leaves) increase erosion resistance of the bed and valley substrate. Coarsening of the bed material moderates bed erosion.

Photo 1. Upstream view of cobbly substrate along the bed near the downstream extent of Reach A5.

Photo 2. Upstream view of wood debris and organic matter accumulation along the bed which adds additional roughness.

4.2 Reach D2

Immediately downstream of Reach A2, Reach D2 is morphologically sensitive and is adjusting to unnaturally deep and fast flows resulting from watershed urbanization west of Emil Kolb Parkway (**Photo 3**). Reach D2 is a sinuous channel confined on both sides by terraces (1.5 – 2.0 m high) and prominent valley walls with no accessible floodplain. The channel has incised through alluvial floodplain into underlying till. Increased peak flows have also begun to widen and deepen the channel, creating a new corridor with a low discontinuous floodplain. The new corridor has a width and depth of 5 m and 1.5 m. The averaged bankfull width and depth are 3 m and 0.4 m, respectively. The bankfull depth is well below the physical top of bank following rapid bed degradation. The average bed gradient along the reach is approximately 4.15%. Bed morphological units (e.g. pools, riffles) are poorly defined due to active degradation. Bed materials are dominated by gravels and cobbles and locally overlain by sand (**Photo 4**). Till is exposed locally along the bed, mostly along the thalweg, and extensively along the lower banks.

Photo 3. Downstream view of channel incision that has lowered the bed 1.5 to 2.0 m below the floodplain.

Photo 4. Downstream view of gravel and cobble bed material locally overlain by sand.

5. Erosion Thresholds

5.1.1 Reach A5 – Coarse-grained Material

Using the Shields (1936) approach[2], a critical shear stress of 116 N/m^2 was established for the D_{50} (120 mm) of the gravel and cobbly to boulder alluvium lag along the bed of Reach A5. This critical shear stress is exceeded at a discharge of 0.21 m^3/s, which corresponds to approximately 41% of the bankfull flow[3] (0.51 m^3/s), demonstrating that the coarse grain bed material is mobilized during flows below the physical tops of bank. However, bed structure (steps, knickpoints, roots, etc.), cohesive till material and woody debris provide stability along the reach bottom, moderating erosive potential and therefore transport potential of cobble and boulder substrate.

5.1.2 Reach A5 – Fine-grained Material

Using the Hjulström (1935) approach, a critical velocity of 0.53 m/s was established for silt (0.05 mm). This critical velocity is exceeded at a discharge of 0.058 m^3/s, which corresponds to approximately 11% of the bankfull flow (0.51 m^3/s). Thus, the fine-grained material along the channel periphery and in the interstitial spaces of the coarser-grained sediments will be more readily eroded in Reach A5 than the coarse-grained material.

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[2] *Critical Shields (1936) parameter assumed to be 0.06 (Church, 2006).*

[3] *To estimate bankfull hydraulics, a Manning's 'n' of 0.075 was chosen for Reach A5 due to the large relative roughness and accumulation of organic debris. This value was corroborated by measured Manning's 'n' values presented in Hick and Mason (1991) for is a watercourse that had a similar gradient and discharge to Reach A5.*

5.1.3 Reach D2

Using the Shields (1936) approach[4], a critical shear stress of 25 N/m^2 was established for the D_{50} (34 mm) of the bed material in Reach D2. This critical shear stress is exceeded at a discharge of 0.18 m^3/s, which corresponds to approximately 8% of the bankfull flow[5] (2.29 m^3/s), demonstrating that bed material is mobilized during flows well below bankfull conditions. Furthermore, average shear stresses at bankfull conditions can entrain the D_{95} (105 mm), indicating bankfull flow can lead to reach-scale morphological restructuring in Reach D2. The erosion threshold of Reach D2 (0.18 m^3/s) is less than the erosion threshold of the coarse-grained fraction in Reach A5 (0.21 m^3/s) but considerably higher than the erosion threshold of the fine-grained fraction of Reach A5 (0.058 m^3/s).

6. Summary and Recommendations

Palmer completed an erosion threshold assessment along two headwater tributaries (A5 and D2) downstream of a proposed SWM pond outlet. An erosion threshold of 0.058 m^3/s was established for the observed fine-grained sediments in A5. The established erosion threshold will not exacerbate ongoing instability in Reach D2. The established erosion threshold (0.058 m^3/s) exceeds the 25 mm 4-hour Chicago storm event discharge (0.011 m^3/s). Therefore, the 25 mm storm discharge from the SWM Pond is only 17% of the established erosion threshold.

7. Certification

This memorandum was prepared and reviewed by the undersigned:

Prepared By:

Michael Brierley, M.Sc.
Fluvial Processes Specialist

Reviewed By:

Dan McParland, M.Sc., P.Geo
Fluvial Processes Specialist

Approved By:

Robin McKillop, M.Sc., P.Geo., CAN-CISEC
Principal, Fluvial Geomorphologist

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[4] *Critical Shields (1936) parameter assumed to be 0.045 (Church, 2006).*
[5] *To estimate bankfull hydraulics, a Manning's 'n' of 0.04 was chosen for Reach D2.*

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APPENDIX “B”

Geotechnical Investigation for Proposed Residential Development, Chickadee Lane and Glasgow Road, Town of Caledon, Soil Engineers Ltd., dated July 2018, Reference No. 1801-S032

Supplementary Slope Stability Assessment prepared by Soil Engineers Ltd. Dated August 31st 2020, Reference No. 1801-S032

Soil Engineers Letter dated March 23rd 2021 - Determination of Long-Term Stable Slope Line and Erosion Hazard Limit, Reference No. 1801-S032

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A REPORT TO
BROOKVALLEY PROJECT MANAGEMENT INC.

A GEOTECHNICAL INVESTIGATION FOR PROPOSED RESIDENTIAL DEVELOPMENT

CHICKADEE LANE AND GLASGOW ROAD

TOWN OF CALEDON

REFERENCE NO. 1801-S032

JULY 2018

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1.0 INTRODUCTION

In accordance with the written authorization dated November 13, 2017, from Mr. Frank Filippo of Brookvalley Project Management Inc., a geotechnical investigation was conducted at a parcel of property located in the area of Chickadee Lane and Glasgow Road in the Town of Caledon.

The purpose of the investigation was to reveal the subsurface conditions and to determine the engineering properties of the disclosed soils for the design and construction of a residential development project. Since the property is located in close proximity of the Humber River, a slope stability study was also completed for the development. The findings and resulting recommendations are presented in this Report.

2.0 SITE AND PROJECT DESCRIPTION

The site is located at the south sector of the Town of Caledon, which is situated on Peel-Markham till plain where the drift dominates the soil stratigraphy. In places, lacustrine sand, silt, clay and drift which has been reworked by the water action of Peel Ponding (glacial lake) have modified the drift stratigraphy.

The subject property, approximately 10.91 hectares in area, is located beside the intersection of Chickadee Lane and Glasgow Road in the Town of Caledon. The existing site gradient is relatively flat, with sloping ground to the north and east of the property towards the vicinity of Humber River. The valley land is well vegetated with trees and bushes.

At the time of investigation, part of the property was an open field, with dwellings on the southeast and northwest of the road intersection.

The proposed development will consist of a residential subdivision on the south portion of the property, with municipal services and access roadways meeting the municipal standards.

3.0 FIELD WORK

The field work, consisting of twelve (12) sampled boreholes, was performed between January 23 and 29, 2018, at the locations shown on the Borehole Location Plan of Drawing No. 1. Boreholes 2 and 12, located close to the top of slope, extended to a depth of 19.8 m and 32.0 m from the prevailing ground surface. The remaining boreholes were terminated at a depth of 6.5 m or 8.1 m from the prevailing ground level.

The holes were advanced at intervals to the sampling depths by a track-mounted, continuous-flight power-auger machine equipped for soil sampling. Standard Penetration Tests, using the procedures described on the enclosed "List of Abbreviations and Terms", were performed at the sampling depths. The test results are recorded as the Standard Penetration Resistance (or 'N' values) of the subsoil. The relative density of the granular strata and the consistency of the cohesive strata are inferred from the 'N' values. Split-spoon samples were recovered for soil classification and laboratory testing.

Upon completion of borehole drilling and sampling, monitoring wells were completed at the location of Boreholes 2, 5, 6 and 12 for hydrogeological study. The wells at Boreholes 5 and 6 were installed at a depth of 6.0 m. At the locations of Boreholes 2 and 12, nested wells were installed at a depth of 7.6 m and at the deeper levels of 19.8 m and 32.0 m, respectively. The locations and depths of the monitoring wells were specified by Palmer Environmental Consulting Group Inc., who will also be monitoring the wells.

The ground elevation at each borehole and monitoring well location was interpolated from the spot elevations shown on the Plan of Survey prepared by KRCMAR Surveyors Ltd. dated March 2017.

4.0 SUBSURFACE CONDITIONS

The boreholes revealed that beneath a veneer of topsoil and a layer of earth fill in places, the site is underlain by silty clay till with sandy silt till deposit at the deeper level. Detailed descriptions of the subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 12, inclusive. The revealed stratigraphy is plotted on the Subsurface Profile in Drawing Nos. 2 and 3. The engineering properties of the disclosed soils are discussed herein.

4.1 **Topsoil** (All Boreholes)

The revealed topsoil is 16 cm to 46 cm in thickness. Thicker topsoil layers are expected to occur in places, especially in the treed area and the low-lying drainage area.

The topsoil is dark brown in colour, indicating appreciable amounts of roots and humus. These materials are unstable and compressible under loads; therefore, the topsoil can only be used for general landscaping purposes. Its suitability for planting and sodding purposes must be further assessed by fertility testing.

Due to the humus content, the topsoil may produce volatile gases and generate an offensive odour under anaerobic conditions. Therefore, the topsoil must not be buried below any structures or deeper than 1.2 m below the finished grade, so that it will not have an adverse impact on the environmental well-being of the developed areas.

4.2 **Earth Fill** (Boreholes 4, 5, 7, 9 and 11)

A layer of earth fill, consisting of brown and grey silty clay, with sand and gravel, occasional rootlets, topsoils inclusions wood and brick fragments, was contacted in some of the boreholes. The fill extends to a depth of 0.6 m to 2.4 m from the prevailing ground surface. It may be placed for site grading when the road and the existing houses were constructed in the past.

The water content of the earth fill samples was determined, ranging from 19% to 34%, indicating moist to wet conditions.

The obtained 'N' values range from 3 to 30, with a median of 6 blows per 30 cm of penetration, showing the fill is non-uniform in compaction and is unsuitable to support any structures sensitive to movement. For structural uses, the existing earth fill must be subexcavated, sorted free of topsoil and any deleterious material, aerated and properly compacted in layers.

<u>One must be aware that the samples retrieved from boreholes 10 cm in diameter may not be truly representative of the geotechnical quality of the fill, and do not indicate whether the topsoil beneath the earth fill was completely stripped. This should be further assessed by test pits.</u>

4.3 **Silty Clay Till** (All Boreholes)

The native silty clay till deposit is heterogeneous in structure and amorphous in places. Some of the clay till samples were found to contain sand seams and clay layers. Grain size analyses were performed on 3 representative samples and the results are plotted on Figure 13.

Intermittent hard resistance to augering was encountered, indicating the presence of cobbles and boulders in the stratum.

The silty clay till deposit was found to be weathered at the upper layer in some of the boreholes, up to a depth of 0.6 m to 0.8 m from grade. The obtained 'N' values range from 2 to 69 blows, with a median of 27 blows per 30 cm of penetration. This indicates that the consistency of the clay till is soft to hard, having the soft till in the weathered zone near the ground surface only. The consistency of the clay till is generally very stiff.

The Atterberg Limits of 4 representative samples and the water content values for all the clay till samples were determined. The results are plotted on the Borehole Logs and summarized below:

Liquid Limit	42, 38, 37, 36
Plastic Limit	21, 21, 19, 20
Natural Water Content	12% to 32% (median 17%)

The above results show that the clay till is cohesive, with medium plasticity. The natural water content values are mostly below the plastic limit, confirming the generally very stiff consistency of the clay as determined from the 'N' values. The higher water content samples were obtained near the ground surface which could have been disturbed by weathering.

Based on the above findings, the engineering properties of the clay till pertaining to the project design are given below:

- Highly frost susceptible and soil adfreezing potential.
- Low water erodibility.

- Very low in permeability, with an estimated coefficient of permeability of 10^{-7} cm/sec and runoff coefficients of:

Slope	
0% - 2%	0.15
2% - 6%	0.20
6% +	0.28

- A cohesive-frictional soil, its shear strength is derived from consistency and is augmented by internal friction, thus being inversely moisture dependent and, to a lesser extent, dependent on soil density.
- In excavation, the clay till will be stable in relatively steep slopes; however, prolonged exposure will allow infiltrating precipitation to saturate the fissures and sand layers in the till, causing localized sloughing.
- A poor pavement-supportive material, with an estimated California Bearing Ratio (CBR) value of 5%.
- Moderate corrosivity to buried metal, with an estimated electrical resistivity of 3500 ohm·cm.

4.4 Sandy Silt Till (Boreholes 2 and 12)

The sandy silt till was contacted below 16.5 m and 22.5 m at Boreholes 2 and 12, respectively. It is heterogeneous in structure with occasional sand seams, cobbles and boulders.

The obtained 'N' values range from 28 to 78, with a median of 39 blows per 30 cm of penetration. This indicates that the relative density of the silt till is compact to very dense, generally in the dense range.

The water content values for the silt till samples were determined; the results are plotted on the Borehole Logs, ranging from 12% to 15%.

Based on the above findings, the properties of the silt till pertaining to the project are given below:

- Moderately frost susceptibility, with high soil adfreezing potential.
- Low water erodibility.
- Relatively low in permeability, with an estimated coefficient of permeability of 10^{-6} cm/sec and runoff coefficients of:

Slope	
0% - 2%	0.15
2% - 6%	0.20
6% +	0.28

- A cohesive-frictional soil, its shear strength is derived from consistency and is augmented by internal friction, thus being inversely moisture dependent and, to a lesser extent, dependent on soil density.
- In excavation, the silt till will be stable in relatively steep slopes; however, prolonged exposure will allow infiltrating precipitation to saturate the sand layers causing localized sloughing.
- A poor pavement-supportive material, with an estimated CBR value of 8%.
- Moderate corrosivity to buried metal, with an estimated electrical resistivity of 4000 ohm·cm.

4.5 Compaction Characteristics of the Revealed Soils

The obtainable degree of compaction is primarily dependent on the soil moisture and, to a lesser extent, on the type of compactor used and the effort applied. As a general guide, the typical water content values of the revealed soils for Standard Proctor compaction are presented in Table 1.

Table 1 - Estimated Water Content for Compaction

Soil Type	Determined Natural Water Content (%)	Water Content (%) for Standard Proctor Compaction	
		100% (optimum)	Range for 95% or +
Earth Fill	19 to 34	19	15 to 22
Silty Clay Till	12 to 32 (median 17)	18	14 to 22
Sandy Silt Till	12 to 15 (median 13)	14	10 to 17

Based on the above findings, the on-site materials are mostly suitable for 95% or + Standard Proctor compaction. However, some of the earth fill and the weathered soils are relatively too wet, which will require mixing with dry soils or aeration during dry and warm weather before compaction.

Any use of the existing earth fill should be reviewed, sorted free of organics and deleterious material, aerated, before reuse for structural backfill.

The on-site material should be compacted using a heavy-weight, kneading-type roller. The lifts for compaction should be limited to 20 cm, or to a suitable thickness as assessed by test strips performed by the equipment which will be used at the time of construction.

When compacting the onsite material with cementation, the compactive energy will frequently bridge over the chunks in the soil and be transmitted laterally in the soil mantle. Therefore, the lifts of this soil must be limited to 20 cm or less (before compaction). It is difficult to monitor the lifts of backfill placed in deep trenches; therefore, it is preferable that the compaction of backfill at depths over 1.0 m below the pavement subgrade be carried out on the wet side of the optimum. This would allow a wider latitude of lift thickness.

If the compaction of the soils is carried out with the water content within the range for 95% Standard Proctor dry density but on the wet side of the optimum, the surface of the compacted soil mantle will roll under the dynamic compactive load. This is unsuitable for pavement construction since each component of the pavement structure is to be placed under dynamic conditions which will induce the rolling action of the subgrade surface and cause structural failure of the new pavement.

The foundation or bedding of the sewer and slab-on-grade will be placed on a subgrade which will not be subjected to impact loads. Therefore, the structurally compacted soil mantle with the water content on the wet side or dry side of the optimum will provide an adequate subgrade for the construction.

5.0 GROUNDWATER CONDITIONS

Groundwater seepage encountered during augering of boreholes was recorded on the field logs. Upon completion, the level of groundwater and cave-in were measured in the boreholes; the data are plotted on the Borehole Logs and listed in Table 2.

Table 2 - Groundwater Levels

Borehole/ Monitoring Well No.	Ground Elevation (m)	Borehole Depth (m)	Soil Colour Changes Brown to Grey		Measured Groundwater/ Cave-In* Level On Completion	
			Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
1	256.5	8.1	5.6	250.9	dry	-
2**	255.7	19.8/7.6	6.3	249.4	3.0	252.7
3	255.8	6.5	6.3	249.5	dry	-
4	258.9	6.5	5.4	253.5	dry	-
5	259.5	6.5	> 6.5	-	3.8	255.7
6	259.9	6.5	5.3	254.6	4.0	255.9
7	260.0	6.5	4.6	255.4	0.3	259.7
8	259.5	6.5	5.8	253.7	dry	-
9	260.0	6.5	4.3	255.7	1.5/4.0*	258.5/256.0*
10	257.8	6.5	3.4	254.4	dry	-
11	259.3	6.5	2.9	256.4	dry	-
12**	258.3	32.0/7.6	7.6	250.7	6.1	252.2

* Cave-in level upon completion of drilling

** With nested Monitoring Wells at shallow and deep level

Groundwater was recorded in six boreholes, at a depth of 0.3 m to 6.1 m from the ground surface, or El. 252.2 m to 259.7 m. The other six boreholes were dry throughout the investigation process.

The recorded water level in the open boreholes may represent perched groundwater in the earth fill or sand seams within the till stratum. It will fluctuate with the seasons.

In excavation, any groundwater yield is anticipated to be slow in rate and limited in quantity. It can be collected into a sump and remove by conventional pumping.

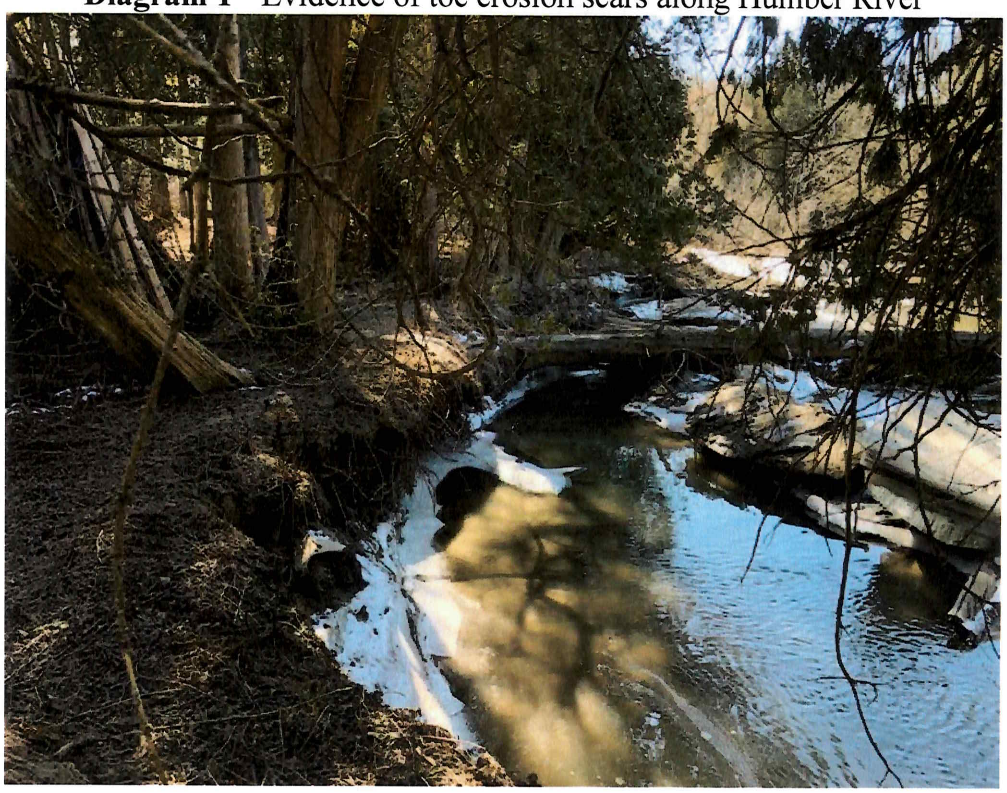
Palmer Environmental Consulting Group Inc., retained by Brookvalley Project Management Inc., will be monitoring the wells.

6.0 SLOPE STABILITY STUDY

A slope stability study was conducted for the valley land to the north and east of the subject property. It includes a visual inspection of the slope and stability analysis using force-moment-equilibrium criteria of the Bishop's method.

A visual inspection of the slope was performed on March 20, 2018. The inspection revealed that the sloping ground is generally covered with mature trees or vegetation, with isolated bare spots covered with fallen leaves and wood branches. Most of the trees appeared in the upright position. There were no signs of water seepage or surface erosion along the slope surface, except multiple gullies and surface erosion were present to the north and west of the property. Toe erosion scars were also evident along Humber River, as seen in Diagram 1.

Diagram 1 - Evidence of toe erosion scars along Humber River



Towards the east of the property, the bottom of slope is a park vicinity with no erosion hazard.

Three slope sections were selected for stability analysis, based on the field observation and the contours of slope inclination. The locations of these sections are shown on Drawing No. 1. Each slope section has a height of 20 to 30 m, with an inclination between 1 vertical (V) : 2 horizontal (H) and 1V : 3H.

The slope profiles are interpreted from the contours on the topographic plan obtained from First Base Solutions. The subsurface profiles of the slope sections were interpreted from the findings of the nearby Boreholes 2 and 12 (Enclosure Nos. 2 and 12). The groundwater level recorded in these boreholes, at a depth of 3.0 m and 6.1 m, was used as the phreatic groundwater along the slope, although it was discontinuous and was considered as the perched water in the boreholes. The soil strength parameters of each soil layer are presented in Table 3.

Table 3 - Soil Strength Parameters

Soil Type	**Unit Weight γ (kN/m^3)**	**Shear Strength Parameters**	
		c' (kPa)	**ϕ' (degree)**
Silty Clay Till, very stiff	22.0	5	28
Silty Clay Till, stiff	21.5	5	25
Sandy Silt Till, dense	22.0	5	30

The stability analysis was completed using "SLIDE", developed by Rocscience Inc. The results are illustrated on Drawing Nos. 4 to 6 and summarized in Table 4. The Technical Guide "River and Stream Systems: Erosion Hazard Limit" of Ministry of Natural Resources and Forestry (MNRF Guideline) was used for the management of erosion hazards along the bank.

Table 4 - Factors of Safety of Slope Sections

Slope Section	Minimum Factor of Safety of Existing Slope
A-A	1.393
B-B	1.496
C-C	1.509

The minimum Factors of Safety (FOS) in Table 4 meets the Design Minimum Factor of Safety (Table 4.3 in the guideline) of 1.3 to 1.5 for Active Landuse (habitable or occupied structures near slope; residential, commercial and industrial buildings, retaining walls, storage warehousing of non-hazardous substances).

Due to the low permeability of subsoil, the water penetration into the subsoil during regional flooding is local. Any instability due to saturation of subsoil during rapid drawdown is considered insignificant.

To establish the long-term stable slope line (LTSSL), a 5 m toe erosion allowance is recommended along the gullies and river bank where there are signs of erosion, according to Table 3 of MNRF Guideline. The LTSSL is shown on Drawing No. 7.

Any new development will have to set back a minimum of 6 m from the LTSSL. The Erosion Hazard Limit, including the 6 m setback from the LTSSL is also shown on Drawing No. 7.

In order to maintain the safety of slope from erosion, the following geotechnical constraints should be stipulated for any development next to the slope:

1. The prevailing vegetative cover must be maintained, since its extraction would deprive the slope of the rooting system that acts as reinforcement against soil erosion by weathering. If for any reason the vegetation cover is

stripped, it must be reinstated to its original, or better than its original, protective condition.

2. The leafy topsoil cover on the slope face should not be disturbed, since this provides insulation and screen against frost wedging and rainwash erosion.
3. Grading of the land adjacent to the slope must be such that concentrated runoff is not allowed to drain onto the slope face. Landscaping features, which may cause runoff to pond at the top of the slope, such as infiltration trenches, as well as soil saturation at the tableland must not be permitted.
4. Where development is carried out near the top of the slope, there are other factors to be considered related to possible human environmental abuse. These include soil saturation from frequent watering to maintain of landscaping features, stripping of topsoil or vegetation, and dumping of loose fill and material storage close to the top of slope; none of these should be permitted.

7.0 DISCUSSION AND RECOMMENDATIONS

The investigation revealed that beneath a veneer of topsoil and a layer of earth fill in places, the site is underlain by soft to hard, generally very stiff silty clay till stratum and compact to very dense, generally dense sandy silt till deposit at the deeper level. Groundwater was recorded in six boreholes, at a depth of 0.3 m to 6.1 m from the ground surface. It represents a perched groundwater in the earth fill or sand seams within the till stratum.

The existing slope inclination has the minimum Factors of Safety (FOS) above 1.3 to 1.5, meeting the Design Minimum Factor of Safety (Table 4.3 in the MNRF guideline) for Active Landuse. A 5 m Toe Erosion Allowance is recommended along the gullies and river bank where there are signs of erosion. Any new development will have to set back a minimum of 6 m for the Erosion Access Allowance. The Erosion Hazard Limit, including the 5 m setback for the Toe Erosion Allowance and 6 m setback for the Erosion Access Allowance is shown on Drawing No. 7.

The geotechnical findings which warrant special consideration are presented below:

1. The existing topsoil must be removed for the development. The revealed thickness of topsoil at the borehole locations is between 16 cm and 46 cm. Thicker topsoil layer can occur, especially in depressed areas.
2. After demolition of existing area, the foundation and debris should be removed and disposal off-site. The cavity should be backfilled with an engineered fill for development.
3. The topsoil is void of engineering value and should be stripped and removed for the project construction. It must not be buried within the building envelope or deeper than 1.2 m below the exterior finished grade of the

development.

4. Engineered fill and sound natural soils are suitable for normal spread and strip footing construction for the proposed development. The footings must be designed in accordance with the recommended bearing pressures in Section 7.2 and the footing subgrade must be inspected by a geotechnical engineer to ensure that its condition is compatible with the design of the foundations.
5. For slab-on-grade construction, the slab should be constructed on a granular base, 20 cm thick, consisting of 20-mm Crusher-Run Limestone, or equivalent, compacted to its maximum Standard Proctor dry density.
6. A Class 'B' bedding, consisting of compacted 20-mm Crusher-Run Limestone, is recommended for the construction of the underground services. Where water-bearing soil is present, a Class 'A' concrete bedding should be used.
7. Excavation should be carried out in accordance with Ontario Regulation 213/91.

The recommendations appropriate for the project described in Section 2.0 are presented herein. One must be aware that the subsurface conditions may vary between boreholes. Should this become apparent during construction, a geotechnical engineer must be consulted to determine whether the following recommendations require revision.

7.1 **Site Preparation**

The property is an open field, with existing dwellings on the southeast and northwest of the road intersection. For site preparation of development, the existing topsoil must be removed and the site can be regraded with an engineered fill for normal footing, sewer and pavement construction. After demolition of the existing dwellings, the foundation cavity should be subexcavated to undisturbed soil stratum, followed by backfilling with engineered fill, compacted in layers. The requirements for engineered fill construction are discussed in Section 7.3.

The existing earth fill should also be sub-excavated. Test pits may be excavated to evaluate the depth and the extent of earth fill for removal. The fill should be sorted free of topsoil, organic inclusion, debris, wood and other deleterious material, prior to reuse for engineered fill or structural backfill.

7.2 Foundations

The development will consist of residential houses with a normal depth basement. Based on the borehole findings, the houses can be built on conventional footings founded on sound natural silty clay till or engineered fill.

The recommended soil bearing pressures of 150 kPa (SLS) and 250 kPa (ULS) should be used for the design of normal spread and strip footings, founded on sound native soils or engineered fill. The total and differential settlements of the footings are estimated to be 25 and 15 mm, respectively.

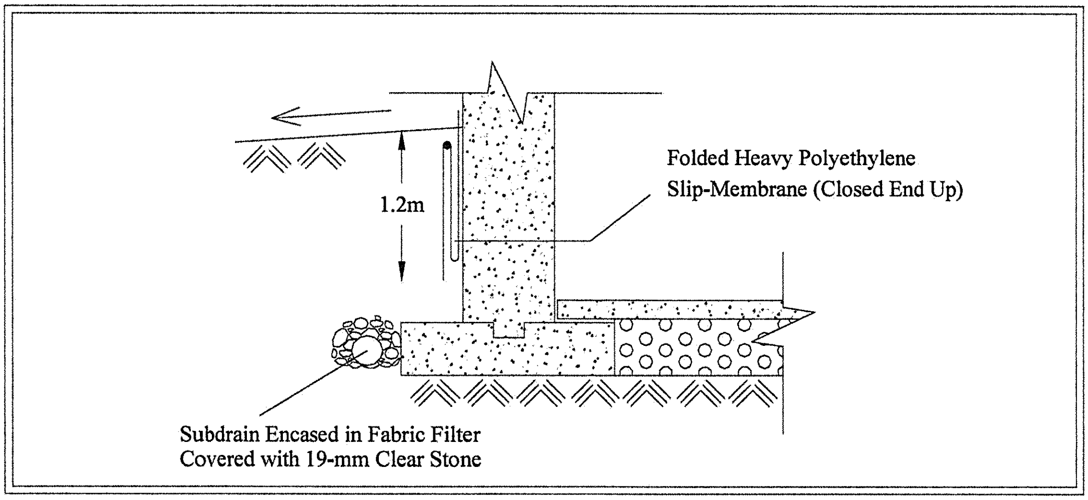
Higher design bearing pressures may be available for individual buildings at designated area. The building foundations can be reviewed by the geotechnical engineer after the site grading plan and the details of the proposed development is finalized.

The footing subgrade must be confirmed by inspection performed by a geotechnical engineer or a geotechnical technician under the supervision of a geotechnical engineer, to ensure that the revealed conditions are compatible with the foundation requirements.

Footings exposed to weathering, or in unheated areas, should have at least 1.2 m of earth cover for protection against frost action.

Some of the in situ soils have high soil-adfreezing potential. In order to alleviate the risk of frost damage, the foundation walls must be constructed of concrete and either the backfill must consist of non-frost-susceptible granular material, or the foundation walls must be shielded with a polyethylene slip-membrane between the concrete wall and the backfill. The recommended measures are schematically illustrated in Diagram 2.

Diagram 2 - Frost Protection Measures (Foundations)



Perimeter subdrains and dampproofing of the foundation walls will be required. All subdrains must be encased in a fabric filter to protect them against blockage by silting.

The building foundation must meet the requirements specified in the latest Ontario Building Code. As a guide, the structures founded on the sound native soils or engineered fill can be designed to resist an earthquake force using Site Classification 'D' (stiff soil).

7.3 Engineered Fill

Where earth fill is required to raise the site, it is generally more economical to place engineered fill for normal footing, underground service pipes and road construction. The engineering requirements for a certifiable fill for road construction, municipal services, and footings designed with a Maximum Allowable Soil Pressure (SLS) of 150 kPa and a Factored Ultimate Soil Bearing Pressure (ULS) of 250 kPa are presented below:

1. All the topsoil must be removed, and the subgrade must be inspected and proof-rolled prior to any fill placement. The weathered soils and earth fill must be subexcavated, inspected, sorted free of organics and topsoil, aerated and properly compacted in layers.
2. The in situ organic-free soils can be used, and they must be uniformly compacted in 20 cm thick lifts to 98% or + of their maximum Standard Proctor dry density, up to the proposed lot grade and/or road subgrade. The soil moisture must be properly controlled near the optimum.
3. If the foundations are to be built soon after the fill placement, the densification process for the engineered fill must be increased to 100% of the maximum Standard Proctor compaction.
4. If imported fill is to be used, it should be inorganic soils, free of deleterious material with environmental issue (contamination). Any potential imported earth fill from off site must be reviewed for geotechnical and environmental quality by the appropriate personnel as authorized by the developer or agency, before it is hauled to the site.
5. If the engineered fill is to be left over the winter months, adequate earth cover, or equivalent, must be provided for protection against frost action.
6. The engineered fill must extend over the entire graded area; the engineered fill envelope and the finished elevations must be clearly and accurately defined in

the field, and they must be precisely documented by qualified surveyors.

7. Foundations partially on engineered fill must be reinforced by two 15-mm steel reinforcing bars, depending on the thickness of the fill, in the footings and upper section of the foundation walls, or be designed by a structural engineer to properly distribute the stress induced by the abrupt differential settlement (estimated to be 15± mm) between the natural soils and engineered fill.
8. The engineered fill must not be placed during the period from late November to early April, when freezing ambient temperatures occur either persistently or intermittently. This is to ensure that the fill is free of frozen soils, ice and snow.
9. The fill operation must be inspected on a full-time basis by a technician under the direction of a geotechnical engineer.
10. Where the fill is to be placed on a bank steeper than 1 vertical:3 horizontal, the face of the bank must be flattened to 3 + so that it is suitable for safe operation of the compactor and the required compaction can be obtained.
11. Where the ground is wet due to subsurface water seepage, an appropriate subdrain scheme must be implemented prior to the fill placement, particularly if it is to be carried out on sloping ground.
12. The fill operation must be fully supervised and monitored by a technician under the direction of a geotechnical engineer.
13. The footings and underground services subgrade must be inspected by the geotechnical consulting firm that inspected the engineered fill placement. This is to ensure that the foundations are placed within the engineered fill envelope, and the integrity of the fill has not been compromised by interim construction, environmental degradation and/or disturbance by the footing excavation.
14. Any excavation carried out in certified engineered fill must be reported to the geotechnical consultant who inspected the fill placement in order to document

the locations of excavation and/or to inspect reinstatement of the excavated areas to engineered fill status. If construction on the engineered fill does not commence within a period of 2 years from the date of certification, the condition of the engineered fill must be assessed for re-certification.

15. Despite stringent control in the placement of the engineered fill, variations in soil type and density may occur in the engineered fill. Therefore, the foundations must be properly reinforced and designed by structural engineer for the project. The total and differential settlements of 25 mm and 15 mm, respectively, should be considered in the design of the foundations founded on engineered fill. In sewer construction, the engineered fill is considered to have the same structural proficiency as a natural inorganic soil.

7.4 **Underground Services**

The subgrade for the underground services should consist of natural soils or engineered fill. In areas where the subgrade consists of earth fill and/or weathered soil or loose soils, these soils should be subexcavated and replaced with properly compacted inorganic soil and/or bedding material compacted to at least 95% or + of their Standard Proctor compaction.

Where the sewers are to be constructed using the open-cut method, the construction must be carried out in accordance with Ontario Regulation 213/91. In areas where a vertical cut is necessary, the use of a trench box is appropriate.

A Class 'B' bedding is recommended for construction of the underground services. The bedding material should consist of compacted 20-mm Crusher-Run Limestone, or equivalent, as approved by a geotechnical engineer. Where water bearing soil is present, a Class 'A' bearing should be used. This can be determined at the time of construction.

In order to prevent pipe floatation when the sewer trench is deluged with water, a soil cover with a thickness equal to the diameter of the pipe should be in place at all times after completion of the pipe installation.

Openings to subdrains and catch basins should be shielded with a fabric filter to prevent blockage by silting.

The subgrade of the underground services will generally consist of silty clay till of moderate corrosivity. The underground services should be protected against soil corrosion. For estimation of anode weight requirements, the estimated electrical resistivity of 3500 ohm·cm can be used. This, however, should be confirmed by testing the soil along the water main alignment at the time of sewer construction.

7.5 Backfilling in Trenches and Excavated Areas

The backfill in service trenches should be compacted to at least 95% of its maximum Standard Proctor dry density and increased to 98% below the floor-slab.

In the zone within 1.0 m below the road subgrade, the material should be compacted with the water content 2% to 3% drier than the optimum; and the compaction should be increased to 98% of the respective maximum Standard Proctor dry density to provide the required stiffness for pavement construction.

Most of the in situ inorganic soils are generally suitable for use as trench backfill; however, where the soil is too wet for a 95% or + Standard Proctor compaction, it can be aerated by spreading it thinly on the ground for drying prior to structural compaction. In cases where the material is too dry to compact, it may require the addition of water or mixing with a wet material.

In normal construction practice, the problem areas of settlement largely occur adjacent to foundation walls, columns, manholes, catch basins and services crossings. In areas which are inaccessible to a heavy compactor, sand backfill should be used. Unless compaction of the backfill is carefully performed, settlement will occur. Often, the interface of the native soils and sand backfill will have to be flooded for a period of several days.

Narrow trenches for services crossings should be cut at 1V:2H, so that the backfill in the trenches can be effectively compacted. Otherwise, soil arching in the trenches will prevent the achievement of proper compaction. The lift of each backfill layer should either be limited to a thickness of 20 cm, or the thickness should be determined by test strips.

One must be aware of possible consequences during trench backfilling and exercise caution as described below:

- When construction is carried out in freezing winter weather, allowance should be made for these following conditions. Despite stringent backfill monitoring, frozen soil layers may inadvertently be mixed with the structural trench backfill. Should the in situ soil have a water content on the dry side of the optimum, it would be impossible to wet the soil due to the freezing condition, rendering difficulties in obtaining uniform and proper compaction. Furthermore, the freezing condition will prevent flooding of the backfill when it is required, such as when the trench box is removed. The above will invariably cause backfill settlement that may become evident within 1 to several years, depending on the depth of the trench which has been backfilled.
- In areas where the underground services construction is carried out during winter months, prolonged exposure of the trench walls will result in frost heave within the soil mantle of the walls. This may result in some settlement

as the frost recedes, and repair costs will be incurred prior to final surfacing of the new pavement.

- To backfill a deep trench, one must be aware that future settlement is to be expected, unless the side of the cut is flattened to at least 1V:1.5+H, and the lifts of the fill and its moisture content are stringently controlled; i.e., lifts should be no more than 20 cm (or less if the backfilling conditions dictate) and uniformly compacted to achieve at least 95% of the maximum Standard Proctor dry density, with the moisture content on the wet side of the optimum.
- It is often difficult to achieve uniform compaction of the backfill in the lower vertical section of a trench which is an open cut or is stabilized by a trench box, particularly in the sector close to the trench walls or the sides of the box. These sectors must be backfilled with sand. In a trench stabilized by a trench box, the void left after the removal of the box will be filled by the backfill. It is necessary to backfill this sector with sand, and the compacted backfill must be flooded for 1 day, prior to the placement of the backfill above this sector, i.e., in the upper sloped trench section. This measure is necessary in order to prevent consolidation of inadvertent voids and loose backfill which will compromise the compaction of the backfill in the upper section. In areas where groundwater movement is expected in the sand fill mantle, anti-seepage collars should be provided.

7.6 Garages, Driveways and Landscaping

Due to moderately high frost susceptibility of the underlying soil, heaving of the pavement is expected to occur during the cold weather. The driveways at the entrances to the garages must be backfilled with non-frost-susceptible granular material, with a frost taper at a slope of 1V:1H.

The slab-on-grade in open areas should be designed to tolerate frost heave, and the grading around the slab-on-grade must be such that it directs runoff away from the surface.

Interlocking stone pavement and slab-on-grade to be constructed in areas susceptible to ground movement must be constructed on a free-draining granular base at least 1.0 m thick, with proper drainage, which will prevent water from ponding in the granular base.

7.7 Pavement Design

In preparation of the pavement subgrade, topsoil and earth fill must be removed and the entire area should be proofrolled. Any soft spots should be subexcavated, and replaced by properly compacted inorganic earth fill. New fill should consist of organic free material, compacted to 95% or + of its maximum Standard Proctor dry density. In the zone within 1.0 m below the pavement subgrade, the backfill should be compacted to 98% or + of its maximum Standard Proctor dry density, with the water content 2% to 3% drier than the optimum. The pavement design for local residential roadway and collectors is presented in Table 5.

Table 5 - Pavement Design

Course	Thickness (mm)	OPS Specifications
Asphalt Surface	40	HL-3
Asphalt Binder	60	HL-8
Granular Base	150	OPSS Granular 'A'
Granular Sub-Base	350	OPSS Granular 'B'

All the granular bases should be compacted to their maximum Standard Proctor dry density.

The pavement subgrade will suffer a strength regression if water is allowed to infiltrate prior to paving. The following measures should therefore be incorporated into the construction and pavement design:

- If the pavement construction does not immediately follow the trench backfilling, the subgrade should be properly crowned and smooth-rolled to allow interim precipitation to be properly drained.
- Lot areas adjacent to the roads should be properly graded to prevent the ponding of large amounts of water during the interim construction period.
- If the roads are to be constructed during the wet seasons and extremely soft subgrade occurs, the granular sub-base may require thickening. This can be further assessed during construction.
- Fabric filter-encased curb subdrains are required to meet the Town requirements. These subdrains should be collected to catch basins or positive outlets where water can be removed by gravity.

7.8 Soil Parameters

The recommended soil parameters for the project design are given in Table 6.

Table 6 - Soil Parameters

Unit Weight and Bulk Factor	**Unit Weight (kN/m^3)**	**Estimated Bulk Factor**	
	Bulk	**Loose**	**Compacted**
Earth Fill	21.0	1.25	1.00
Silty Clay Till / Sandy Silt Till	22.0	1.33	1.05
Lateral Earth Pressure Coefficients	**Active K_a**	**At Rest K_o**	**Passive K_p**
Compacted Earth Fill	0.43	0.60	2.30
Silty Clay Till / Sandy Silt Till	0.36	0.53	2.70

Table 6 - Soil Parameters (cont'd)

Coefficients of Friction	
Between Concrete and Granular Base	0.50
Between Concrete and Sound Natural Soils	0.40

7.9 Excavation

Excavation should be carried out in accordance with Ontario Regulation 213/91. For excavation purposes, the types of soils are classified in Table 7.

Table 7 - Classification of Soils for Excavation

Material	Type
Silty Clay Till / Sandy Silt Till	2
Earth Fill	3

Excavation into the till containing cobbles and boulders will require extra effort and the use of heavy-duty equipment.

In excavation, any groundwater yield is anticipated to be slow in rate and limited in quantity. It can be collected into a sump and remove by conventional pumping.

Prospective contractors must be asked to assess the in situ subsurface conditions for soil cuts by digging test pits to at least 0.5 m below the sewer subgrade. These test pits should be allowed to remain open for a period of at least 4 hours to assess the trenching conditions.

8.0 LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the account of Brookvalley Project Management Inc., for review by the designated consultants, financial institutions, and government agencies. Use of this report is subject to the conditions and limitations of the contractual agreement. The material in the report reflects the judgment of Adrian Lo, B.Sc. and Bennett Sun, P.Eng., in light of the information available to it at the time of preparation. Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, are the responsibility of such Third Parties. Soil Engineers Ltd. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

SOIL ENGINEERS LTD.

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CHUN C. B. SUN
July 6, 2018
PROVINCE OF ONTARIO

LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs and figures, and in the text of the report, are as follows:

SAMPLE TYPES

AS	Auger sample
CS	Chunk sample
DO	Drive open (split spoon)
DS	Denison type sample
FS	Foil sample
RC	Rock core (with size and percentage recovery)
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

PENETRATION RESISTANCE

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows for each foot of penetration of a 2-inch diameter, 90° point cone driven by a 140-pound hammer falling 30 inches.

Plotted as '—•—'

Standard Penetration Resistance or 'N' Value:

The number of blows of a 140-pound hammer falling 30 inches required to advance a 2-inch O.D. drive open sampler one foot into undisturbed soil.

Plotted as 'O'

WH	Sampler advanced by static weight
PH	Sampler advanced by hydraulic pressure
PM	Sampler advanced by manual pressure
NP	No penetration

SOIL DESCRIPTION

Cohesionless Soils:

'N' (blows/ft)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

Cohesive Soils:

Undrained Shear Strength (ksf)	'N' (blows/ft)	Consistency
less than 0.25	0 to 2	very soft
0.25 to 0.50	2 to 4	soft
0.50 to 1.0	4 to 8	firm
1.0 to 2.0	8 to 16	stiff
2.0 to 4.0	16 to 32	very stiff
over 4.0	over 32	hard

Method of Determination of Undrained Shear Strength of Cohesive Soils:

x 0.0 Field vane test in borehole; the number denotes the sensitivity to remoulding

△ Laboratory vane test

□ Compression test in laboratory

For a saturated cohesive soil, the undrained shear strength is taken as one half of the undrained compressive strength

METRIC CONVERSION FACTORS

1 ft = 0.3048 metres	1 inch = 25.4 mm
1lb = 0.454 kg	1ksf = 47.88 kPa

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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	Sample Number	Type	N-Value	Moisture Content (%)
256.5	Ground Surface				
256.3 / 0.2	**160 mm TOPSOIL**				
	Brown, hard **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders (weathered)	1	DO	4	50
		2	DO	28	17
		3	DO	41	15
		4	DO	33	16
		5	DO	32	16
		6	DO	41	18
	(brown / grey)	7	DO	23	19
		8	DO	22	18
248.4 / 8.1	**END OF BOREHOLE**				

Depth Scale (m): 0–11

● 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: Dry on completion

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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)	Moisture Content (%)	WATER LEVEL
255.7	Ground Surface						
255.5 / 0.2	**160 mm TOPSOIL**				0		
	Brown, stiff to hard **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders; weathered	1	DO	6		36	
		2	DO	18	1	18	
		3	DO	19	2	20	
		4	DO	34		18	
	sandy	5	DO	46	3	12	∇
		6	DO	31	4, 5	18	
	brown / grey	7	DO	32	6	20	
		8	DO	27	7, 8	17	
		9	DO	15	9	19	
		10	DO	9	10, 11	28	

Legend: ● 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

W.L @ Ele. 252.7 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

Legend: ● 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

El. (m) / Depth (m)	SOIL DESCRIPTION	Samples Number	Type	N-Value	Depth Scale (m)	Moisture Content (%)
	SILTY CLAY TILL (Cont'd)				11	
					12	
		11	DO	21		18
					13	
		12	DO	22	14	18
					15	
		13	DO	21		16
					16	
239.3 / 16.4	Grey, compact to dense **SANDY SILT TILL** some clay and sand trace of gravel occ. sand seams, cobbles and boulders					
		14	DO	28	17	12
					18	
		15	DO	39		13
					19	
235.9 / 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.**				20	
					21	
					22	

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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

Legend: ● 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

El. (m) / Depth (m)	SOIL DESCRIPTION	Sample Number	Type	N-Value	Moisture Content (%)
255.7	Ground Surface				
0.0	Brown, firm to hard **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders	1	DO	6	36
		2	DO	18	18
		3	DO	19	20
		4	DO	34	18
		5	DO	46	12
		6	DO	31	18
		7	DO	32	20
248.1 / 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.**				

Depth Scale (m): 0 1 2 3 4 5 6 7 8 9 10 11

W.L @ Ele. 252.7 m upon completion.

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JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed Residential Development

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

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

DRILLING DATE: January 26, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	Sample Number	Type	N-Value	Depth Scale (m)	Moisture Content (%)	WATER LEVEL
255.8	Ground Surface						
255.5 / 0.0 / 0.3	**260 mm TOPSOIL**				0		Dry on completion
	Brown, very stiff to hard **SILTY CLAY TILL** trace of gravel occc. sand seams, cobbles and boulders (weathered)	1	DO	5		31	
		2	DO	28	1	17	
		3	DO	35		16	
		4	DO	38	2	18	
		5	DO	29	3	18	
		6	DO	37	4–5	15	
	brown / grey	7	DO	24	6	18	
249.3 / 6.5	**END OF BOREHOLE**						

Legend: ● 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

Depth Scale (m): 0 1 2 3 4 5 6 7 8 9 10 11

Soil Engineers Ltd.

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)	Moisture Content (%)	WATER LEVEL
258.9	Ground Surface						
258.7 / 0.2	**210 mm TOPSOIL** **EARTH FILL** brown and grey silty clay, pockets of sand and gravel, some topsoil and rootlets	1	DO	30	0	19	Dry on completion
		2	DO	8	1	19	
257.3 / 1.6	Brown, very stiff to hard **SILTY CLAY TILL** trace of gravel, occ. sand seams, cobbles and boulders	3	DO	18		18	
		4	DO	35	2	18	
		5	DO	39	3	15	
		6	DO	61	4	16	
	brown / grey				5		
		7	DO	26	6	14	
252.4 / 6.5	**END OF BOREHOLE**				7 – 11		

Legend: ● 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

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JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 5

FIGURE NO.: 5

PROJECT DESCRIPTION: Proposed Residential Development

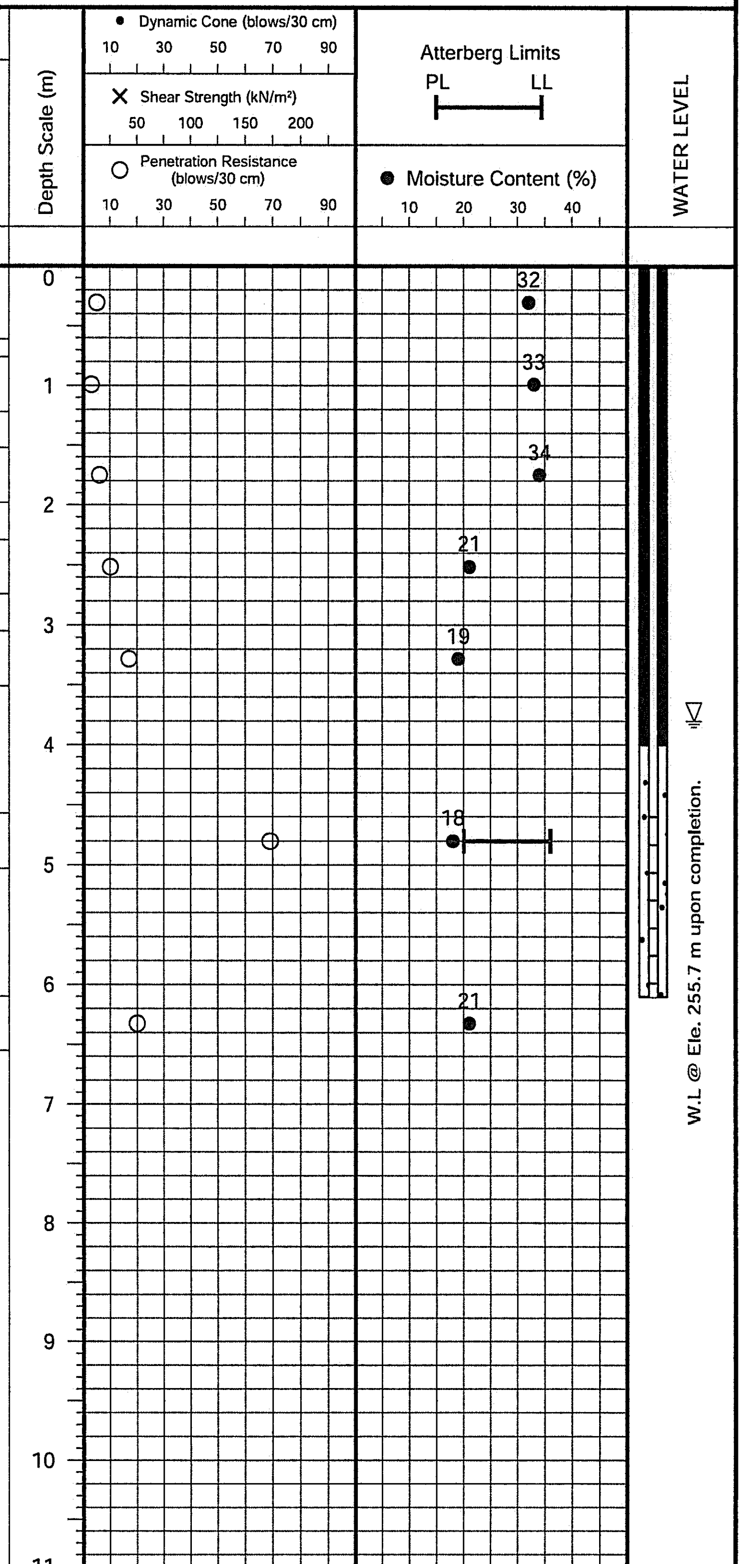
METHOD OF BORING: Flight-Auger (Solid-Stem)

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
259.5	Ground Surface			
0.0	**440 mm TOPSOIL**	1	DO	5
259.1 / 0.4	**EARTH FILL** brown and grey silty clay, pockets of topsoil, some rootlets, occ. wood pieces	2	DO	3
		3	DO	6
257.1 / 2.4	Grey and brown, stiff to hard **SILTY CLAY TILL** trace of gravel, occ. sand seams, cobbles and boulders	4	DO	10
		5	DO	17
		6	DO	69
		7	DO	20
253.0 / 6.5	**END OF BOREHOLE**			

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.



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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	Sample Number	Type	N-Value	Depth Scale (m)	Moisture Content (%)
259.9	Ground Surface					
259.7 / 0.2	**230 mm TOPSOIL**				0	
	Very stiff to hard **SILTY CLAY TILL**, trace of gravel, occc. sand seams, cobbles and boulders — weathered	1	DO	6		32
		2	DO	19	1	23
		3	DO	32		17
		4	DO	44	2	15
		5	DO	43	3	14
		6	DO	28	4–5	14
	brown / grey					
253.3 / 6.5		7	DO	18	6	18

Legend: ● Dynamic Cone (blows/30 cm) 10 30 50 70 90; X 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

Depth Scale (m): 0 1 2 3 4 5 6 7 8 9 10 11

W.L @ Ele. 255.9 m upon completion.

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.

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JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 7

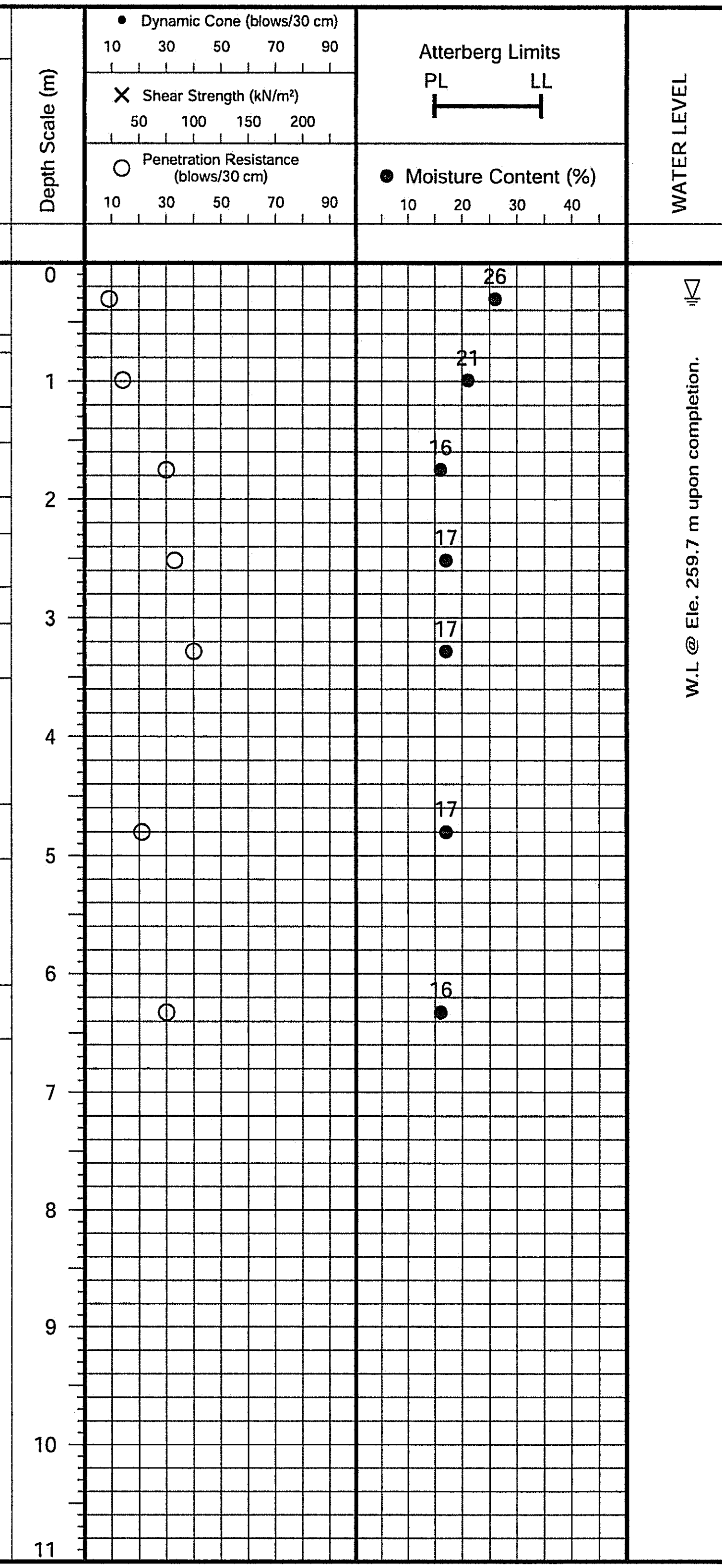
PROJECT DESCRIPTION: Proposed Residential Development

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	Sample Number	Type	N-Value
260.0	Ground Surface			
0.0	**280 mm TOPSOIL**			
259.7 / 0.3	**EARTH FILL** brown silty clay mixed with topsoil some brick fragments	1	DO	9
259.1 / 0.9	Stiff to hard **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders	2	DO	14
		3	DO	30
		4	DO	33
		5	DO	40
	brown / grey	6	DO	21
		7	DO	30
253.5 / 6.5	**END OF BOREHOLE**			



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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	Number	Type	N-Value	Moisture Content (%)
259.5	Ground Surface				
259.3 / 0.2	**210 mm TOPSOIL**				
	Very stiff to hard **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders	1	DO	5	25
	weathered	2	DO	23	17
		3	DO	25	18
		4	DO	44	15
		5	DO	23	16
		6	DO	23	16
	brown / grey	7	DO	24	16
253.0 / 6.5	**END OF BOREHOLE**				

Chart headings: 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; Depth Scale (m) 0–11

WATER LEVEL: Dry on completion

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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

Legend: ● Dynamic Cone (blows/30 cm) 10 30 50 70 90; X Shear Strength (kN/m²) 50 100 150 200; O Penetration Resistance (blows/30 cm) 10 30 50 70 90; Atterberg Limits PL —— LL; ● Moisture Content (%) 10 20 30 40

El. (m) / Depth (m)	SOIL DESCRIPTION	Sample Number	Type	N-Value	Moisture Content (%)
260.0	Ground Surface				
0.0 / 259.7 / 0.3	**280 mm TOPSOIL**	1	DO	3	38
259.2 / 0.8	**EARTH FILL** brown silty clay, pockets of topsoil, occ. rootlets	2	DO	7	20
	Very stiff to hard **SILTY CLAY TILL** trace of gravel, occ. sand seams, cobbles and boulders	3	DO	7	25
		4	DO	27	19
		5	DO	33	16
	brown / grey	6	DO	25	16
253.5 / 6.5		7	DO	25	19
	END OF BOREHOLE				

WATER LEVEL:
W.L @ Ele. 258.5 m upon completion.
Cave-In @ Ele. 256 m upon completion.

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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	Sample Number	Type	N-Value	Depth Scale (m)	Penetration Resistance (blows/30 cm)	Moisture Content (%)	WATER LEVEL
257.8	Ground Surface							
0.0 / 257.5 / 0.3	280 mm TOPSOIL				0			Dry on completion
	Very stiff to hard SILTY CLAY TILL trace of gravel occ. sand seams, cobbles and boulders (weathered)	1	DO	2			26	
		2	DO	28	1		17	
		3	DO	31	2		16	
		4	DO	30			17	
	brown / grey	5	DO	33	3		16	
		6	DO	26	4–5		17	
251.3 / 6.5		7	DO	22	6		15	
	END OF BOREHOLE				7–11			

Legend: ● 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

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	Sample Number	Type	N-Value	Depth Scale (m)	Penetration Resistance (blows/30 cm)	Moisture Content (%)	WATER LEVEL
259.3	Ground Surface							
259.1 / 0.2	**210 mm TOPSOIL**				0			Dry on completion
258.7 / 0.6	**EARTH FILL** dark brown silty clay mixed with topsoil some gravel	1	DO	5		5	32	
	Very stiff to hard **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders	2	DO	23	1	23	17	
		3	DO	28	2	28	16	
		4	DO	45		45	15	
	brown / grey				3			
		5	DO	25		25	15	
					4			
		6	DO	23	5	23	17	
					6			
252.8 / 6.5		7	DO	31		31	13	
	END OF BOREHOLE				7–11			

Legend: ● 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

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	Sample Number	Type	N-Value	Depth Scale (m)	Penetration Resistance (blows/30 cm)	Moisture Content (%)	Atterberg Limits (PL–LL)	WATER LEVEL
258.3	Ground Surface								
0.0	**460 mm TOPSOIL**	1	DO	12	0		30		
257.8 / 0.5	Stiff to hard (weathered) **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders	2	DO	10	1		16		
		3	DO	38			16		
		4	DO	32	2		16		
		5	DO	39	3		16		
		6	DO	31	4		16		
		7	DO	25	6		17		W.L @ Ele. 252.2 m upon completion.
	brown / grey	8	DO	28	7		13		
		9	DO	24	9		16		
		10	DO	18	11		17		

Legend: • 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; ● Moisture Content (%) 10 20 30 40; Atterberg Limits PL LL

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)

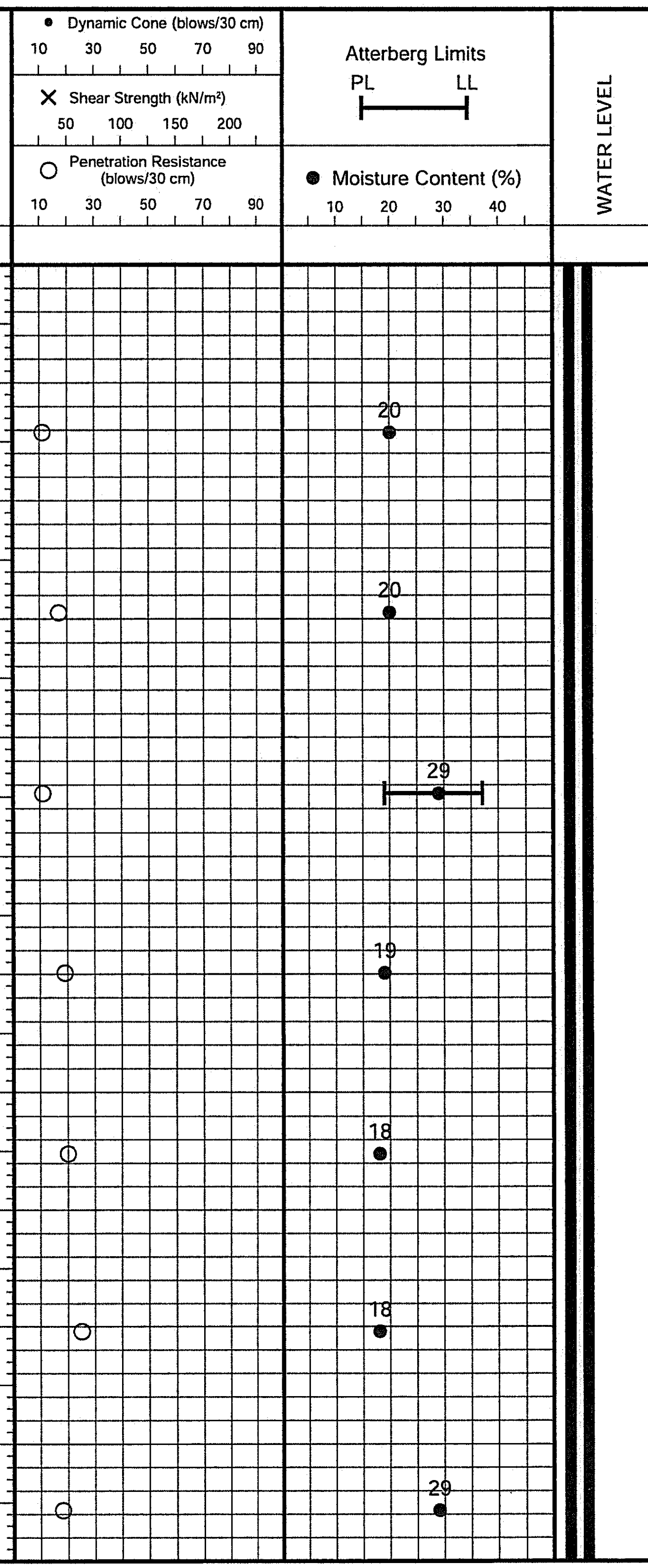
PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 24, 2018

SILTY CLAY TILL (Cont'd)

silty clay layer (at approx. 15.5 m)

SAMPLES Number	Type	N-Value	Depth Scale (m)	Moisture Content (%)
11	DO	11	12.4	20
12	DO	17	13.9	20
13	DO	11	15.5	29
14	DO	19	17.0	19
15	DO	20	18.5	18
16	DO	25	20.0	18
17	DO	18	21.5	29



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	Number	Type	N-Value	Depth Scale (m)	Penetration Resistance (blows/30 cm)	Moisture Content (%)	WATER LEVEL
235.8 / 22.5	Grey, compact to very dense **SANDY SILT TILL** some clay and gravel occ. sand seams, cobbles and boulders	18	DO	39	23	39	12	
		19	DO	37	24–25	37	15	
		20	DO	29	26	29	13	
		21	DO	43	27–28	43	12	
		22	DO	78	29	78	14	
		23	DO	52	30–31	52	12	
226.3 / 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.**				32			

Legend: ● Dynamic Cone (blows/30 cm) 10 30 50 70 90; X 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

Depth scale: 22 23 24 25 26 27 28 29 30 31 32 33

Soil Engineers Ltd.

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	Type	N-Value	Moisture Content (%)
258.3	Ground Surface				
0.0	Brown, stiff to hard **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders	1	DO	12	30
		2	DO	10	16
		3	DO	38	16
		4	DO	32	16
		5	DO	39	16
		6	DO	31	16
		7	DO	25	17
250.7 / 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.**				

Legend: ● 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

Depth Scale (m): 0 1 2 3 4 5 6 7 8 9 10 11

WATER LEVEL: W.L @ Ele. 252.2 m upon completion.

Soil Engineers Ltd.

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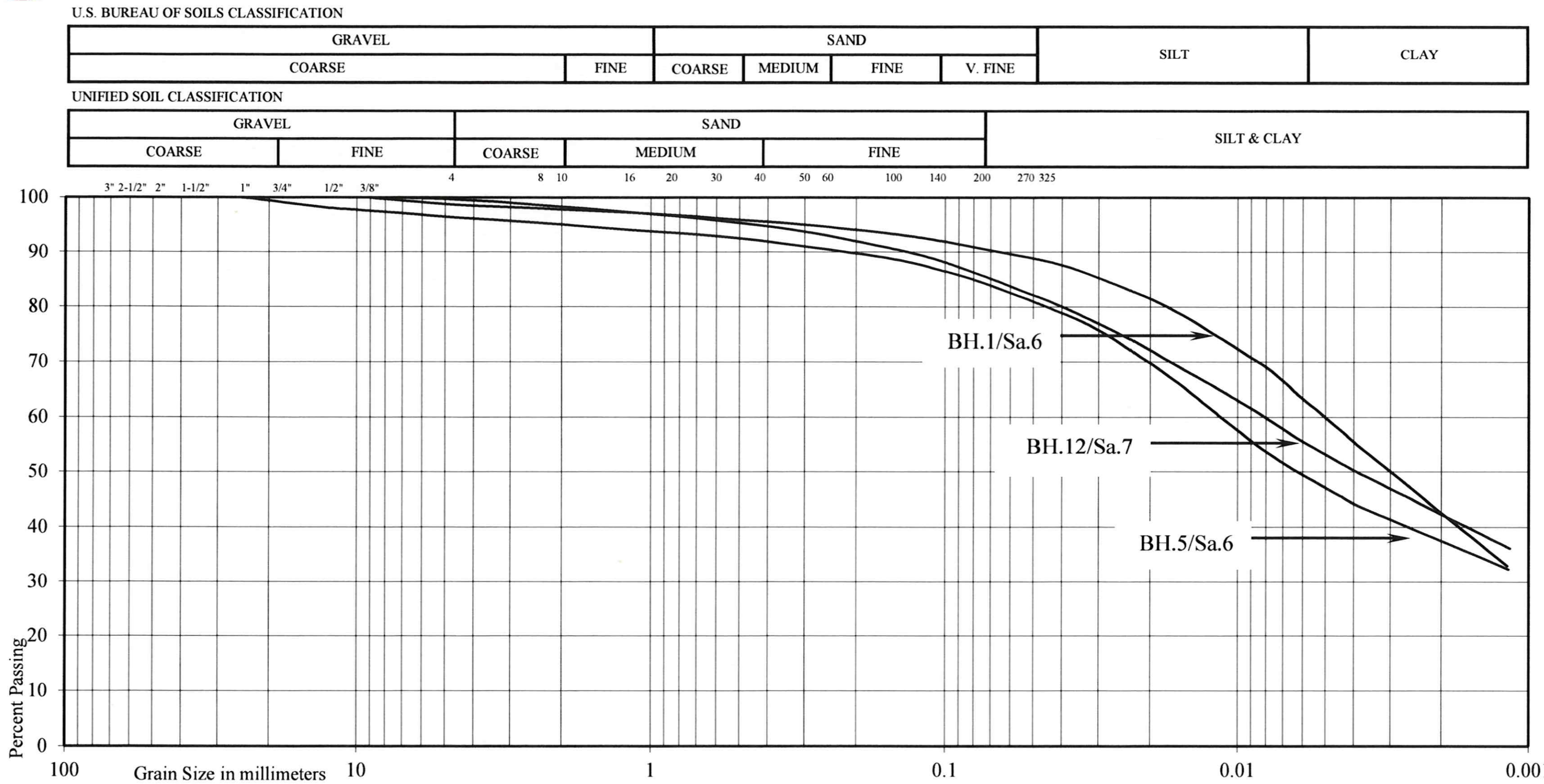
GRAIN SIZE DISTRIBUTION

Reference No: 1801-S032



Project:	Proposed Residential Development		
Location:	Chickadee Lane and Glasgow Road, Town of Caledon		
Borehole No:	1	5	12
Sample No:	6	6	7
Depth (m):	4.7	4.7	6.3
Elevation (m):	251.8	254.8	252.0

BH./Sa.	1/6	5/6	12/7
Liquid Limit (%) =	42	36	38
Plastic Limit (%) =	21	20	21
Plasticity Index (%) =	21	16	17
Moisture Content (%) =	18	18	17
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}	10^{-7}

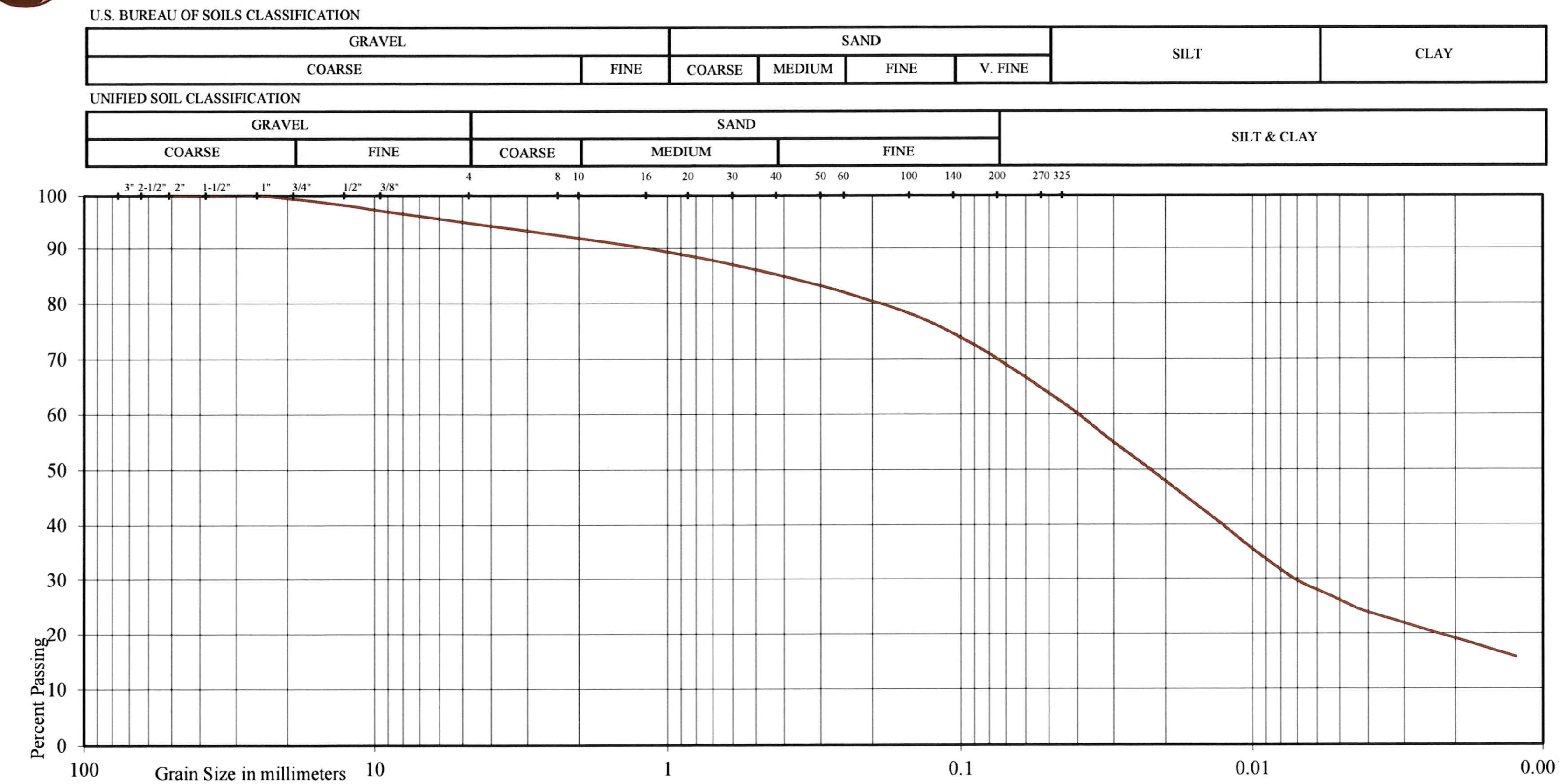
Classification of Sample [& Group Symbol]: SILTY CLAY TILL, a trace to some sand, a trace of gravel

Figure: 13

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1801-S032



Project: Proposed Residential Development

Location: Chickadee Lane and Glasgow Road, Town of Caledon

Borehole No: 2

Sample No: 15

Depth (m): 18.5

Elevation (m): 237.2

Liquid Limit (%) = 25

Plastic Limit (%) = 16

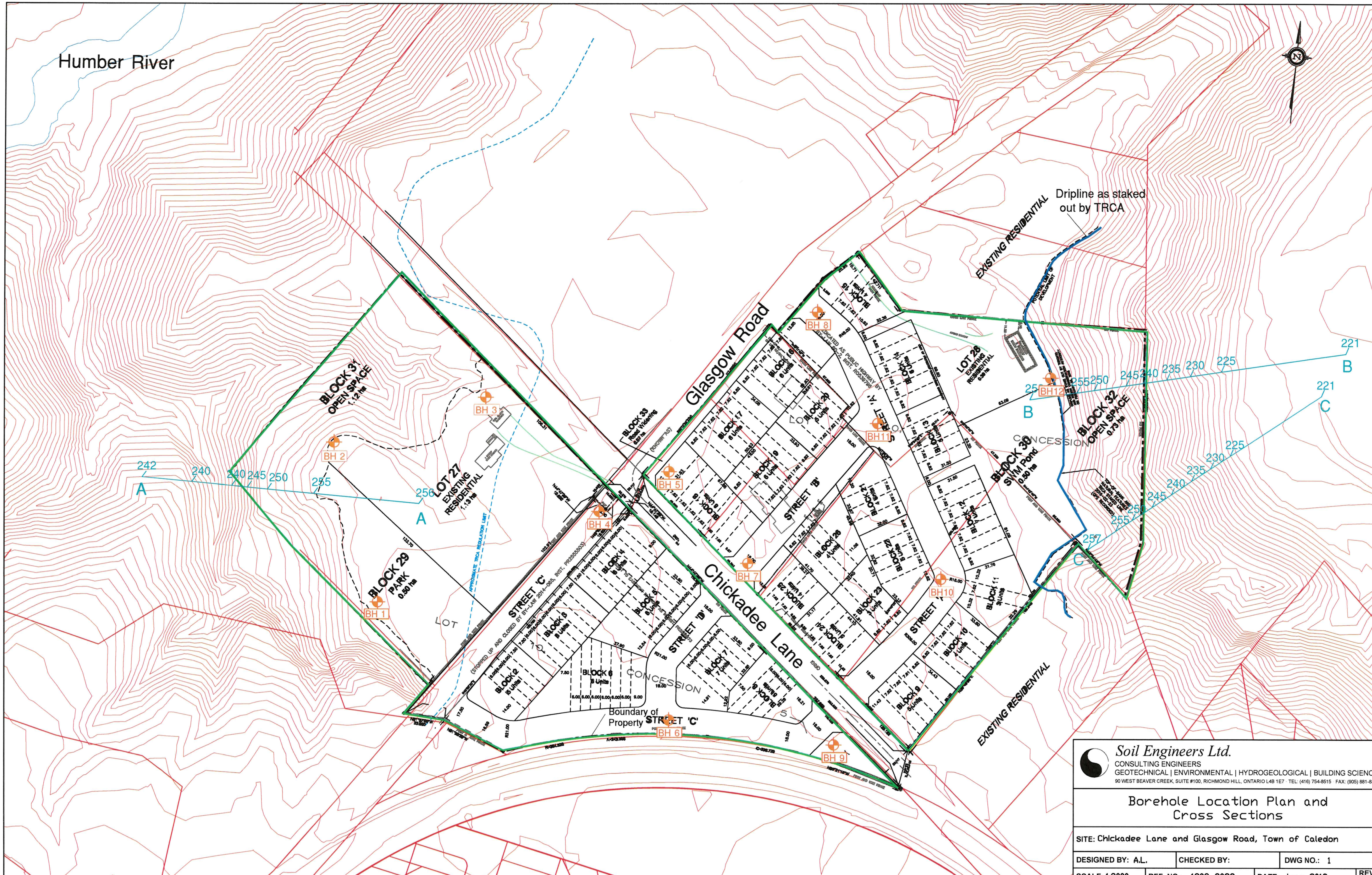
Plasticity Index (%) = 9

Moisture Content (%) = 13

Estimated Permeability (cm./sec.) = 10^{-7}

Classification of Sample [& Group Symbol]: SANDY SILT TILL, some clay and sand, a trace of gravel

Figure: 14



Soil Engineers Ltd. CONSULTING ENGINEERS GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE 90 WEST BEAVER CREEK, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 TEL: (416) 754-8515 FAX: (905) 881-8335	
Borehole Location Plan and Cross Sections	
SITE: Chickadee Lane and Glasgow Road, Town of Caledon	
DESIGNED BY: A.L. | CHECKED BY: | DWG NO.: 1	
SCALE: 1:2000 | REF. NO.: 1802-S032 | DATE: June 2018 | REV	

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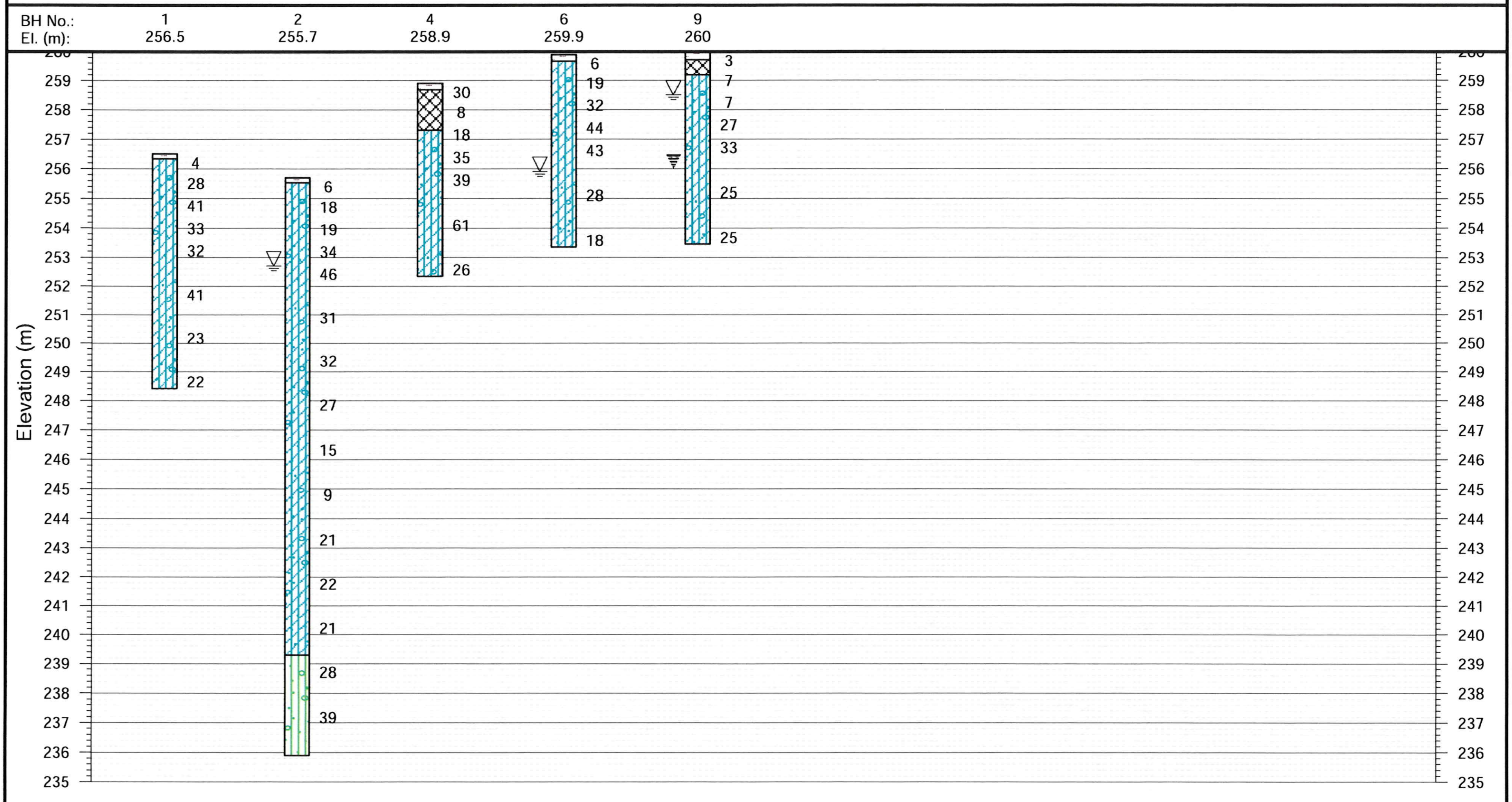
SUBSURFACE PROFILE
DRAWING NO. 2
SCALE: AS SHOWN

JOB NO.: 1801-S032
REPORT DATE: June 2018
PROJECT DESCRIPTION: Proposed Residential Development
PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

LEGEND

TOPSOIL FILL SANDY SILT TILL SILTY CLAY TILL



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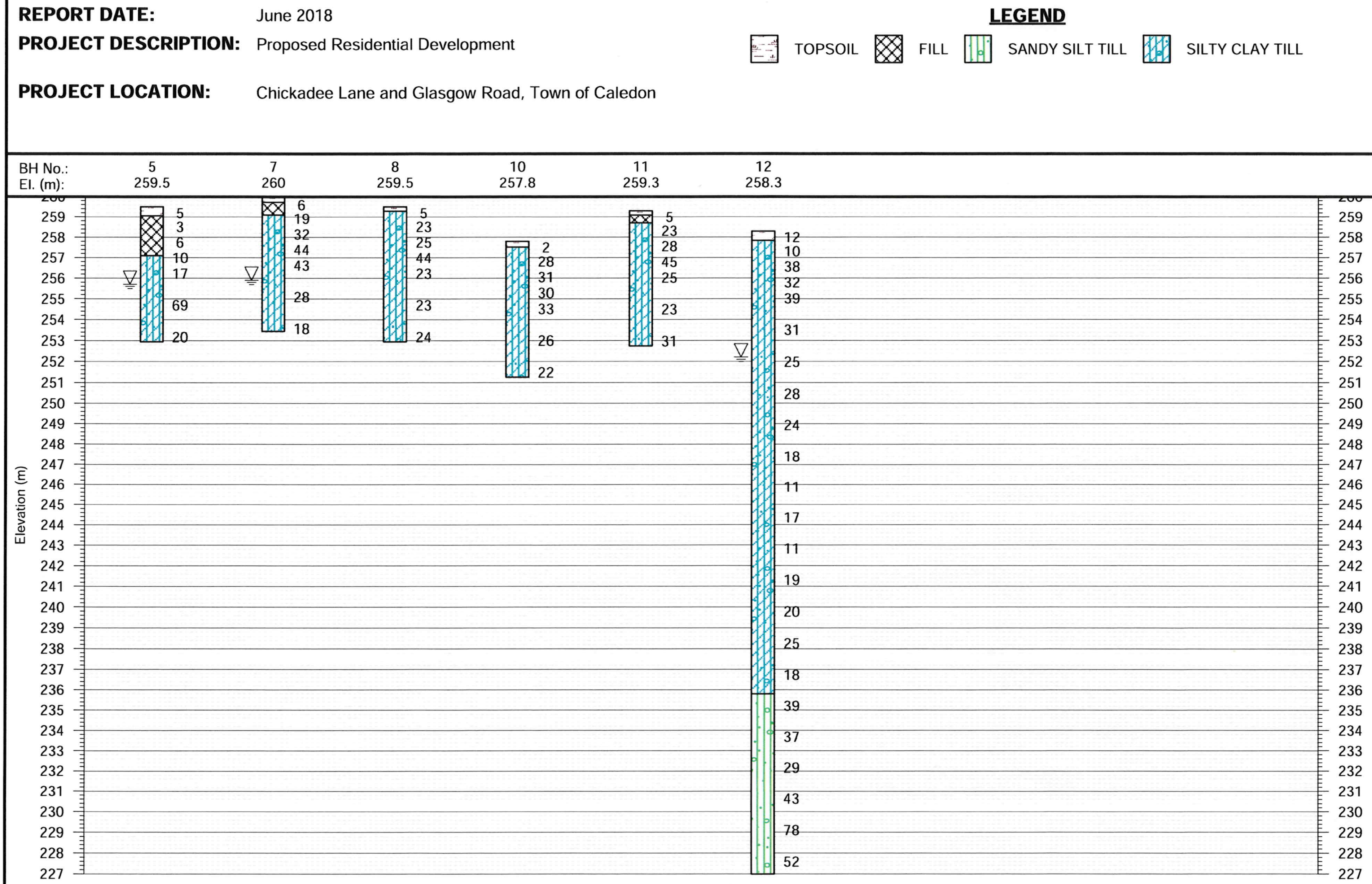
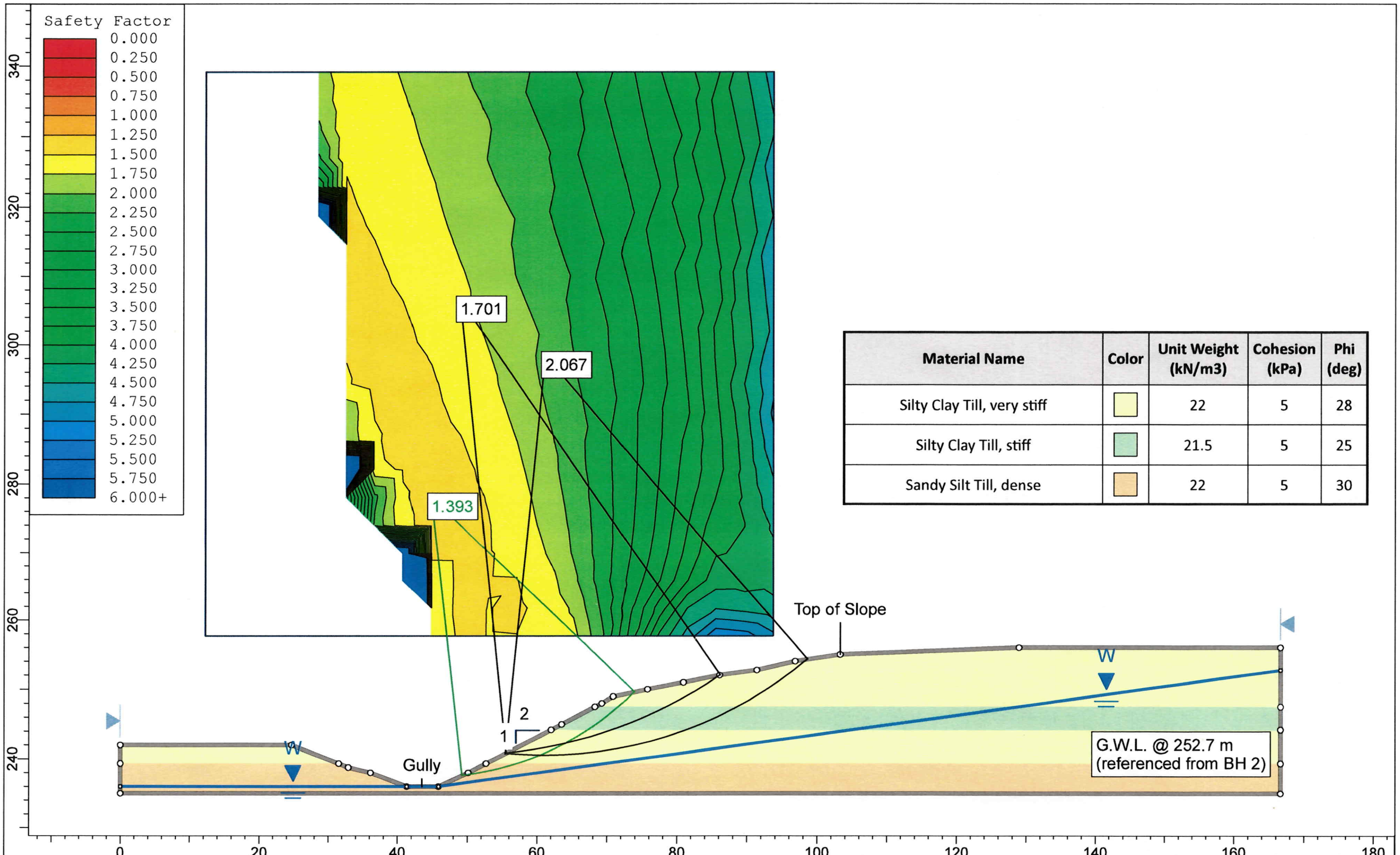
SUBSURFACE PROFILE
DRAWING NO. 3
SCALE: AS SHOWN

JOB NO.: 1801-S032
REPORT DATE: June 2018
PROJECT DESCRIPTION: Proposed Residential Development
PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon





Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Silty Clay Till, very stiff		22	5	28
Silty Clay Till, stiff		21.5	5	25
Sandy Silt Till, dense		22	5	30

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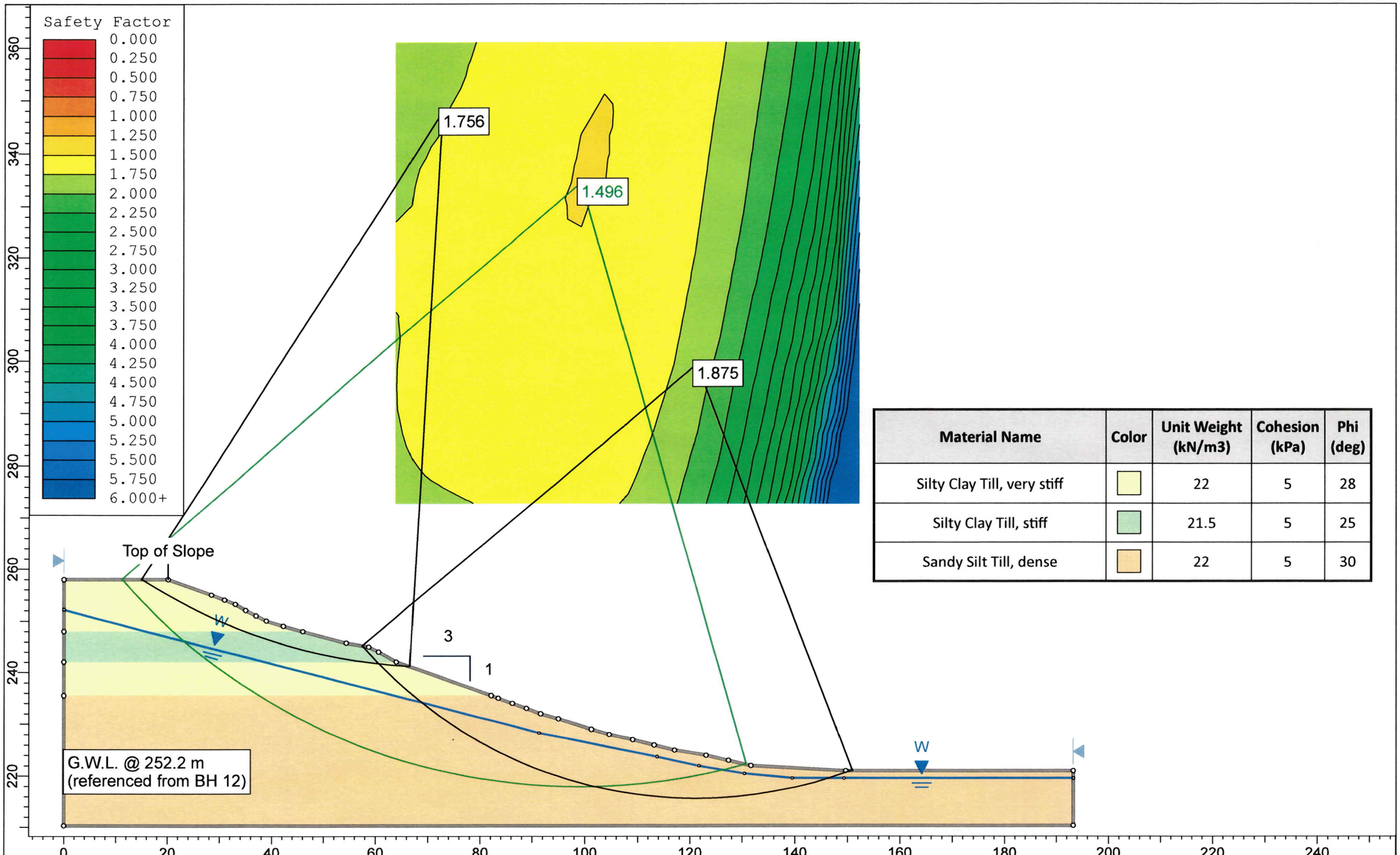
90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

Project Title: Slope Stability Analysis - Cross Section A-A			Load Case: Existing Condition
Location: Chickadee Lane and Glasgow Road, Town of Caledon			
Drawn By: A.L.	Checked By:	Scale: 1:750	Revision:
Date: May 2018		Reference No.: 1801-S032	Drawing No.: 4



Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Silty Clay Till, very stiff		22	5	28
Silty Clay Till, stiff		21.5	5	25
Sandy Silt Till, dense		22	5	30

Soil Engineers Ltd.
CONSULTING ENGINEERS
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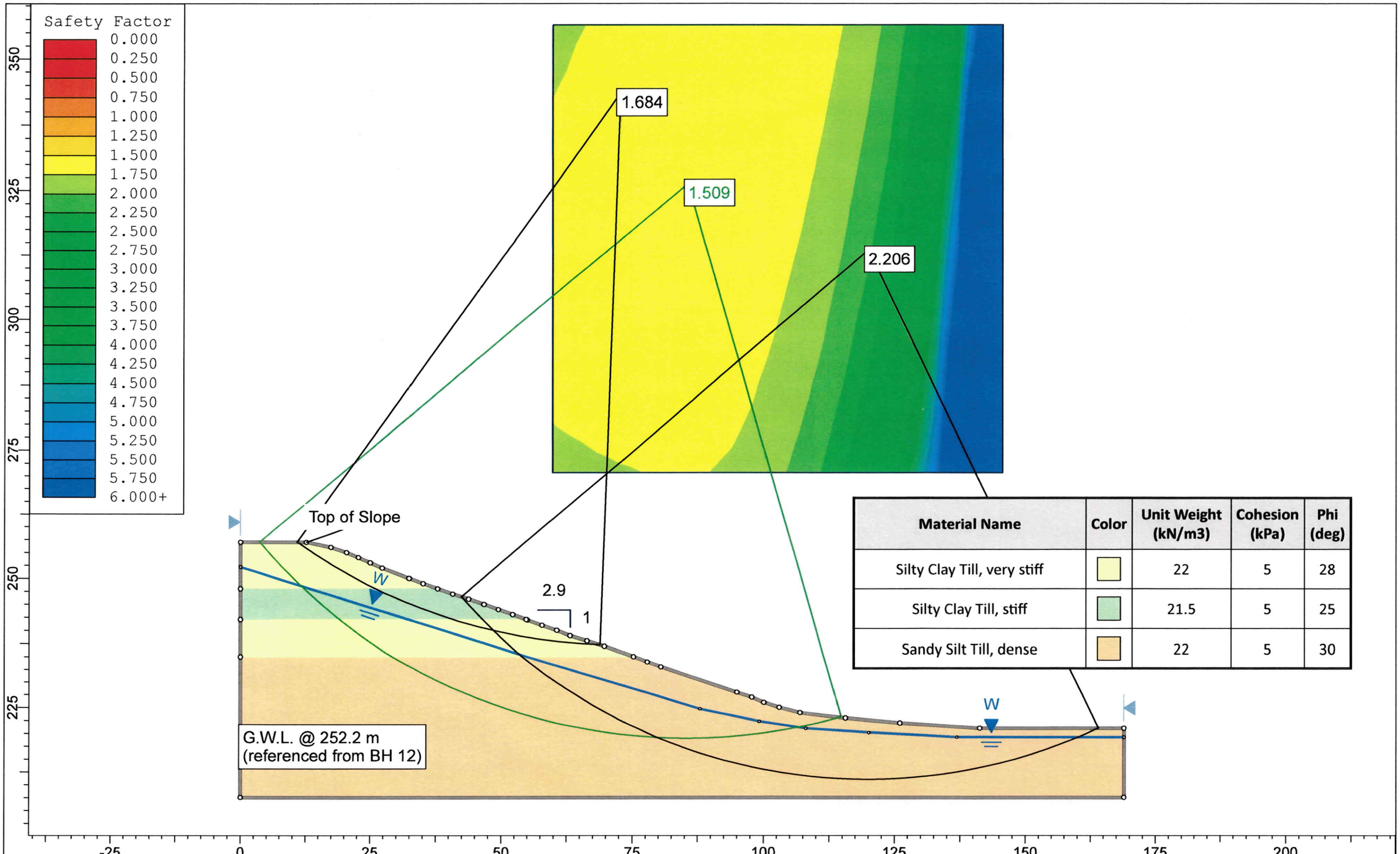
90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 TEL: (416) 754-8515 FAX: (905) 881-8335

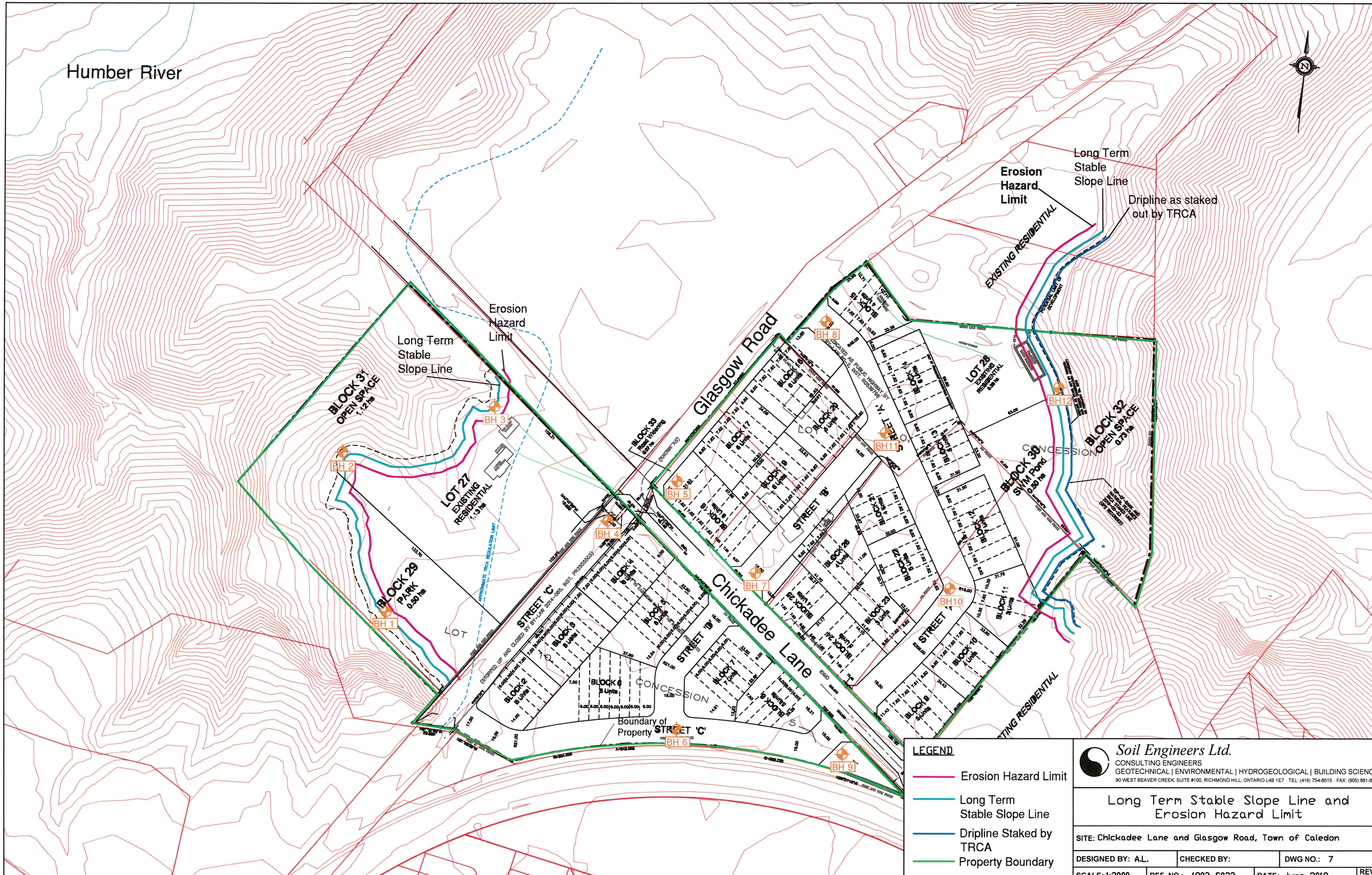
Project Title: Slope Stability Analysis - Cross Section B-B			Load Case: Existing Condition
Location: Chickadee Lane and Glasgow Road, Town of Caledon			
Drawn By: A.L.	Checked By	Scale: 1:1000	Revision
Date: June 2018		Reference No.: 1801-S032	Drawing No.: 5



Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Silty Clay Till, very stiff		22	5	28
Silty Clay Till, stiff		21.5	5	25
Sandy Silt Till, dense		22	5	30

Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE
90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

Project Title: Slope Stability Analysis - Cross Section C-C				Load Case: Existing Condition
Location: Chickadee Lane and Glasgow Road, Town of Caledon				
Drawn By: A.L.	Checked By:	Scale: 1:1000		Revision:
Date: June 2018		Reference No.: 1801-S032		Drawing No.: 6



LEGEND

- Erosion Hazard Limit
- Long Term Stable Slope Line
- Dripline Staked by TRCA
- Property Boundary

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90 WEST BEAVER CREEK, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

Long Term Stable Slope Line and Erosion Hazard Limit

SITE: Chickadee Lane and Glasgow Road, Town of Caledon		
DESIGNED BY: A.L.	CHECKED BY:	DWG NO.: 7
SCALE: 1:2000	REF. NO.: 1802-S032	DATE: June 2018
REV		

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90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL (416) 754-8515 · FAX (905) 881-8335

BARRIE	MISSISSAUGA	OSHAWA	NEWMARKET	GRAVENHURST	PETERBOROUGH	HAMILTON
TEL: (705) 721-7863	TEL: (905) 542-7605	TEL: (905) 440-2040	TEL: (905) 853-0647	TEL: (705) 684-4242	TEL: (905) 440-2040	TEL: (905) 777-7956
FAX: (705) 721-7864	FAX: (905) 542-2769	FAX: (905) 725-1315	FAX: (905) 881-8335	FAX: (705) 684-8522	FAX: (905) 725-1315	FAX: (905) 542-2769

August 31, 2020

Zancor Homes (Bolton) Ltd.
221 North Rivermede Road
Concord, Ontario
L4K 3N7

Attention: Mr. Frank Filippo

Re: A Supplementary Slope Stability Assessment for Proposed Residential Development Chickadee Lane and Glasgow Road Town of Caledon

Dear Sir:

As requested, Soil Engineers Ltd. has carried out a supplementary slope stability assessment in Blocks 27, 29, 30 and 31 of the captioned site to further delineate the Long-Term Stable Slope Line (LTSSL). We herein provide a summary of our findings and analytical results of the concerned slope.

Background

The subject site is located at the intersection of Chickadee Lane and Glasgow Road, in the Town of Caledon. The concerned slope is located at the west limit of the subject site in Blocks 27, 29, 30 and 31. The height of the slope varies from 10 to 30 m, having a gradient of 1.6 to 5+ horizontal (H): 1 vertical (V). Humber River is more than 15 m away from the bottom of slope.

Subsurface Investigation

A geotechnical investigation report, Reference No. 1801-S032, dated July 2018 was completed for the subject site. Three (3) sampled boreholes (Boreholes 1 to 3, inclusive) were located in the vicinity of the concerned slope. The boreholes indicated that topsoil, 160 mm to 260 mm in thickness, was encountered at the surface of the area. Beneath the topsoil veneer, the subsoil generally consisted of firm to hard silty clay till deposit extending to a depth of 16.4 m from the prevailing ground surface, overlying compact to dense sandy silt till deposit to the maximum investigated depth of the borehole at 19.8 m from the ground surface.

Groundwater level was recorded at El. 252.7 m in Borehole 2 upon completion of the drilling program. Boreholes 1 and 3 remained dry on completion. The recorded groundwater represents a perched water condition within the till mantle and will fluctuate with seasons.

Visual Inspection

Visual inspection was performed on March 20, 2018 during the original study. The inspection revealed that the sloping ground is generally covered with mature trees or vegetation, with isolated bare spots covered with fallen leaves and wood branches. Most of the trees appeared in the upright position. There were no signs of water seepage or surface erosion along the slope surface, except multiple gullies and surface erosion were present to the north and west of the property. Toe erosion scars were also evident along Humber River.

Modeling

In addition to the Cross-Section A-A that was analyzed during the original study with the geotechnical investigation, two (2) additional sections (Cross Sections D-D and E-E) are performed to further delineate the LTSSL. The surface profiles of the slope sections are interpreted from the elevation contours shown on the topographic plan obtained from First Base Solutions. The subsurface soil information was derived from the borehole findings. The locations of the cross-sections are shown on Drawing No. 1. The details of the slope at the Cross-Sections A-A, D-D and E-E are presented on Drawing Nos. 2, 3 and 4, respectively.

The analyses were carried out with computer-aided program, SLIDE created by Rocscience Inc., using force-moment-equilibrium criteria with the soil strength parameters shown in the following table:

Soil Type	Unit Weight (kN/m^3)	Effective Cohesion (kPa)	Effective Internal Friction Angle (degrees)
Very stiff to hard Silty Clay Till	22.0	5	28
Stiff Silty Clay Till	21.5	5	25
Sandy Silt Till	22.0	5	30

Where applicable, the highest water level detected in the boreholes and the creek level were incorporated into the analysis as a phreatic surface.

Results

The results of the analyses are summarized in the following table and are presented on Drawing Nos. 2, 3 and 4.

Cross Section	Height (m)	Existing Slope Gradient	Factor of Safety (FOS)	Remodeled Slope Gradient	Resulting FOS
A-A	19.0	1.9 to 5.4H:1V	1.39	2.5H:1V	1.61
D-D	8.5	1.6H:1	1.31	2H:1V	1.51
E-E	7.0	3.1 to 4.7H:1V	2.40	-	-

The resulting FOS at the Cross-Section E-E meet the Ontario Ministry of Natural Resources and Forestry (OMNRF) guideline requirement for 'Active' land use (FOS of 1.5), while the FOS for Cross-Sections A-A and D-D is below the OMNRF guideline requirement. A stable slope allowance will be required for Cross-Sections A-A and D-D.

Even though there were active erosion observed at the bank of the Humber River, however, given that the river is more than 15 m away from the bottom of slope, a Toe Erosion Allowance (T.E.A.) is not required.

After incorporating the stable slope gradient of 2.5 to 2.0H:1V at Cross- Sections A-A and D-D, the resulting FOS for the remodeled slope meets the OMNRF guideline of FOS 1.5. The results are presented on Drawing No. 5 and 6.

Based on the analytical results, the LTSSL, incorporating the stable slope gradient, is established and is illustrated in Drawing No. 1.

A development setback buffer for man-made and environmental degradation based on the TRCA policy will be required. This is subject to the discretion of TRCA.

Where grading of the site requires the area to be raised, the proposed slope should maintain a gradient of 1V:3H or flatter for stability. Any slope steeper than 1V:3H will require further stability analysis and it may need to be constructed as a reinforced earth slope.

In order to prevent disturbance of the existing stable slope and to enhance the stability of the bank for the proposed project, the following geotechnical constraints should be stipulated:

1. The prevailing vegetative cover must be maintained, since its extraction would deprive the bank of the rooting system that is reinforcement against soil erosion by weathering. If for any reason the vegetation cover is stripped, it must be reinstated to its original, or better than its original, protective condition.
2. The leafy topsoil cover on the bank face should not be disturbed, since this provides an insulation and screen against frost wedging and rainwash erosion.

3. Grading of the land adjacent to the bank must be such that concentrated runoff is not allowed to drain onto the bank face. Landscaping features which may cause runoff to pond at the top of the bank, as well as saturation of the crown of the bank must not be permitted.
4. Where the construction is carried out near the top of the bank, dumping of loose fill over the bank from topsoil stripping or vegetation removal activities must be prohibited. Topsoil stripping and vegetation removal along the bank are also prohibited.

In case of any removal of vegetation during the course of construction, restoration with selective native plantings, including deep rooting systems which would penetrate the original topsoil, shall be carried out after the development to ensure slope stability. Provided that all the above recommendations are followed, the proposed development at the tableland should not have any adverse effect on the stability of the slope.

The above recommendations should be reviewed and are subject to the approval of TRCA.

We trust the above satisfies your present requirements. Should you have any further queries, please feel free to contact this office.

Yours truly,

SOIL ENGINEERS LTD.

Kin Fung Li, P.Eng.

LICENSED PROFESSIONAL ENGINEER
Aug 31, 2020
K. F. LI
100169280
PROVINCE OF ONTARIO

Bernard Lee, P.Eng.

LICENSED PROFESSIONAL ENGINEER
Aug 31, 2020
B. B. Y. LEE
100104568
PROVINCE OF ONTARIO

KFL/BL

<u>**ENCLOSURES**</u>

Borehole Logs	Figures 1 to 3
Cross Section Location Plan	Drawing No. 1
Slope Stability Analyses (Existing Condition)	Drawing Nos. 2 to 4
Slope Stability Analysis (Geotechnically Stable Condition)	Drawing Nos. 5 and 6

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	Number	Type	N-Value	Depth Scale (m)	Penetration Resistance (blows/30 cm)	Moisture Content (%)	Atterberg Limits	WATER LEVEL
256.5	Ground Surface								
256.3 / 0.2	160 mm TOPSOIL				0		50		Dry on completion
	Brown, hard — weathered **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders	1	DO	4					
		2	DO	28	1		17		
		3	DO	41	2		15		
		4	DO	33			16		
		5	DO	32	3		16		
					4				
		6	DO	41	5		18	PL–LL	
	— brown / grey								
		7	DO	23	6		19		
					7				
248.4 / 8.1		8	DO	22	8		18		
	END OF BOREHOLE				9, 10, 11				

Legend: ● 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

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	Sample Number	Type	N-Value	Moisture Content (%)
255.7	Ground Surface				
255.5 / 0.2	**160 mm TOPSOIL**				
	Brown, stiff to hard **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders; weathered	1	DO	6	36
		2	DO	18	18
		3	DO	19	20
		4	DO	34	18
	sandy	5	DO	46	12
		6	DO	31	18
	brown / grey	7	DO	32	20
		8	DO	27	17
		9	DO	15	19
		10	DO	9	28

Depth Scale (m): 0 1 2 3 4 5 6 7 8 9 10 11

● 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: W.L @ Ele. 252.7 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	Samples Type	Samples N-Value	Depth Scale (m)	Moisture Content (%)
	SILTY CLAY TILL (Cont'd)				11	
		11	DO	21	12	18
		12	DO	22	14	18
		13	DO	21	15	16
239.3 / 16.4	Grey, compact to dense **SANDY SILT TILL** some clay and sand trace of gravel occ. sand seams, cobbles and boulders	14	DO	28	17	12
		15	DO	39	18	13
235.9 / 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.**				20–22	

Legend:
- ● Dynamic Cone (blows/30 cm): 10 30 50 70 90
- X Shear Strength (kN/m²): 50 100 150 200
- O Penetration Resistance (blows/30 cm): 10 30 50 70 90
- Atterberg Limits: PL — LL
- ● Moisture Content (%): 10 20 30 40
- WATER LEVEL

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)

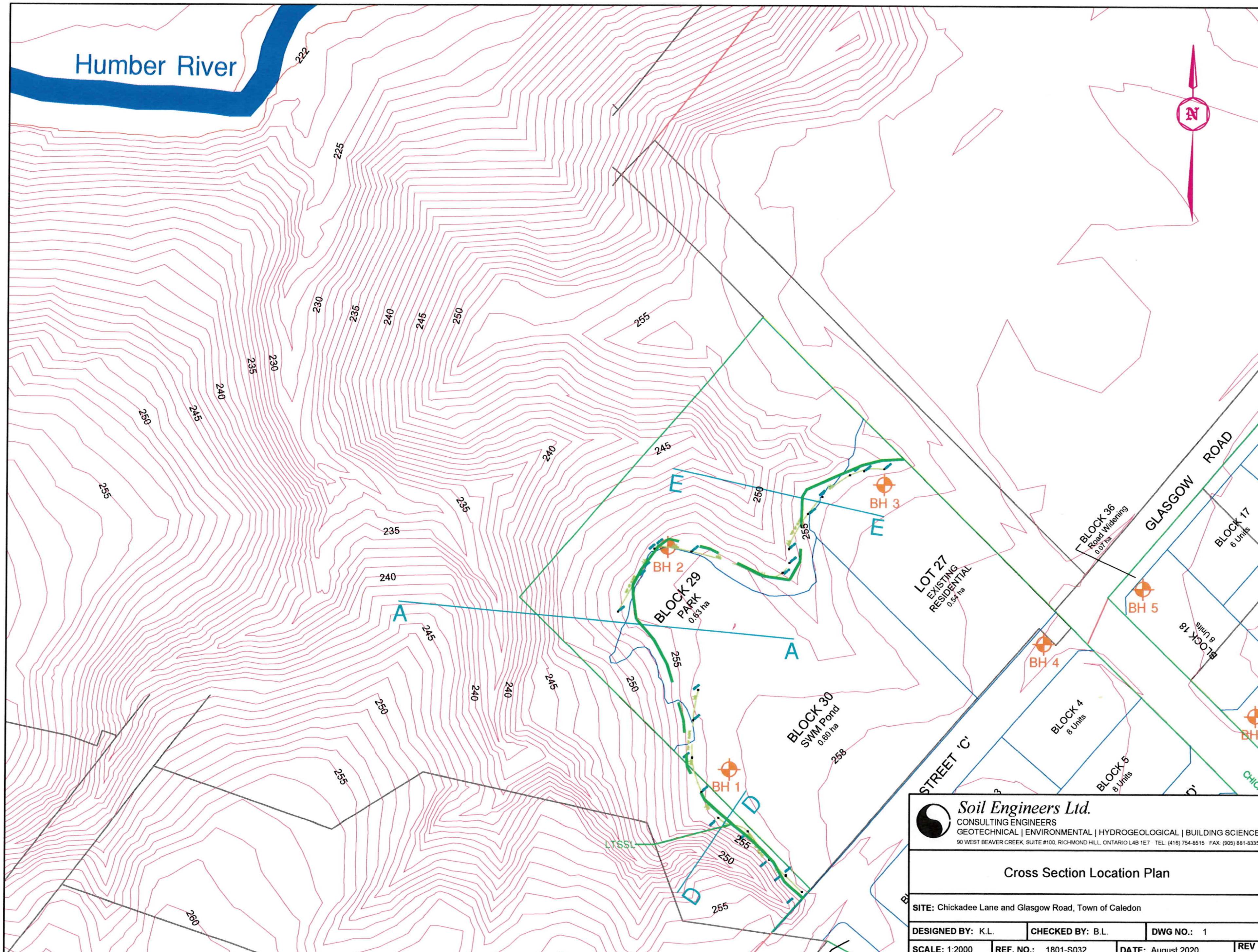
PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 26, 2018

El. (m) / Depth (m)	Soil Description	Sample Number	Type	N-Value	Penetration Resistance (blows/30 cm)	Moisture Content (%)	Water Level
255.8	Ground Surface						
0.0 / 255.5 / 0.3	**260 mm TOPSOIL**						Dry on completion
	Brown, very stiff to hard **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders (weathered to 0.8 m)	1	DO	5		31	
		2	DO	28		17	
		3	DO	35		16	
		4	DO	38		18	
		5	DO	29		18	
		6	DO	37		15	
	(brown / grey)	7	DO	24		18	
249.3 / 6.5	**END OF BOREHOLE**						

Legend: ● 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. Depth Scale (m) 0–11.

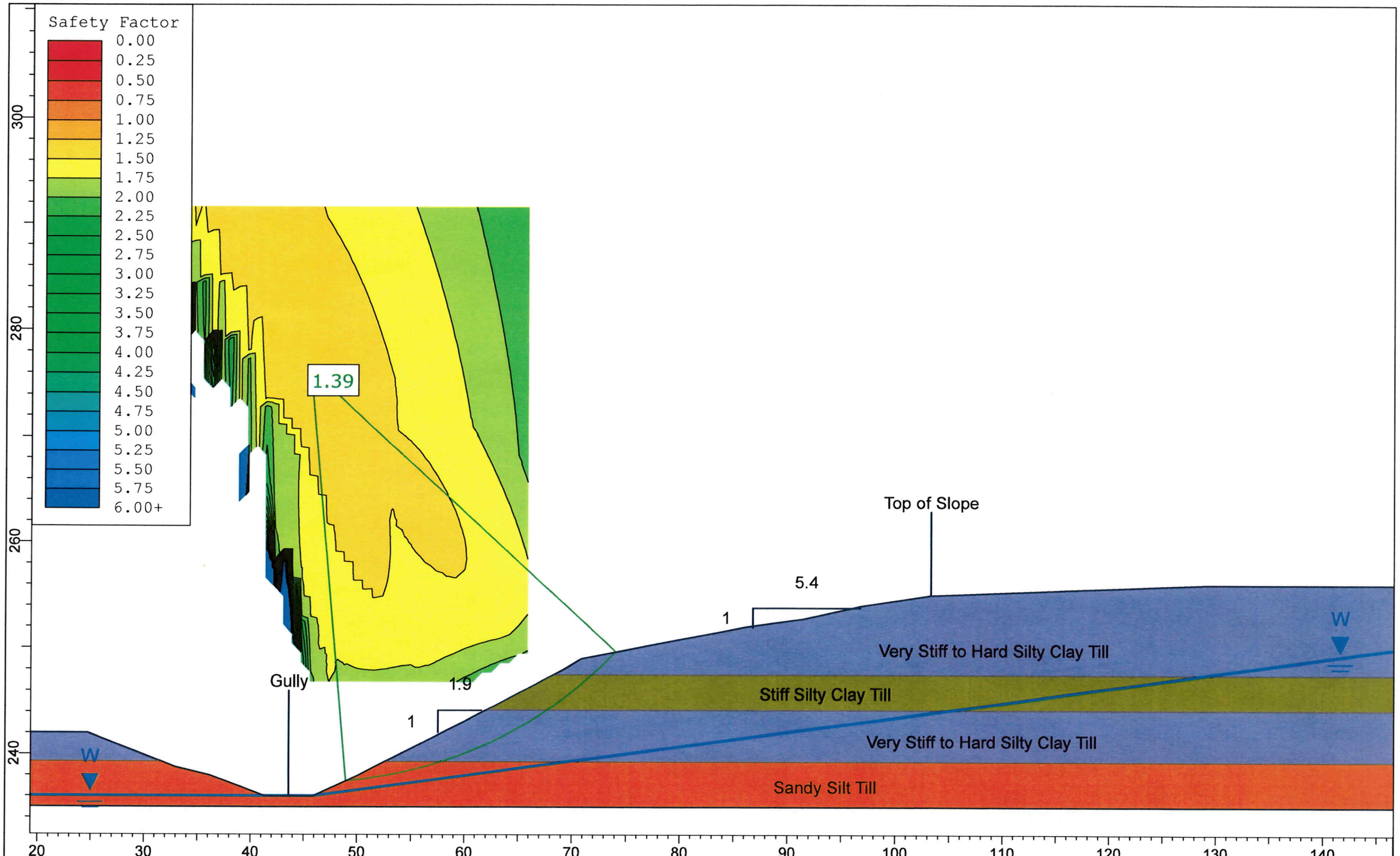
Soil Engineers Ltd.



Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE
90 WEST BEAVER CREEK, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 TEL: (416) 754-8515 FAX: (905) 881-8335

Cross Section Location Plan

SITE: Chickadee Lane and Glasgow Road, Town of Caledon			
DESIGNED BY: K.L.	CHECKED BY: B.L.	DWG NO.: 1	
SCALE: 1:2000	REF. NO.: 1801-S032	DATE: August 2020	REV



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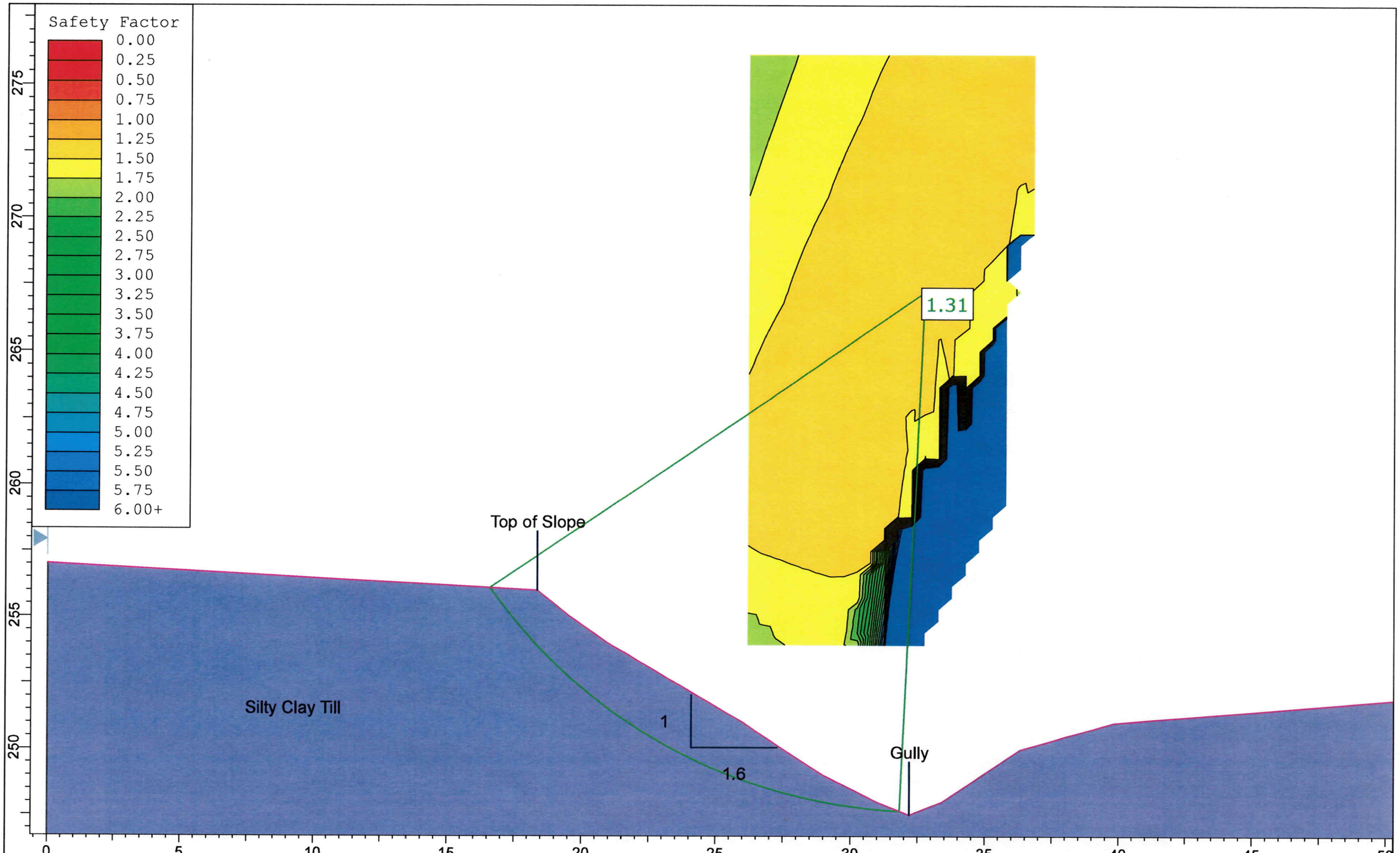
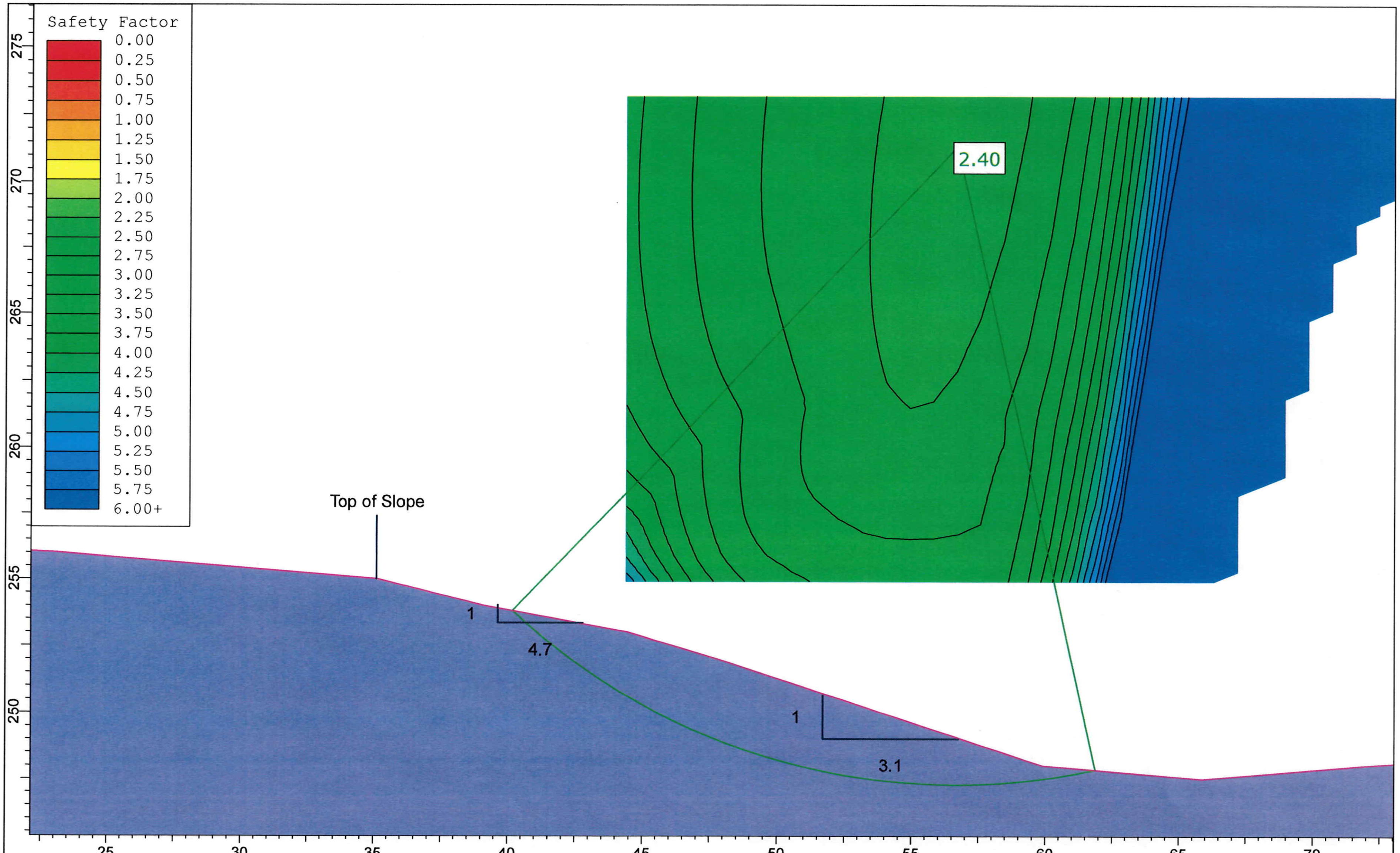
90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

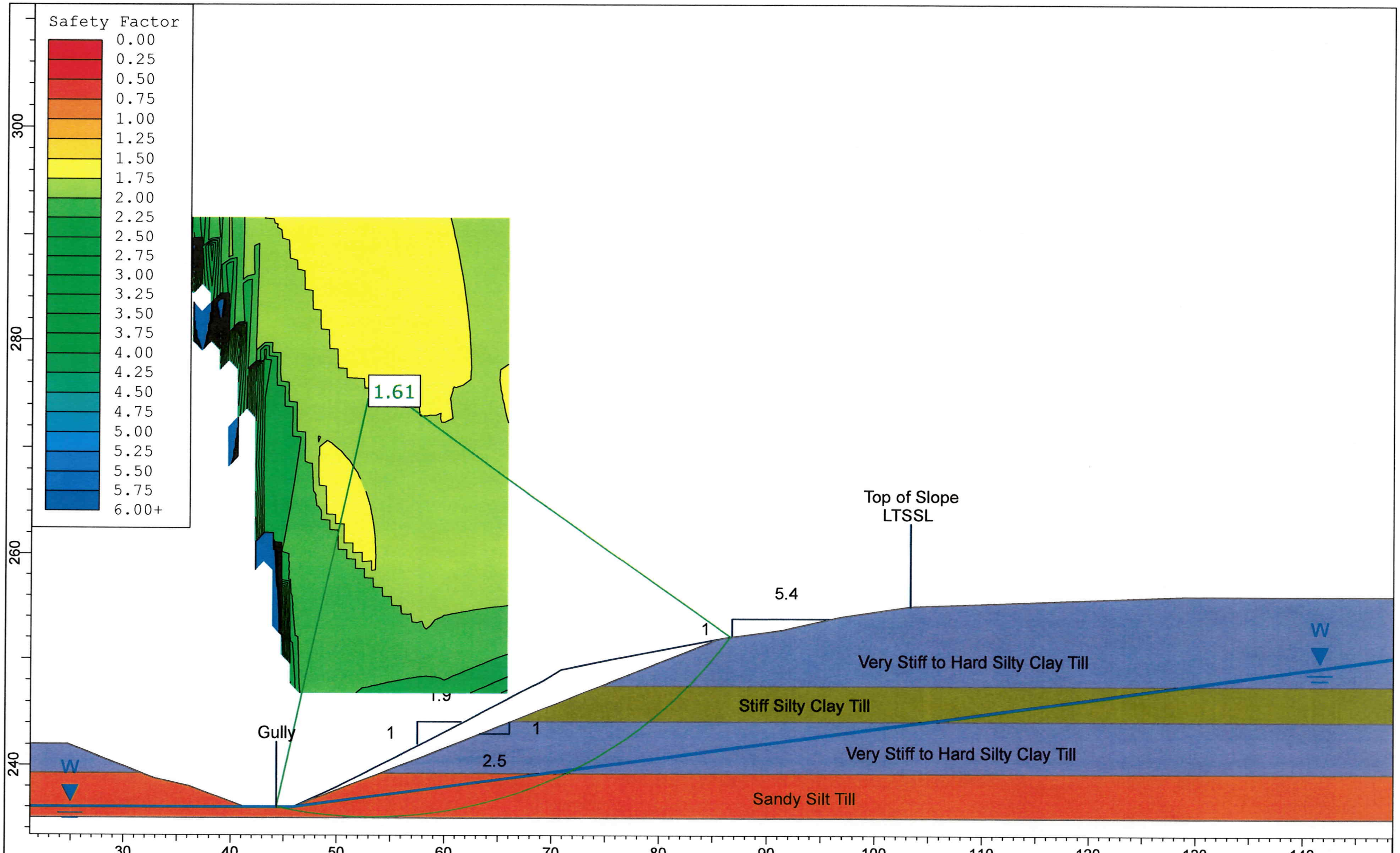
Project Title	Slope Stability Assessment - Cross Section A-A			Load Case	Existing Condition
Location	Chickadee Lane and Glasgow Road, Town of Caledon				
Drawn By	K.L.	Checked By	B.L.	Scale	1:500
Revision	-				
Date	August 2020	Reference No.	1801-S032	Drawing No.	2



Soil Engineers Ltd. CONSULTING ENGINEERS GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE 90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335	Project Title: Slope Stability Assessment - Cross Section D-D		Load Case: Existing Condition
	Location: Chickadee Lane and Glasgow Road, Town of Caledon		
	Drawn By: K.L.	Checked By: B.L.	Scale: 1:200	Revision: -
	Date: August 2020	Reference No.: 1801-S032	Drawing No.: 3



Soil Engineers Ltd. CONSULTING ENGINEERS GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE 90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335	Project Title: Slope Stability Assessment - Cross Section E-E			Load Case: Existing Condition
	Location: Chickadee Lane and Glasgow Road, Town of Caledon			
	Drawn By: K.L.	Checked By: B.L.	Scale: 1:200	Revision: -
	Date: August 2020		Reference No.: 1801-S032	Drawing No.: 4



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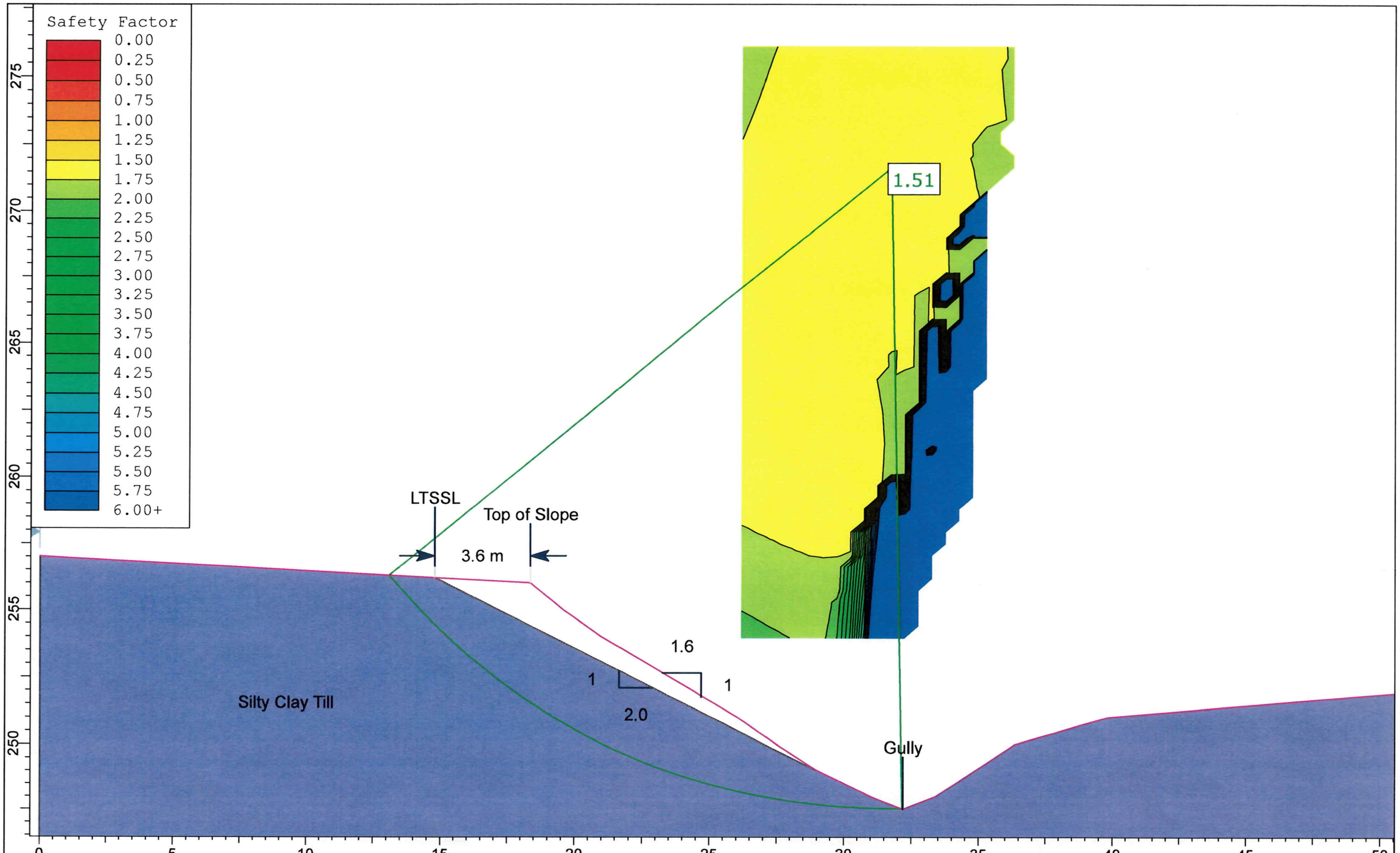
90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 TEL: (416) 754-8515 FAX: (905) 881-8335

Project Title	Slope Stability Assessment - Cross Section A-A	Load Case	Geotechnically Stable Condition
Location	Chickadee Lane and Glasgow Road, Town of Caledon		
Drawn By K.L.	Checked By B.L.	Scale 1:500	Revision -
Date August 2020		Reference No. 1801-S032	Drawing No. 5



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90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

Project Title: Slope Stability Assessment - Cross Section D-D			Load Case: Geotechnically Stable Condition
Location: Chickadee Lane and Glasgow Road, Town of Caledon			
Drawn By: K.L.	Checked By: B.L.	Scale: 1:200	Revision: -
Date: August 2020		Reference No.: 1801-S032	Drawing No.: 6

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90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL (416) 754-8515 · FAX (905) 881-8335

BARRIE	MISSISSAUGA	OSHAWA	NEWMARKET	GRAVENHURST	PETERBOROUGH	HAMILTON
TEL: (705) 721-7863	TEL: (905) 542-7605	TEL: (905) 440-2040	TEL: (905) 853-0647	TEL: (705) 684-4242	TEL: (905) 440-2040	TEL: (905) 777-7956
FAX: (705) 721-7864	FAX: (905) 542-2769	FAX: (905) 725-1315	FAX: (905) 881-8335	FAX: (705) 684-8522	FAX: (905) 725-1315	FAX: (905) 542-2769

March 23, 2021

Reference No. 1801-S032

Zancor Homes (Bolton) Ltd.
221 North Rivermede Road
Concord, Ontario
L4K 3N7

Attention: Mr. Frank Filippo

**Re: A Geotechnical Review for
Proposed Residential Development
Chickadee Lane and Glasgow Road
Town of Caledon**

Dear Sir:

It is our understanding that the Toronto and Region Conservation Authority (TRCA) has requested a geotechnical review regarding whether the proposed stormwater management pond and the outfall will have any adverse effect on the interpretation of the Long-Term Stable Slope Line (LTSSL) as determined in the supplementary slope stability assessment in Blocks 27, 29, 30 and 31 of the captioned site dated August 2020 (Reference No. 1801-S032). We herein provide our opinion on the subject matter.

Determination of Long-Term Stable Slope Line and Erosion Hazard Limit

Based on the Ontario Ministry of Natural Resources guideline, Erosion Hazard Limit is defined by three components: toe erosion allowance, stable slope allowance, and erosion access allowance.

By definition from the website of TRCA, the LTSSL is defined as "As determined through a geotechnical study: a) the physical top of slope where the existing slope is stable and not impacted by toe erosion; or b) the landward limit of the toe erosion allowance plus the stable slope allowance where the existing slope is unstable and/or impacted by erosion."

The slope stability assessments performed by Soil Engineers Ltd. determined the LTSSL, which incorporates the toe erosion allowance and the stable slope allowance. And the erosion access allowance/development setback is to be implemented beyond the LTSSL and in compliance with the TRCA's Living City Policy (LCP).

Discussion

It should be noted that the proposed development is not part of the component in determining the LTSSL, as one must determine the LTSSL prior to providing the development limit. Given that the proposed stormwater management pond is located behind the development limit setback and that the pond is designed as a retention pond (not an infiltration pond), the proposed stormwater management pond is unlikely to have an adverse effect to the condition of the slope.

As for the proposed outfall, proper erosion control should be considered at the outlet location in order to prevent any erosion at the toe of the valley due to the discharge of the pond water near the slope toe. Where necessary, preventive measure can also be implemented along the slope toe near the outlet location. This can be implemented as part of the engineering design for the outlet.

We trust the above satisfies your present requirements. Should you have any further queries, please feel free to contact this office.

Yours truly,

SOIL ENGINEERS LTD.

LICENSED PROFESSIONAL ENGINEER
Mar 23, 2021
K. F. LI
100169280
PROVINCE OF ONTARIO

Kin Fung Li, P.Eng.
KFL/BL

LICENSED PROFESSIONAL ENGINEER
Mar/23, 2021
B. P. Y. LEE
100104568
PROVINCE OF ONTARIO

Bernard Lee, P.Eng.

APPENDIX "C"

Hydrogeological Investigation - Chickadee Lane Rounding Out Area "B", Bolton Ontario, Palmer Environmental Consulting Group Inc., dated October 12th 2018, Project No. 170163

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

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

Hydrogeological Investigation – Chickadee Lane Rounding Out Area B

Bolton, Ontario

PECG Project #
170163

Prepared For
Brookvalley Project Management Inc.

October 12, 2018

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

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

October 12, 2018

Frank Filippo
Director, Land and Construction
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 with the Chickadee Lane Rounding Out Area B, in Bolton, Ontario.

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.

J. Cole

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

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1. Introduction

Palmer Environmental Consulting Group Inc. (PECG) was retained by Brookvalley Project Management Inc. on behalf of Zancor Homes 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.

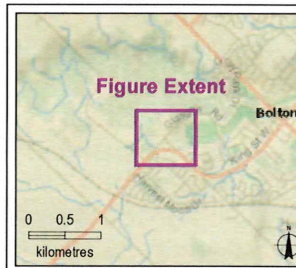
The site is located on an approximately 10.08 ha parcel of land, with 2.75 ha located within the Provincially designated Greenbelt Lands. The Concept Plan for the proposed Chickadee Lane Rounding Out Area B by Humphries Planning Group Inc. (HPG) is presented in **Appendix A**.

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 PECG'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;
- Instrumentation of two (2) wells with Solinst Leveloggers to continuously record groundwater levels;
- Conduct a pre-to-post-development site water balance; and,
- Provide a Hydrogeological Investigation Report to support preliminary site design, CEISMP reporting.



Legend

- L hmhOhdynl dsdq
- L nmhsnqhmf V dkk
- V`sdqbntqd
- Bnmstnq'0 l (
- Rstcx @qd`

0 25 50 75 100
metres

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CQ@V M9A- Dkcdq
BGDBJ DC9Q- Qnkbj
OQNI DBS9 06/ 052
C@SD9 I t k00+1/ 07

Rb`kd 09 / /
TSL Ynmd 06M
M@C 0872

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

Prepared by:

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

CLIENT: Aqnnj U`kkdx Gnl dr
PROJECT: Bgkhb`cdd K`md Dbnknf x `mc Gxcqnf dnknf x

Site Location

FIGURE 1

Cnbt l dmsO`sg9 B9]Df mxsd[Rg`qdc[Oqnidbsr[@bshud[06/ 05 , Aqnnj U`kkdx Gnl dr [06/ 052 , Bgkhb`cdd K`md Dbnknf x `mc Gxcqnf dnknf x[L `oohmf [L wc[06/ 052^Ehf t qd0^Rhsd-l wc

Basemap Service Layer Credits: Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp. Contains information licensed under the Open Government Licence - Ontario and Canada.

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

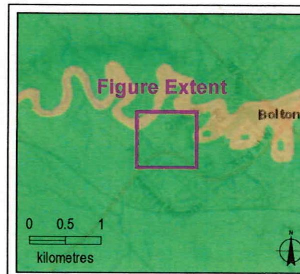
2.2.1 Regional Aquifers and Aquitards

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.

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.

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.



Legend

Surficial Geology

Halton Till:

Modern Alluvium:

0 25 50 75 100
metres

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

Prepared by:

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

CLIENT:
PROJECT:

Surficial Geology

FIGURE 2

Basemap Service Layer Credits: Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp. Contains information licensed under the Open Government Licence - Ontario and Canada.

2.2.2 *Water Supply Wells*

Based on a search of the MECP water well database, 18 water wells were identified within a 500 m radius of the site, none of which exist within the Region of Peel Wellhead Protection Area (WHPA). Of these wells, 9 are used for domestic water supply. The remaining 9 wells are either abandoned or used as observation wells.

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 study area does not contain any critical habitat for aquatic species listed under the species at risk act (SARA; DFO, 2017).

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.

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 1**. 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 2**).

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)						
						March 15, 2018	March 19, 2018	April 4, 2018	May 17, 2018	June 13, 2018	July 19, 2018	August 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

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)*	April 4, 2018	May 17, 2018	June 13, 2018	July 19, 2018	August 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

3.1.2 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.

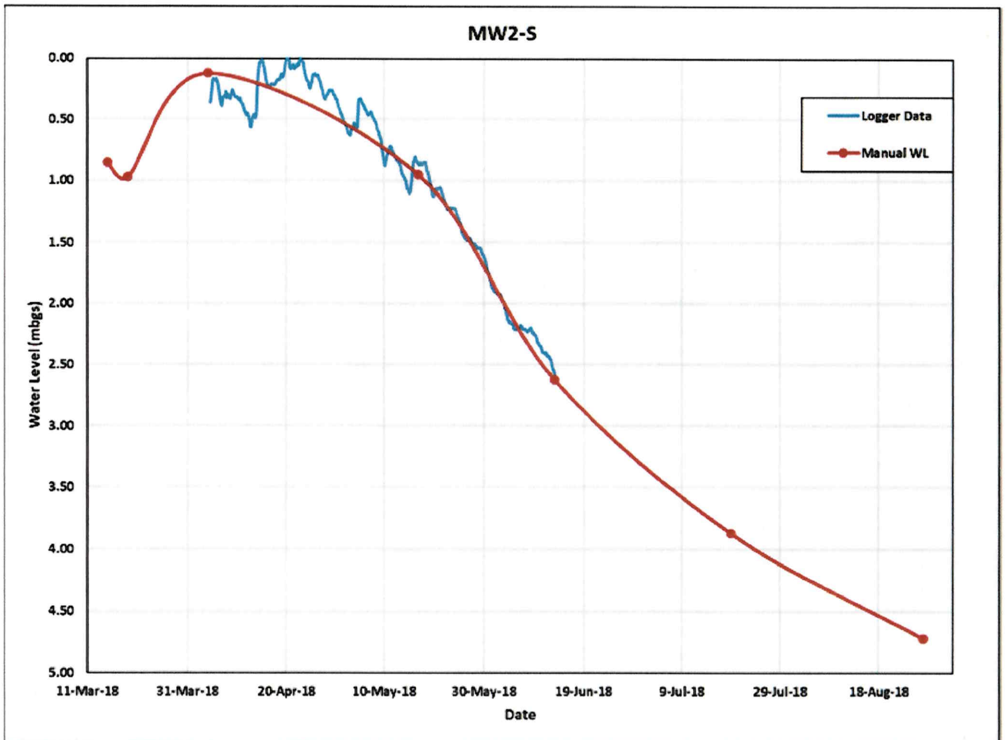
Silty Clay Till: Sediments of silty clay till from the Halton Till formation were encountered in all boreholes underlying either topsoil or earth fill. The thickness of this unit ranged from 4.10 m to 31.54 m, and the bottom of this unit was not encountered during drilling. This unit is expected to be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

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**).

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 3**).



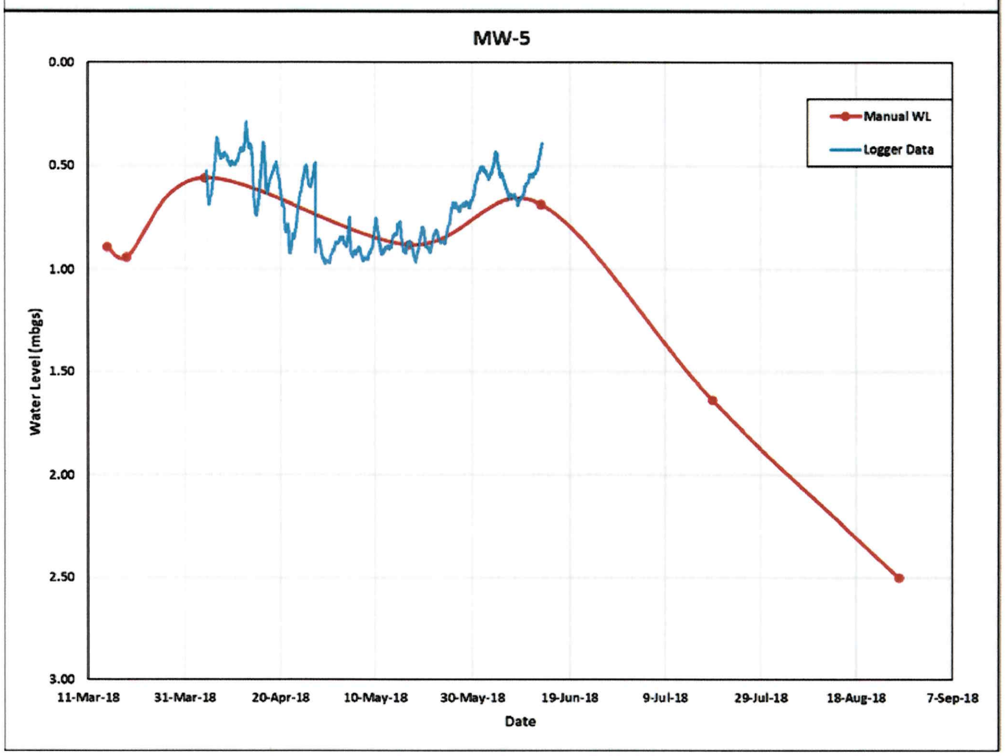
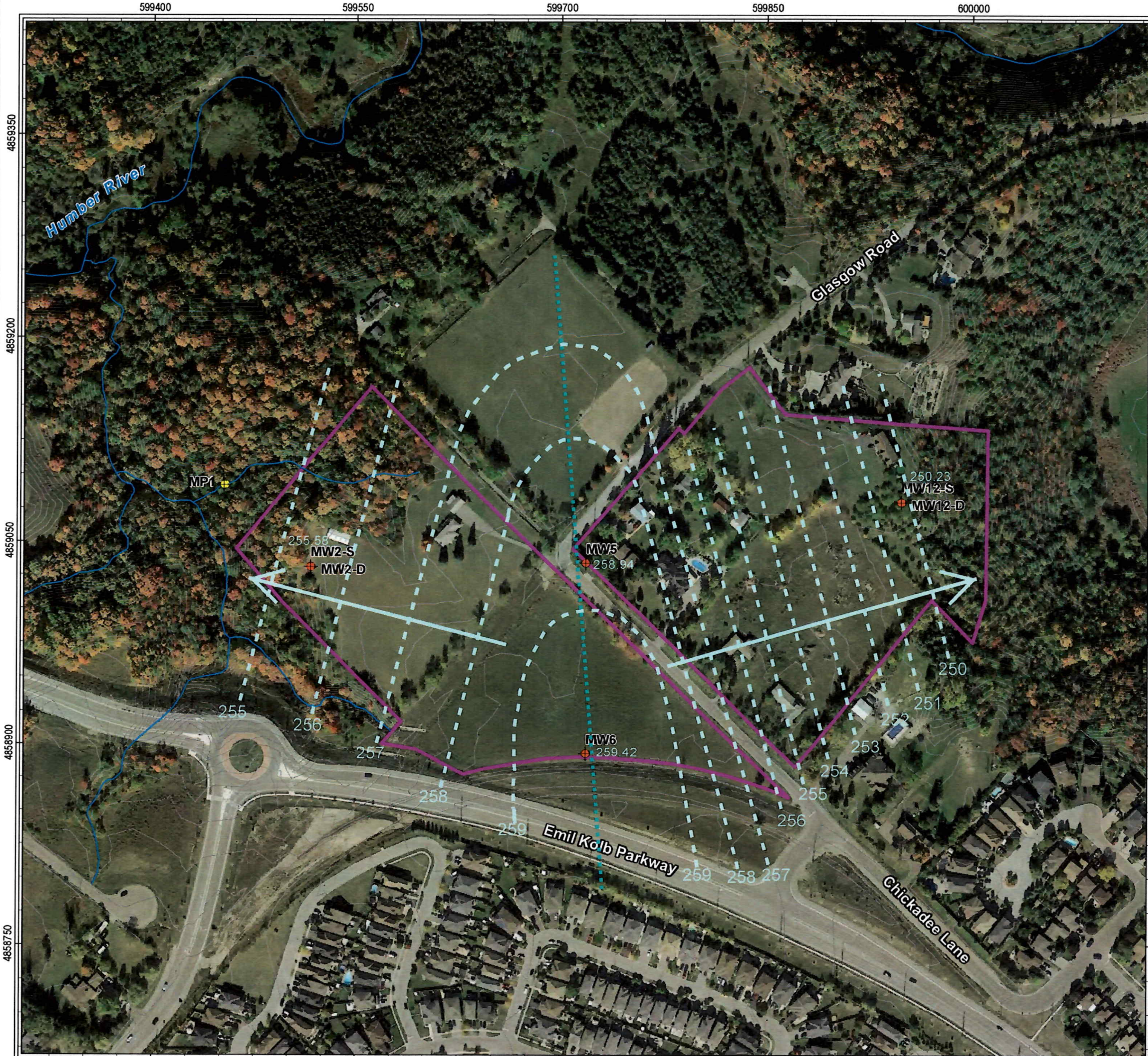


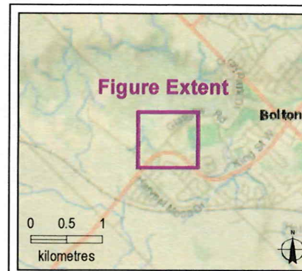
Figure 3. Recorded Groundwater Levels in MW-5 and MW-2S

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 4**). 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.

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.





Legend

- Potentiometric Surface (masl)
- Groundwater Flow Direction
- Local Groundwater Divide

*Manual Water Levels: April 4, 2018

0 25 50 75 100
metres

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Prepared by:

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Groundwater Flow

FIGURE 4

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3.4 Hydraulic Conductivity

On March 19 and April 4, 2018, PECG 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, **Section 2.2.1**).

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	5.1×10^{-7}	Silty Clay Till	Confined	6.1×10^{-7}
	RH	6.3×10^{-7}			
MW2-D	FH	1.2×10^{-7}			
	RH	1.3×10^{-7}			
MW5	FH	4.4×10^{-8}			
	RH	-			
MW6	FH	3.5×10^{-6}			
	RH	4.3×10^{-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*

3.5 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.

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
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***

Parameter	Units	Detection Limit	PWQO	Concentration (MW4)
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
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. 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 nearest to the study area, the Toronto Pearson International Airport (43°40' N, 79°37 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 5**), and land use (**Figure 6**) (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**.

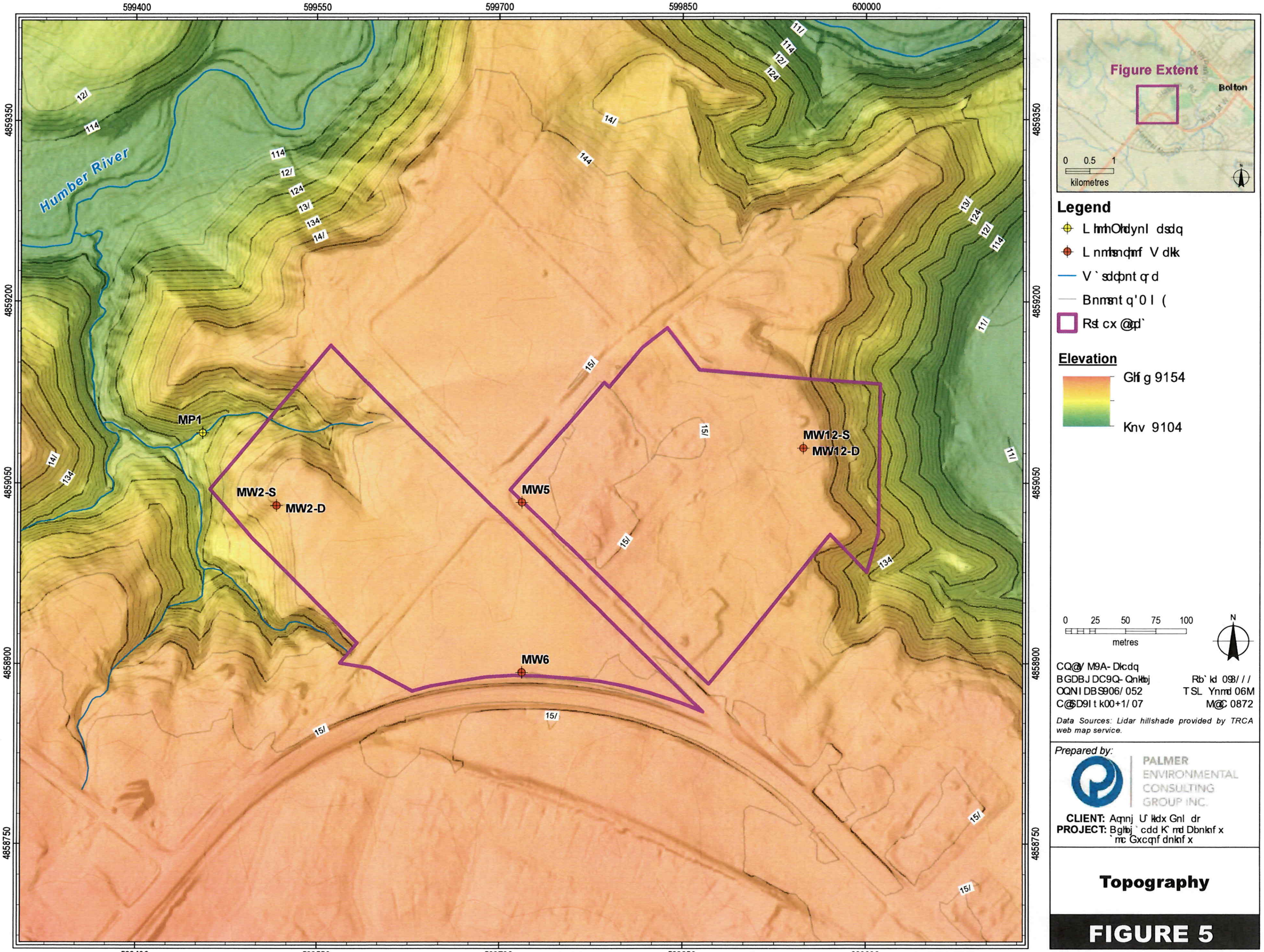
Table 5. Summary of Infiltration Factors (MOEE, 1995)

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 proposed site plan land use design provided by Humphries Planning Group (HPG, 2018; **Appendix A**). 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.



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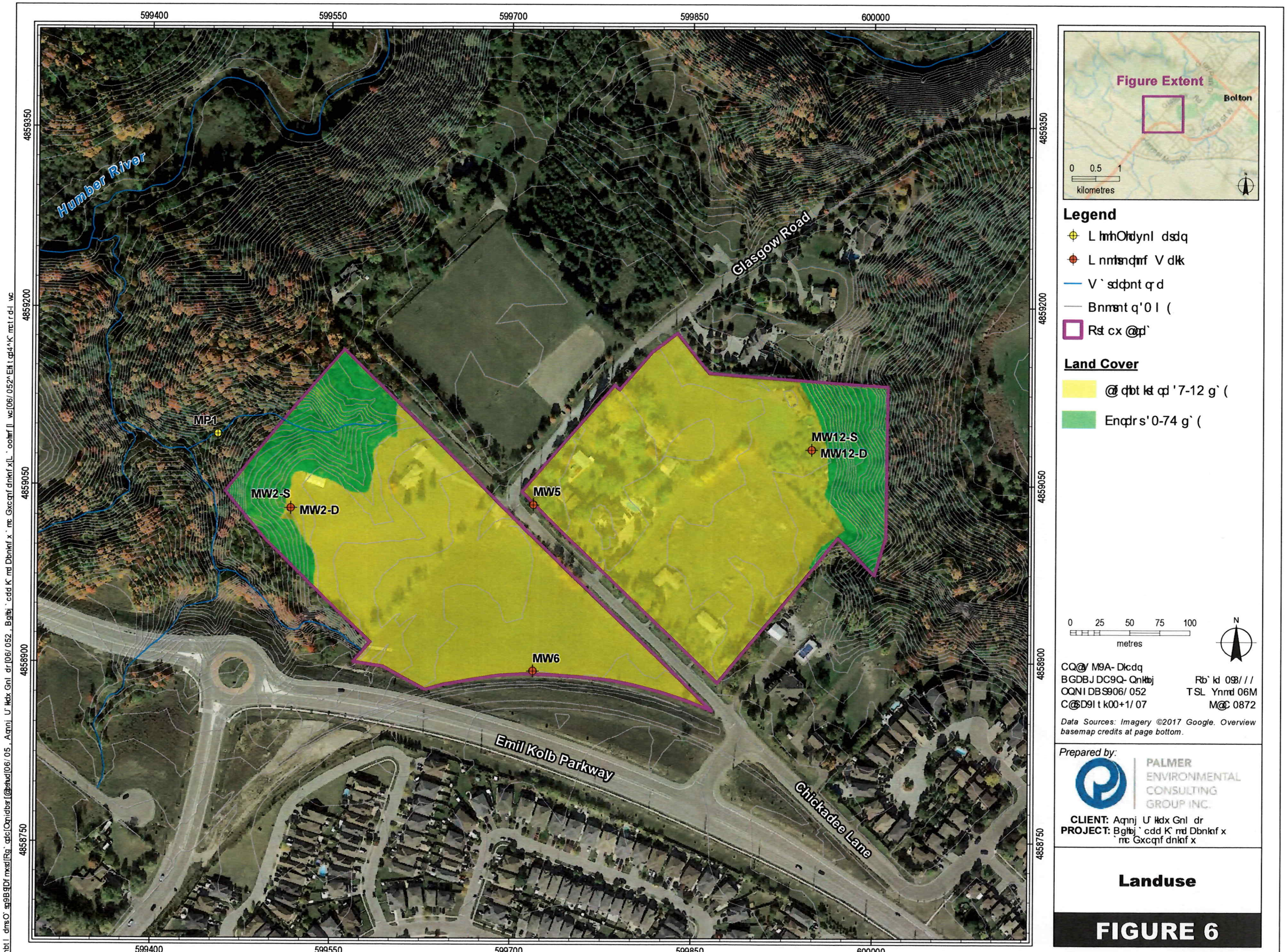

Landuse

FIGURE 6

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4.2 Pre-Development Water Balance Results

Based on 30-year climate normals, total precipitation at the site is approximately 786 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 499 mm/yr and 502 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 629 mm/yr (approximately 80% of total precipitation), while the soil moisture deficit is between 127 mm/yr (Forested) and 130 mm yr^{-1} (Agricultural/Rural Residential).

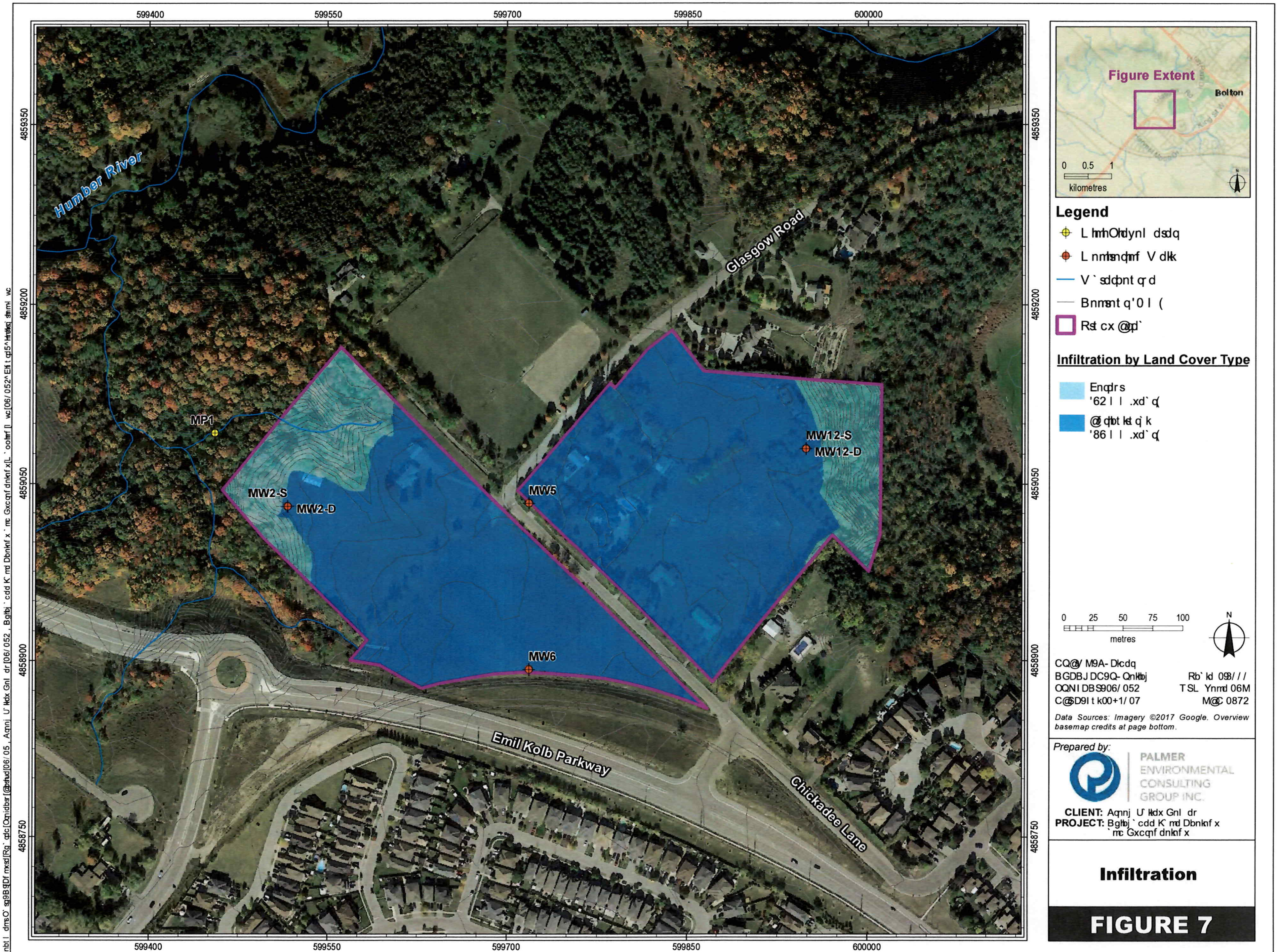
Estimated water surplus within the site ranges from approximately 284 mm/yr (Forested; 36% of total precipitation) to 287 mm/yr (Agricultural; 37% of total precipitation) and is divided into two components: infiltration and runoff. Using the method outlined in the MOE SWM manual and MOEE (1995), approximately 70% (401.77 mm/yr) of the surplus runs off, while the remaining 30% (169.23 mm/yr) infiltrates. Over the entire site area (100,800 m^2), this translates to approximately 9,363 m^3/yr of infiltration, and approximately 19,719 m^3/yr of runoff (**Table 7; Figures 7 & 8**). 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.

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)		51.8	47.7	49.8	68.5	74.3	71.5	75.7	78.1	74.5	61.1	75.1	57.9	786
Temperature (°C)		-5.5	-4.5	0.1	7.1	13.1	18.6	21.5	20.6	16.2	9.5	3.7	-2.2	8.18
Potential Evapotranspiration (PET) (mm)		0	0	0.3	34.7	78.4	117.5	140.5	123.8	81.5	40.5	11.8	0	628.9
P – PET		52	48	50	34	-4	-46	-65	-46	-7	21	63	58	157
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	35	112	103	92	67	42	40	12	0	502
	Soil Moisture Deficit (mm)	0	0	0	0	-34	15	49	57	40	0	0	0	127
	Surplus (P – AET)	**52**	**48**	**50**	**34**	**-38**	**-31**	**-16**	**11**	**33**	**21**	**63**	**58**	**283.6**
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	35	109	98	90	68	48	40	12	0	499
	Soil Moisture Deficit (mm)	0	0	0	0	-31	20	51	56	34	0	0	0	130
	Surplus (P – AET)	**52**	**48**	**50**	**34**	**-35**	**-26**	**-14**	**10**	**27**	**21**	**63**	**58**	**286.6**

Table 7. Summary of Pre-Development Water Balance Analysis

Land Use	Area (ha)	GIS-Based Infiltration (mm/yr)	GIS-Based Runoff (mm/yr)	GIS-Based Infiltration (m^3/yr)	GIS-Based Runoff (m^3/yr)
Agricultural/Rural Residential Area	8.23	96.64	190.36	8,007	15,771
Forested Area	1.85	72.59	211.41	1,356	3,948
Site Total	***10.08***	***169.23***	***401.77***	***9,363***	***19,719***



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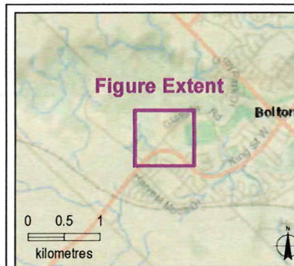

Legend

- L hmhOhdynl dsdq
- L nmhsnqhmf V dkk
- V `sdqbntqrd
- Bnmsntq'0 l (
- Rst cx @qd`

Runoff by Land Cover Type

- @ qbt kst q k '08/ l l .xd`q(
- Enqdrs '100 l l .xd`q(

0 25 50 75 100
metres

CQ@V M9A- Dkcdq
BGDBJ DC9Q- Qnhbj
OQNI DBS906/ 052
C@SD9 I t k00+1/ 07

Rb`kd 09/ / /
TSL Ynmd 06M
M@C 0872

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Prepared by:

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CLIENT: Aqnnj U`kkdx Gnl dr
PROJECT: Bgtbj`cdd K`md Dbnknf x `mc Gxcqnf dnknf x

Runoff

FIGURE 8

Cnbt l dms O`sg9 B9[Df mxsd[Rg`qdc[Qmidbs[@bshud[06/ 05 , Aqnnj U`kkdx Gnl dr[06/ 052 , Bgtbj`cdd K`md Dbnknf x `mc Gxcqnf dnknf x[L `oohmf [l wc[06/ 052^Ehf t qd6^Qt mnee l wc

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5. Development Considerations

5.1 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). Based on our understanding of site geology and groundwater conditions, it is expected that there is sufficient depth to the water table east of Blocks 17 to 20 and Blocks 9 to 14 (Street Townhouses). Additionally, this assumption assumes site grading following development remains the same as pre-development. It is possible that sufficient depth to the water table is achieved through the addition of at least 1 m of fill, particularly near the region of higher water table conditions located near the groundwater divide (**Figure 3**). This will assist in accounting for the apparent perched water table resulting from poor percolation through surficial material into the deeper actual water table at depths of 5 – 8 mbgs.

The surficial materials generally consist of low permeability silt and clay (10^{-8} m/s) therefore LID measures need to take this into consideration. 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. It is recommended that site-specific investigations to confirm site geology, groundwater conditions, and in-situ soil permeability are completed to assess the feasibility of infiltration LIDs.

5.2 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 considered to be 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 PECG 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 (approximately 40 m thick, **Section 3.1.2**). The low permeability of the till (geometric mean K = 6.1×10^{-7} m/s, **Section 3.4**) greatly limits groundwater recharge and contaminant migration.

5.3 Permit To Take Water (PTTW)

Under the new EASR system, water takings that are greater than 50,000 L/day but less than 400,000 L/day do not require a Permit to Take Water (PTTW) from the Ministry of the Environment and Climate Change (MOECC), however the project must be registered on the EASR and meet a series of environmental protection criteria. Based on the low permeability and consistency of the Halton Till aquitard at the site, a PTTW is not expected to be required for construction dewatering.

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 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.

- 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.

- 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 predominantly runoff supported.

- A water balance was completed for the site under both pre- and post-development scenarios. Results of these analyses showed that under pre-development conditions, approximately 9,363 m^3/yr of the annual surplus infiltrates the soils, and 19,719 m^3/yr becomes runoff. Following development and assuming no LID mitigation measures are implemented, a decrease in infiltration by approximately 5,179 m^3/yr (-55%) and an increase in runoff by approximately 27,385 m^3/yr (+139%) across the site is expected.

- 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.

7. Signatures

This report was prepared and reviewed by the undersigned:

Prepared By:

Ryan Rolick, M.Sc., GIT
Environmental Scientist

Reviewed By:

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

8. References

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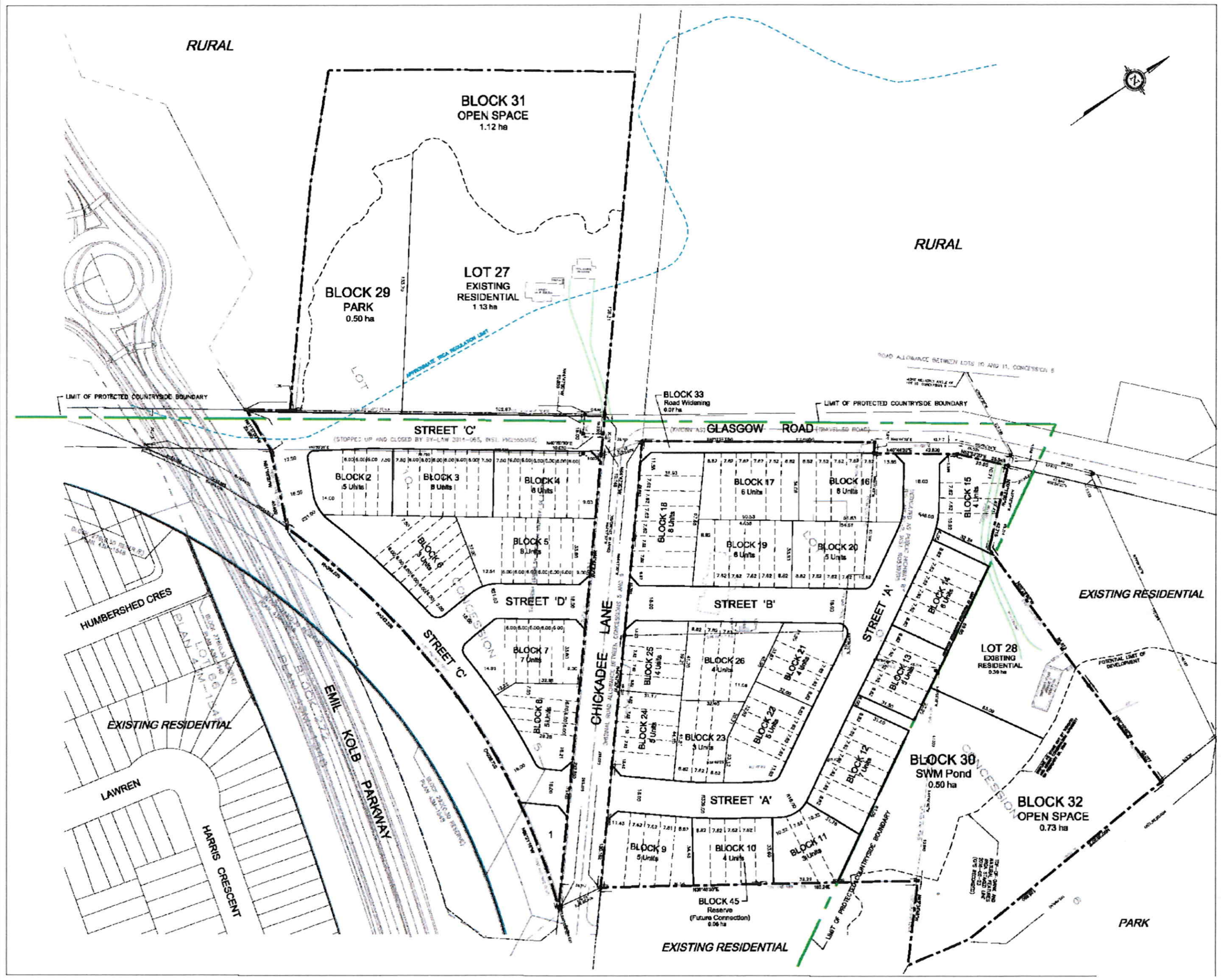
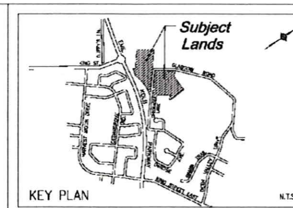
PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A

Chickadee Lane Rounding Out Area B Concept Plan (HPG, 2018)





KEY PLAN N.T.S.

HUMPHRIES PLANNING GROUP INC.

DEVELOPMENT STATISTICS: LAND USE	LOT/ BLK.#	UNITS	AREA
Single Detached Residential	1	1	0.06 ha
Street Townhouses	2–26	139	3.95 ha
Existing Residential	27–28	2	1.52 ha
Park	29		0.50 ha
Storm Water Management Pond	30		0.50 ha
Natural Heritage System	31–32		1.85 ha
Road Widening	33		0.07 ha
Roads STREETS A–D – 16.0m 18.0m R.O.W. – 693m			1.63 ha
TOTAL		142	10.08 ha

OWNER'S CERTIFICATE:

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

________________ Date: ________

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: ________

Kremar 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
OPTION 2

CHECKADEE GROVE COMMUNITY PLAN
PART OF LOT 10, CONCESSION 5
AND PART OF LOT 10, CONCESSION 6
TOWN OF CALEDON
REGIONAL MUNICIPALITY OF PEEL

SCALE 1:1000

10 0 10 20 50 100m

HUMPHRIES PLANNING GROUP INC.

File Number:	Drawing Number: A1
Date Drawn: 21 JULY 2017	
Drawn By: BT	
Checked By: H.H.	
Date Revised: 8 AUG 2017	
CAD File No. :	

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

Appendix B

Borehole Logs

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

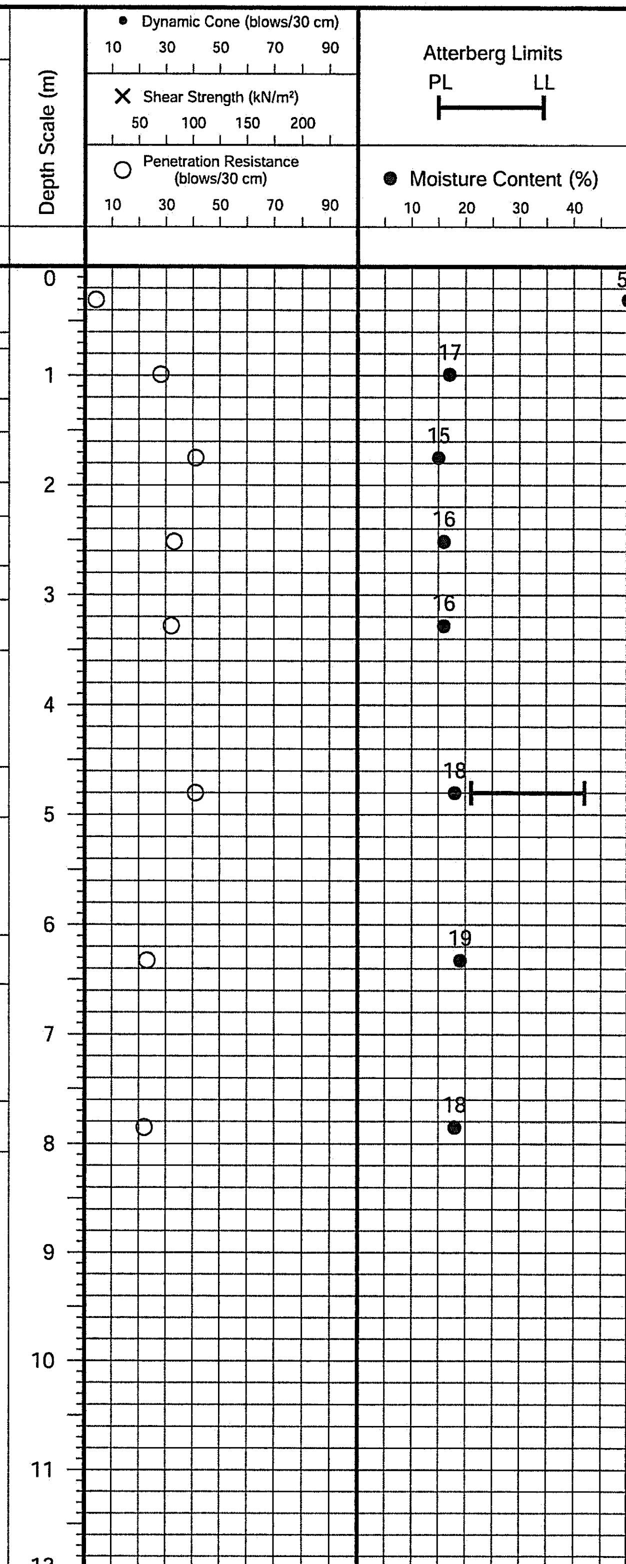
PROJECT DESCRIPTION: Proposed Residential Development

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	Sample Number	Type	N-Value	Moisture Content (%)
256.5	Ground Surface				
0.0	**160 mm TOPSOIL**				
	Brown, hard — weathered	1	DO	4	50
	SILTY CLAY TILL trace of gravel, occ. sand seams, cobbles and boulders	2	DO	28	17
		3	DO	41	15
		4	DO	33	16
		5	DO	32	16
		6	DO	41	18
	brown / grey				
		7	DO	23	19
		8	DO	22	18
8.1	**END OF BOREHOLE**				



WATER LEVEL: Dry on completion

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	Number	Type	N-Value	Moisture Content (%)
255.7	Ground Surface				
0.0	**160 mm TOPSOIL**				
	Brown, stiff to hard (weathered) **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders	1	DO	6	36
		2	DO	18	18
		3	DO	19	20
		4	DO	34	18
		5	DO	46	12
		6	DO	31	18
	brown / grey	7	DO	32	20
		8	DO	27	17
		9	DO	15	19
		10	DO	9	28

Depth Scale (m): 0–12

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

X 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

W.L @ Ele. 252.7 m upon completion.

-In @ 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	Samples Type	Samples N-Value	Depth Scale (m)	Penetration Resistance (blows/30 cm)	Moisture Content (%)	Atterberg Limits (PL–LL)	WATER LEVEL
		11	DO	21	12		18		Cave
		12	DO	22	14		18		
		13	DO	21	15		16		
		14	DO	28	17		12		
		15	DO	39	18		13		
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.**				20				

Chart scales: 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; Moisture Content (%) 10 20 30 40. Depth scale 12–22 m.

Soil Engineers Ltd.

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				0–7.6			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.**							

Depth Scale (m): 0 1 2 3 4 5 6 7 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	Samples Type	Samples N-Value	Depth Scale (m)	Penetration Resistance (blows/30 cm)	Moisture Content (%)	WATER LEVEL
255.8	Ground Surface							
0.0	**260 mm TOPSOIL**				0			Dry on completion
	Brown, very stiff to hard **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders (weathered)	1	DO	5		5	31	
		2	DO	28	1	28	17	
		3	DO	35	2	35	16	
		4	DO	38		38	18	
		5	DO	29	3	29	18	
					4			
		6	DO	37	5	37	15	
	brown / grey	7	DO	24	6	24	18	
6.5	**END OF BOREHOLE**				7–12			

Legend: ● Dynamic Cone (blows/30 cm) 10 30 50 70 90; X Shear Strength (kN/m²) 50 100 150 200; O Penetration Resistance (blows/30 cm) 10 30 50 70 90; Atterberg Limits PL LL; ● Moisture Content (%) 10 20 30 40

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	Sample Number	Type	N-Value	Moisture Content (%)	WATER LEVEL
258.9	Ground Surface					
0.0	**210 mm TOPSOIL** **EARTH FILL** brown and grey silty clay pockets of sand and gravel some topsoil and rootlets	1	DO	30	19	Dry on completion
		2	DO	8	19	
1.6	Brown, very stiff to hard **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders	3	DO	18	18	
		4	DO	35	18	
		5	DO	39	15	
		6	DO	61	16	
	brown / grey					
		7	DO	26	14	
6.5	**END OF BOREHOLE**					

Depth Scale (m): 0 – 12

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

X Shear Strength (kN/m²): 50 100 150 200

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

Atterberg Limits: PL LL

● Moisture Content (%): 10 20 30 40

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	Sample Number	Type	N-Value	Moisture Content (%)
259.5	Ground Surface				
0.0	**440 mm TOPSOIL**	1	DO	5	32
	EARTH FILL brown and grey silty clay, pockets of topsoil, some rootlets, occ. wood pieces	2	DO	3	33
		3	DO	6	34
2.4	Grey and brown, stiff to hard **SILTY CLAY TILL** trace of gravel, occ. sand seams, cobbles and boulders	4	DO	10	21
		5	DO	17	19
		6	DO	69	18
		7	DO	20	21
6.5	**END OF BOREHOLE**				

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.

Legend: ● Dynamic Cone (blows/30 cm) 10 30 50 70 90; X 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

Depth Scale (m): 0 – 12

WATER LEVEL: W.L @ Ele. 255.7 m upon completion.

Soil Engineers Ltd.

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	Sample Number	Type	N-Value	Depth Scale (m)	Moisture Content (%)
259.9	Ground Surface					
0.0	**230 mm TOPSOIL**				0	
	Very stiff to hard **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders (weathered)	1	DO	6		32
		2	DO	19	1	23
		3	DO	32		17
		4	DO	44	2	15
		5	DO	43	3	14
		6	DO	28	4	14
	brown / grey				5	
		7	DO	18	6	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.**				7–12	

Graph legend: ● 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

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	Sample Number	Type	N-Value	Moisture Content (%)
260.0	Ground Surface				
0.0	**280 mm TOPSOIL**				
	EARTH FILL brown silty clay mixed with topsoil some brick fragments	1	DO	9	26
0.9	Stiff to hard **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders	2	DO	14	21
		3	DO	30	16
		4	DO	33	17
		5	DO	40	17
	brown / grey	6	DO	21	17
		7	DO	30	16
6.5	**END OF BOREHOLE**				

Depth Scale (m): 0–12

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: W.L @ Ele. 259.7 m upon completion.

Soil Engineers Ltd.

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	Sample Number	Type	N-Value	Depth Scale (m)	Moisture Content (%)	WATER LEVEL
259.5	Ground Surface						
0.0	**210 mm TOPSOIL**				0		Dry on completion
0.2	Very stiff to hard **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders	1	DO	5		25	
	weathered						
		2	DO	23	1	17	
		3	DO	25		18	
					2		
		4	DO	44		15	
					3		
		5	DO	23		16	
					4		
		6	DO	23	5	16	
	brown / grey				6		
		7	DO	24		16	
6.5	**END OF BOREHOLE**				7		
					8		
					9		
					10		
					11		
					12		

Legend: ● 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

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	Sample Number	Type	N-Value	Depth Scale (m)	Penetration Resistance (blows/30 cm)	Moisture Content (%)
260.0	Ground Surface						
0.0	**280 mm TOPSOIL**				0		
0.3	**EARTH FILL** brown silty clay, pockets of topsoil, occ. rootlets	1	DO	3		3	38
0.8	Very stiff to hard **SILTY CLAY TILL** trace of gravel, occ. sand seams, cobbles and boulders	2	DO	7	1	7	20
		3	DO	7	2	7	25
		4	DO	27		27	19
		5	DO	33	3	33	16
	brown / grey				4		
		6	DO	25	5	25	16
		7	DO	25	6	25	19
6.5	**END OF BOREHOLE**				7		

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

Shear Strength (kN/m²): 50 100 150 200

Atterberg Limits: PL LL

WATER LEVEL

W.L @ Ele. 258.5 m upon completion.

Cave-In @ Ele. 256 m upon completion.

Soil Engineers Ltd.

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	Sample Number	Type	N-Value	Depth Scale (m)	Penetration Resistance (blows/30 cm)	Moisture Content (%)	WATER LEVEL
257.8	Ground Surface							
0.0	**280 mm TOPSOIL**				0			Dry on completion
0.3	Very stiff to hard **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders; weathered	1	DO	2			26	
		2	DO	28	1		17	
		3	DO	31	2		16	
		4	DO	30			17	
	brown / grey	5	DO	33	3		16	
		6	DO	26	4–5		17	
		7	DO	22	6		15	
6.5	**END OF BOREHOLE**				7–12			

Chart scales: 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

Soil Engineers Ltd.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 11

FIGURE NO.: 11

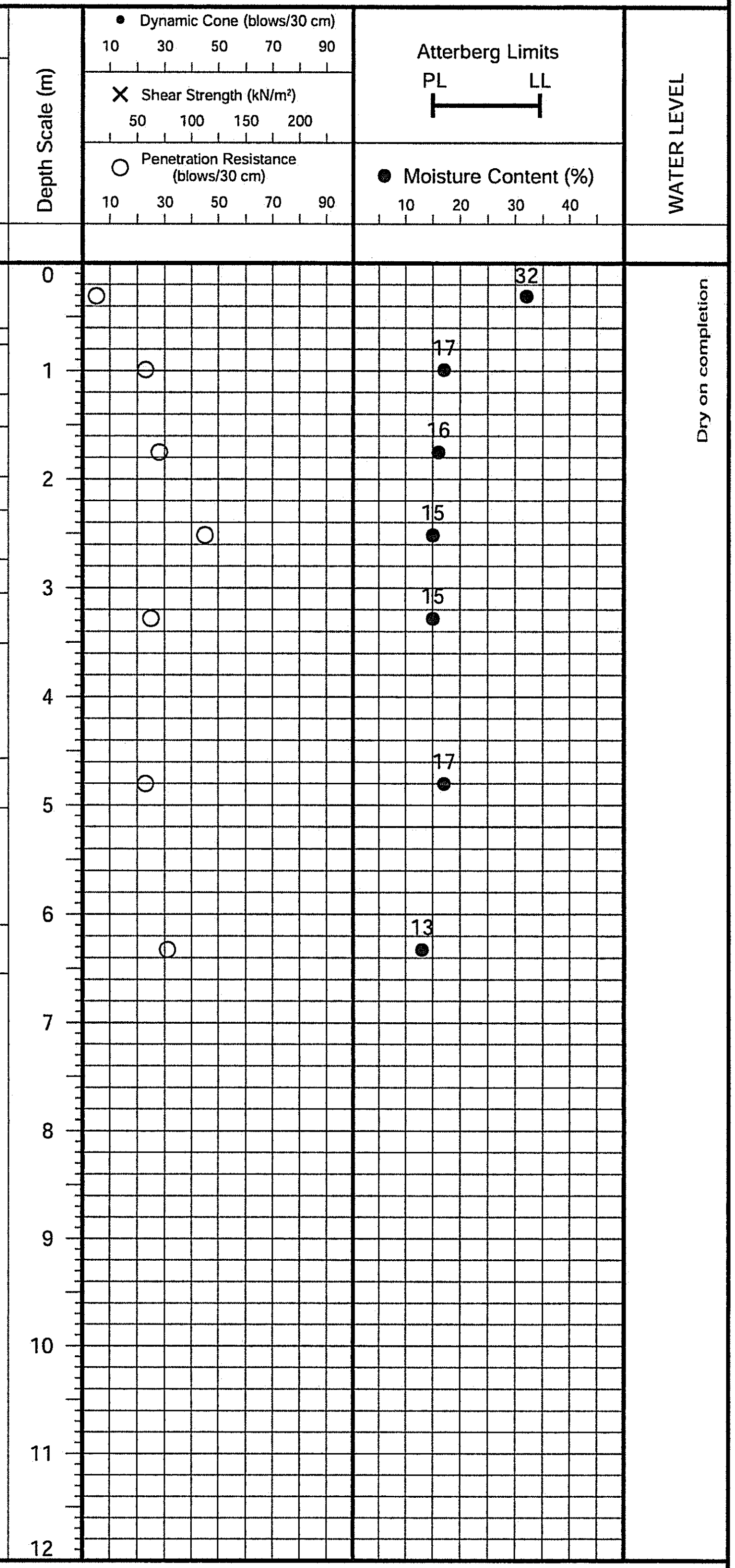
PROJECT DESCRIPTION: Proposed Residential Development

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	Number	Type	N-Value	Moisture Content (%)
259.3	Ground Surface				
0.0	**210 mm TOPSOIL**				
0.2	**EARTH FILL** dark brown silty clay mixed with topsoil some gravel	1	DO	5	32
0.6	Very stiff to hard **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders	2	DO	23	17
		3	DO	28	16
		4	DO	45	15
	brown / grey	5	DO	25	15
		6	DO	23	17
		7	DO	31	13
6.5	**END OF BOREHOLE**				



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)	Penetration Resistance (blows/30 cm)	Moisture Content (%)	Atterberg Limits	WATER LEVEL
258.3	Ground Surface								
0.0	**460 mm TOPSOIL**	1	DO	12	0	12	30		
	Very stiff to hard (weathered) **SILTY CLAY TILL** trace of gravel occ. sand seams, cobbles and boulders	2	DO	10	1	10	16		
		3	DO	38	2	38	16		
		4	DO	32		32	16		
		5	DO	39	3	39	16		
		6	DO	31	4–5	31	16		
		7	DO	25	6	25	17	PL–LL	
	brown / grey	8	DO	28	7–8	28	13		∇
		9	DO	24	9	24	16		
		10	DO	18	10–11	18	17		
					12				

Legend: ● Dynamic Cone (blows/30 cm) 10 30 50 70 90; X 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

W.L @ Ele. 252.2 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
					12			
		11	DO	11			20	
					13			
		12	DO	17	14		20	
					15			
		13	DO	11			29	
					16			
		14	DO	19	17		19	
					18			
		15	DO	20			18	
					19			
		16	DO	25	20		18	
					21			
		17	DO	18			29	
					22			
		18	DO	39	23		12	
					24			

Cave-In @ Ele. 243.1 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

Legend: ● Dynamic Cone (blows/30 cm) 10 30 50 70 90; X Shear Strength (kN/m²) 50 100 150 200; O Penetration Resistance (blows/30 cm) 10 30 50 70 90; Atterberg Limits PL — LL; ● Moisture Content (%) 10 20 30 40; WATER LEVEL

El. (m) Depth (m)	SOIL DESCRIPTION	Sample Number	Type	N-Value	Depth Scale (m)	Moisture Content (%)
		19	DO	37	24–25	15
		20	DO	29	26	13
	– – sandy	21	DO	43	27–28	12
		22	DO	78	29	14
		23	DO	52	30–31	12
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.**				32–34	

Soil Engineers Ltd.

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

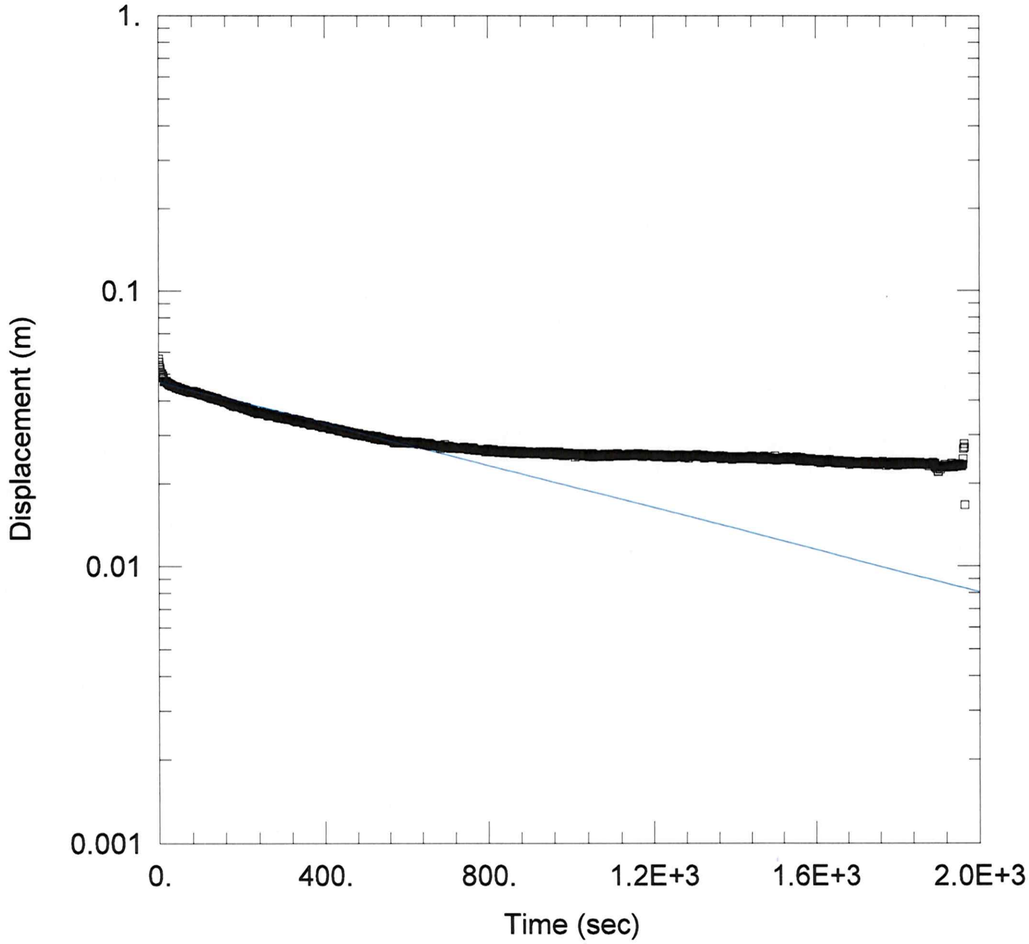
El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Depth Scale (m)	● Dynamic Cone (blows/30 cm) 10 30 50 70 90; X Shear Strength (kN/m²) 50 100 150 200; O Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL; ● Moisture Content (%) 10 20 30 40	WATER LEVEL
258.3	Ground Surface							
0.0	Direct Auger to Water Table to Install Nested Monitoring Well				0–7			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.**				8–12			

Soil Engineers Ltd.

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

Appendix C

Single Well Response Test Analyses



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

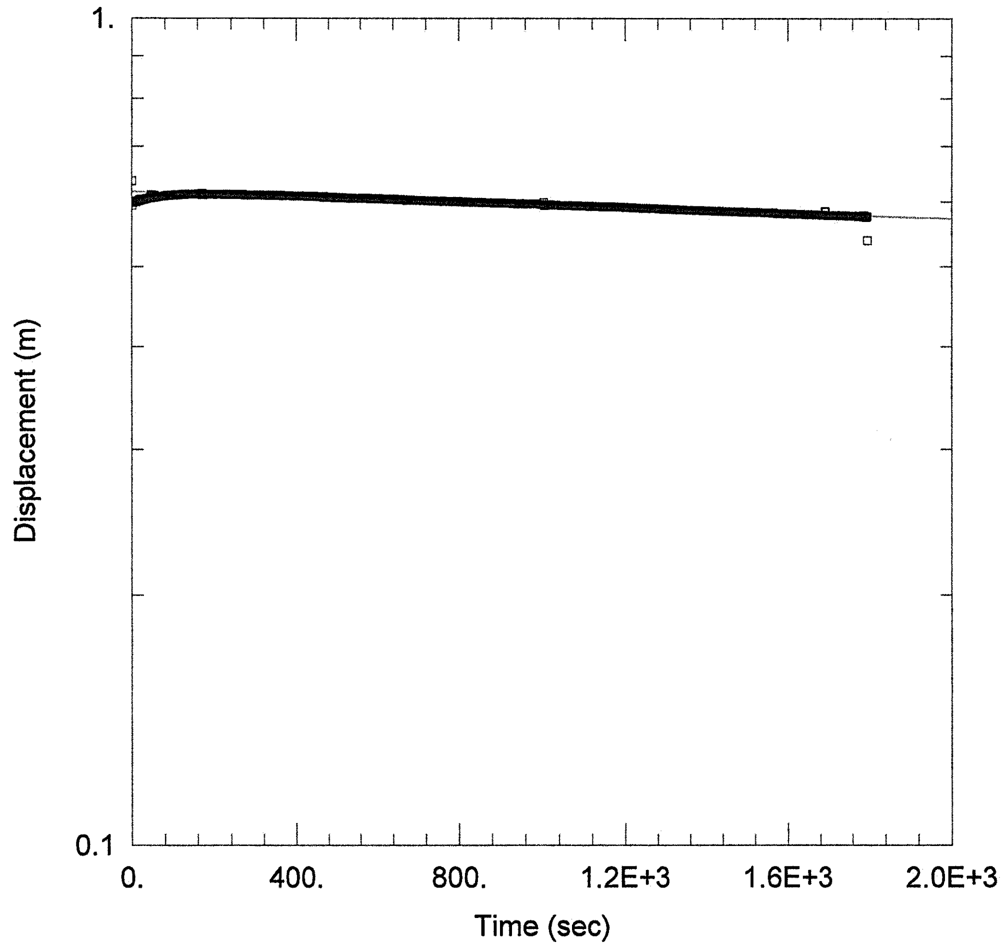
WELL DATA (MW5)

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

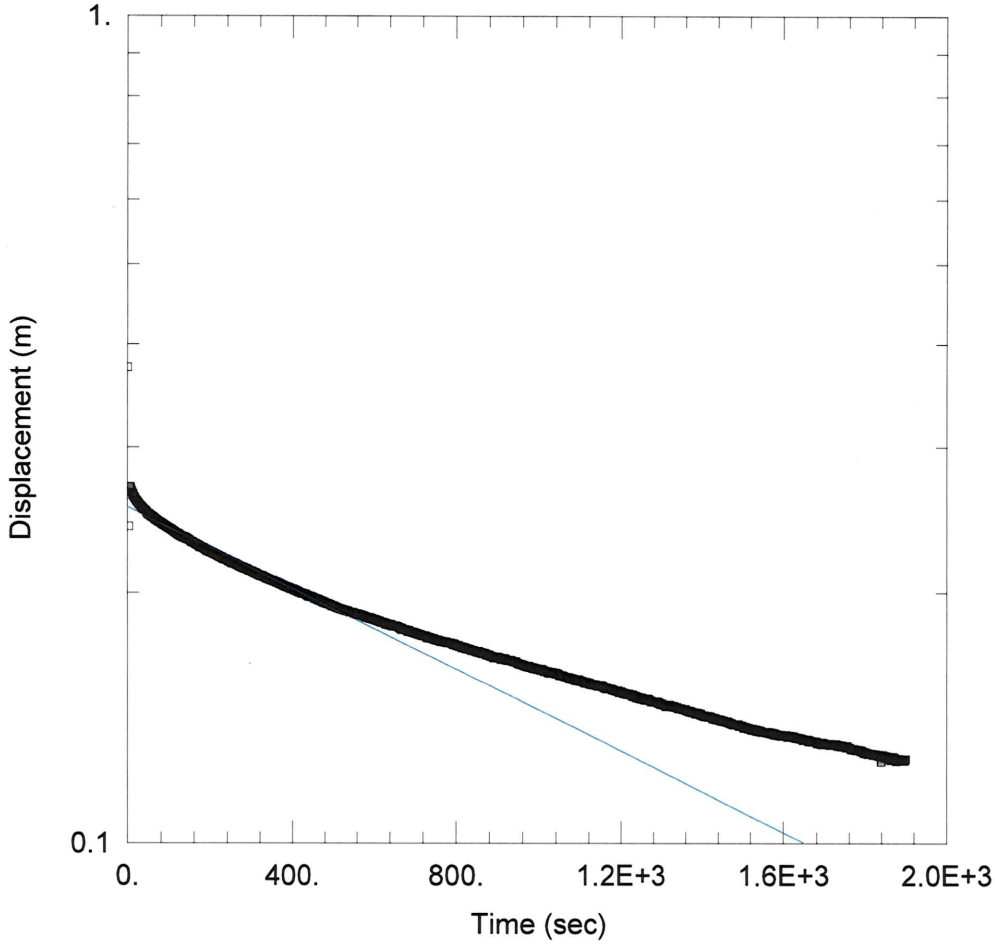
WELL DATA (MW5)

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

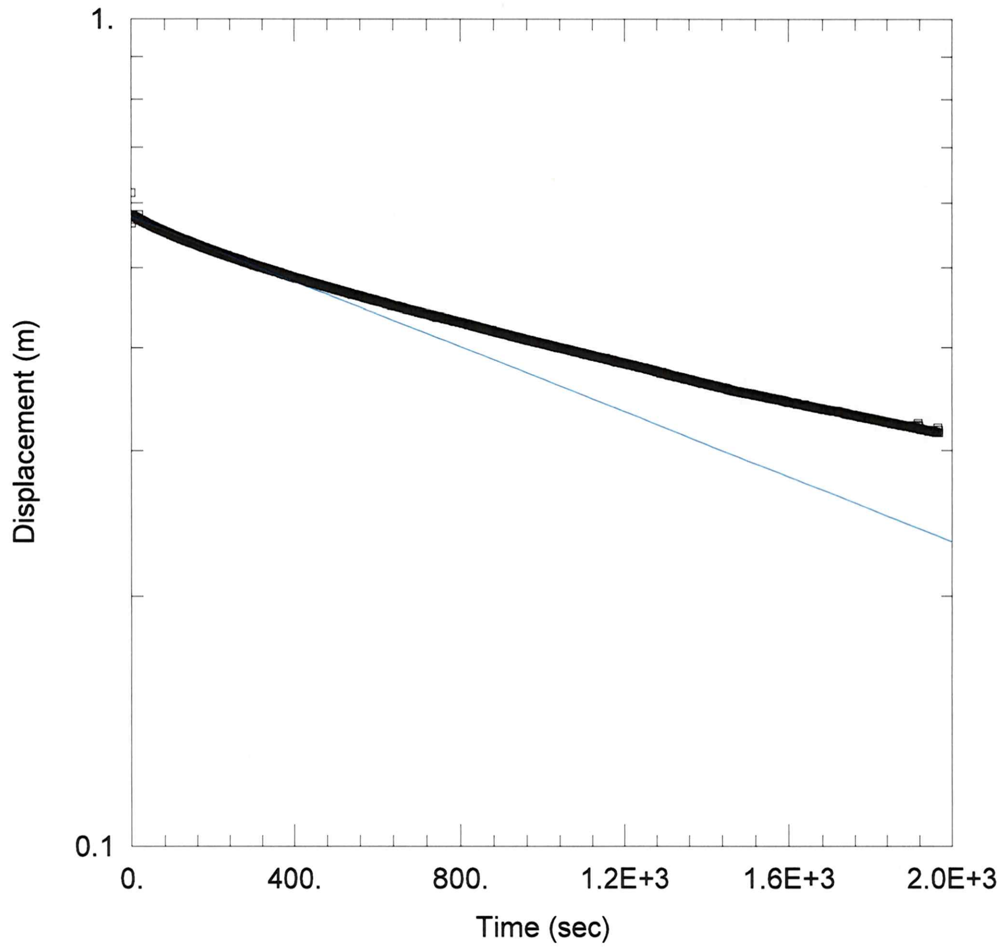
WELL DATA (MW2S)

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)

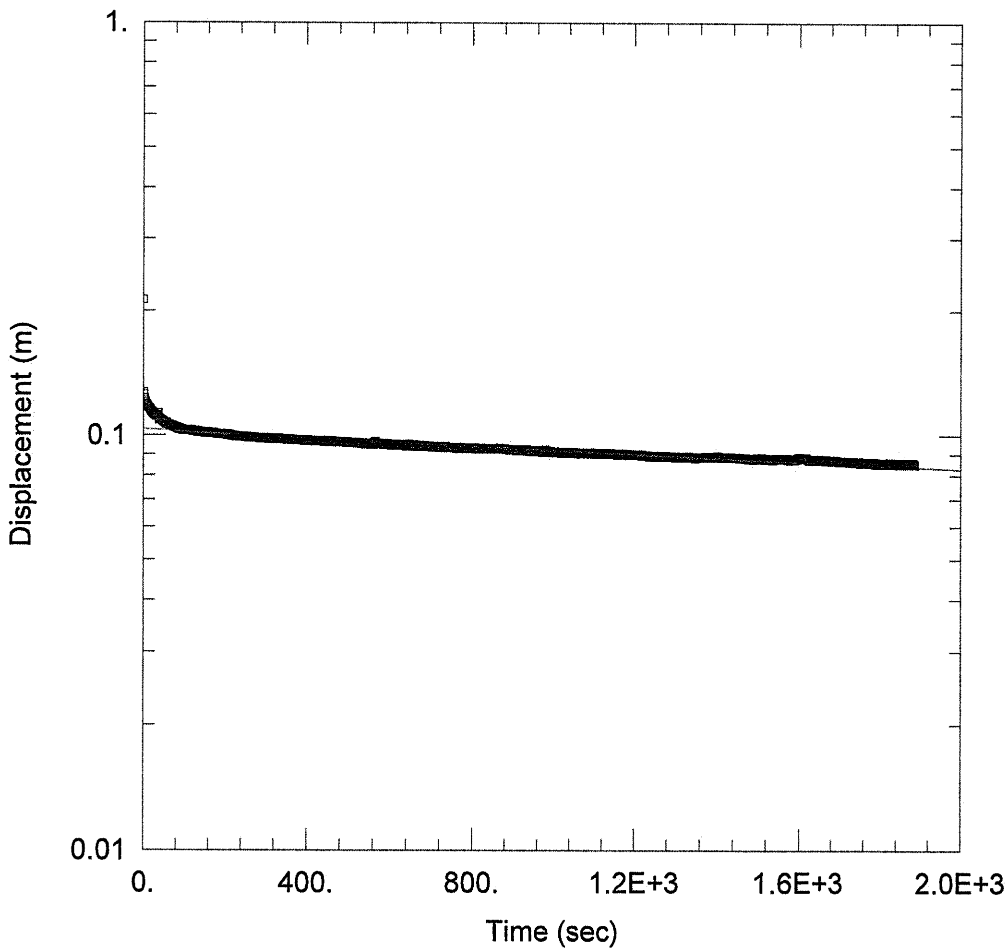
Initial Displacement: 0.6176 m
Total Well Penetration Depth: 5.84 m
Casing Radius: 0.0254 m

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)

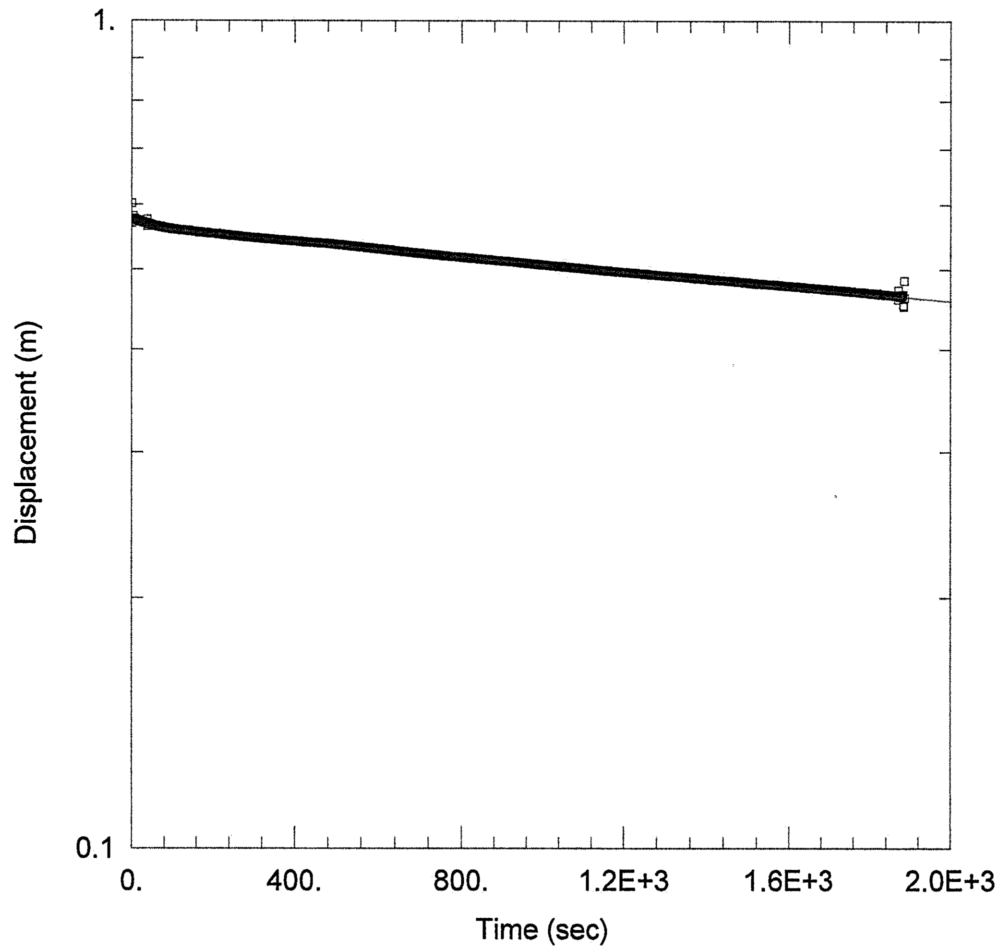
Initial Displacement: 0.213 m
Total Well Penetration Depth: 6.46 m
Casing Radius: 0.0254 m

Static Water Column Height: 6.46 m
Screen Length: 1.5 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

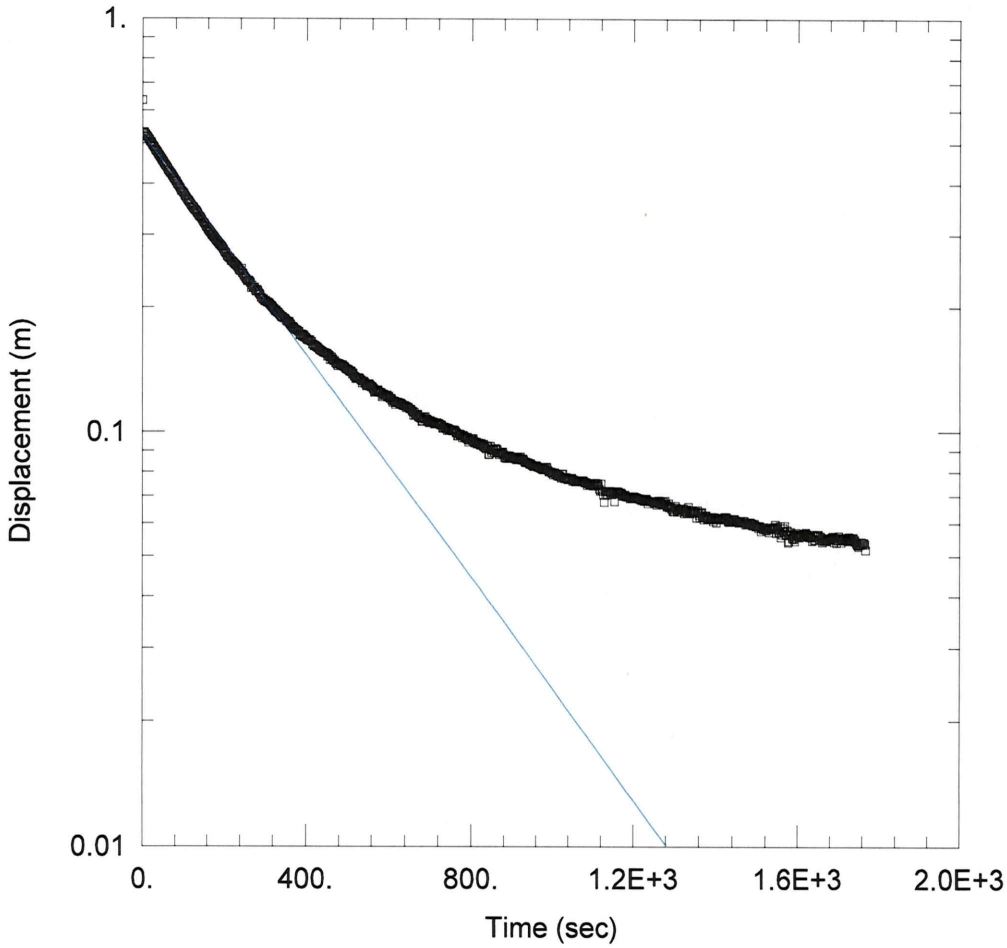
WELL DATA (MW2D)

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

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

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

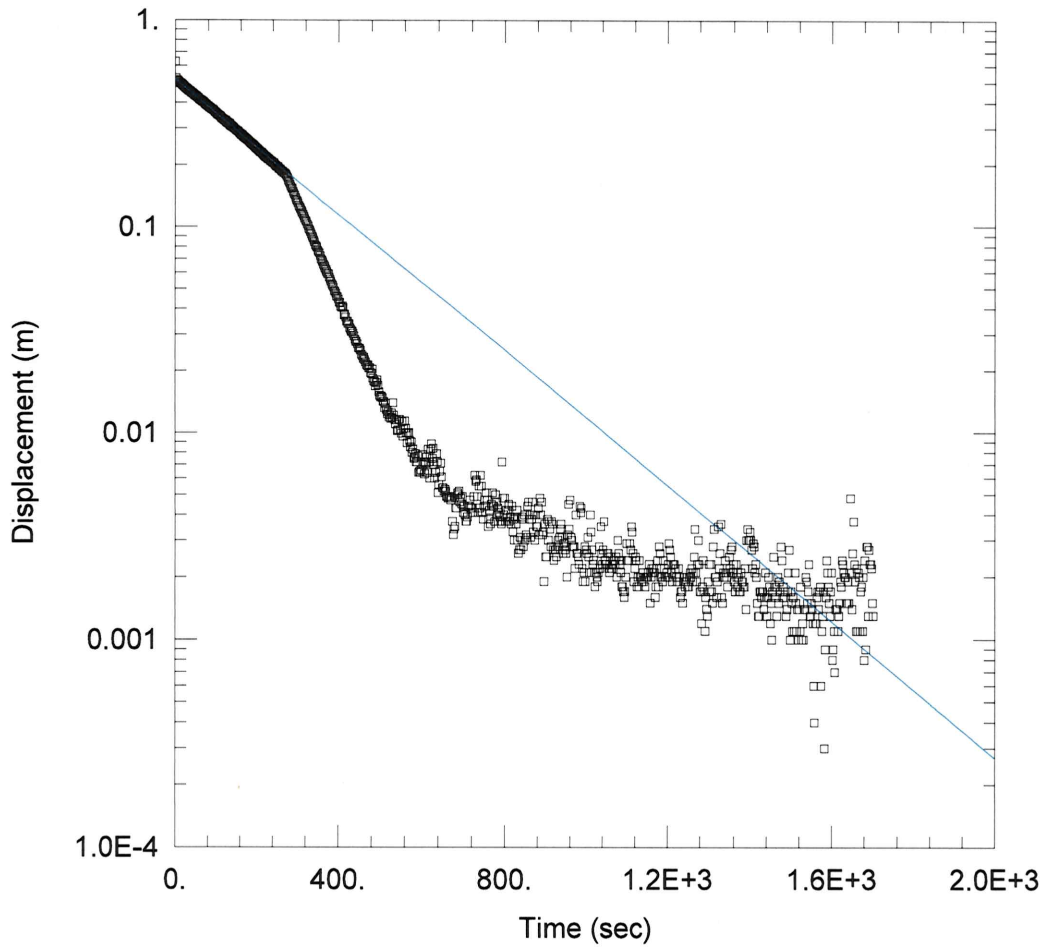
Saturated Thickness: 5.94 m
Anisotropy Ratio (Kz/Kr): 0.1

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:\...\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

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

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

Amanda Fazekas
Account Manager

170163 CHICKADEE LANE

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							
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**

170163 CHICKADEE LANE

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.

ALS Environmental

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

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
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

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			<0.0000050		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

ALS Environmental

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
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**						

ALS Environmental

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
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

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
Company:	PECG - PALMER ENVIRONMENTAL
Contact:	Ryan@pecg.ca
Phone:	604-790-6051
	Company address below will appear on the final report
Street:	74 Berkeley St
City/Province:	Toronto Ontario
Postal Code:	M5A 2W7
Invoice To	Same as Report To [X] YES [ ] NO
	Copy of Invoice with Report [X] YES [ ] NO
Company:	
Contact:	

Report Format / Distribution:

Select Report Format: [X] PDF [X] EXCEL [ ] EDD (DIGITAL)

Quality Control (QC) Report with Report [X] YES [ ] NO

[X] Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: [X] EMAIL [ ] MAIL [ ] FAX

Email 1 or Fax: Ryan@pecg.ca

Email 2: Corinne@pecg.ca

Email 3: Jason@pecg.ca

Invoice Distribution

Select Invoice Distribution: [X] EMAIL [ ] MAIL [ ] FAX

Email 1 or Fax: Jason@pecg.ca

Email 2:

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

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

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

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

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

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

Project Information

ALS Account # / Quote #:

Job #: 170163 Chickadee Lane

PO / AFE:

LSD:

ALS Lab Work Order # (lab use only): L2068971 IGB

Oil and Gas Required Fields (client use)

AFE/Cost Center: | PO#

Major/Minor Code: | Routing Code:

Requisitioner:

Location:

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, Cobal, EC, pH, Redox, TDS, Turb	NH3, TP	SAMPLES ON HOLD	Sample is hazardous (please provide further details)	NUMBER OF CONTAINERS
2	MW6	15-Mar-18	15:45	Groundwater	X	X	X	X	X	X			6

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

Are samples taken from a Regulated DW System? [ ] YES [X] NO

Are samples for human consumption/ use? [ ] YES [ ] NO

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

Compare with Ontario drinking water standards

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: [illegible]	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

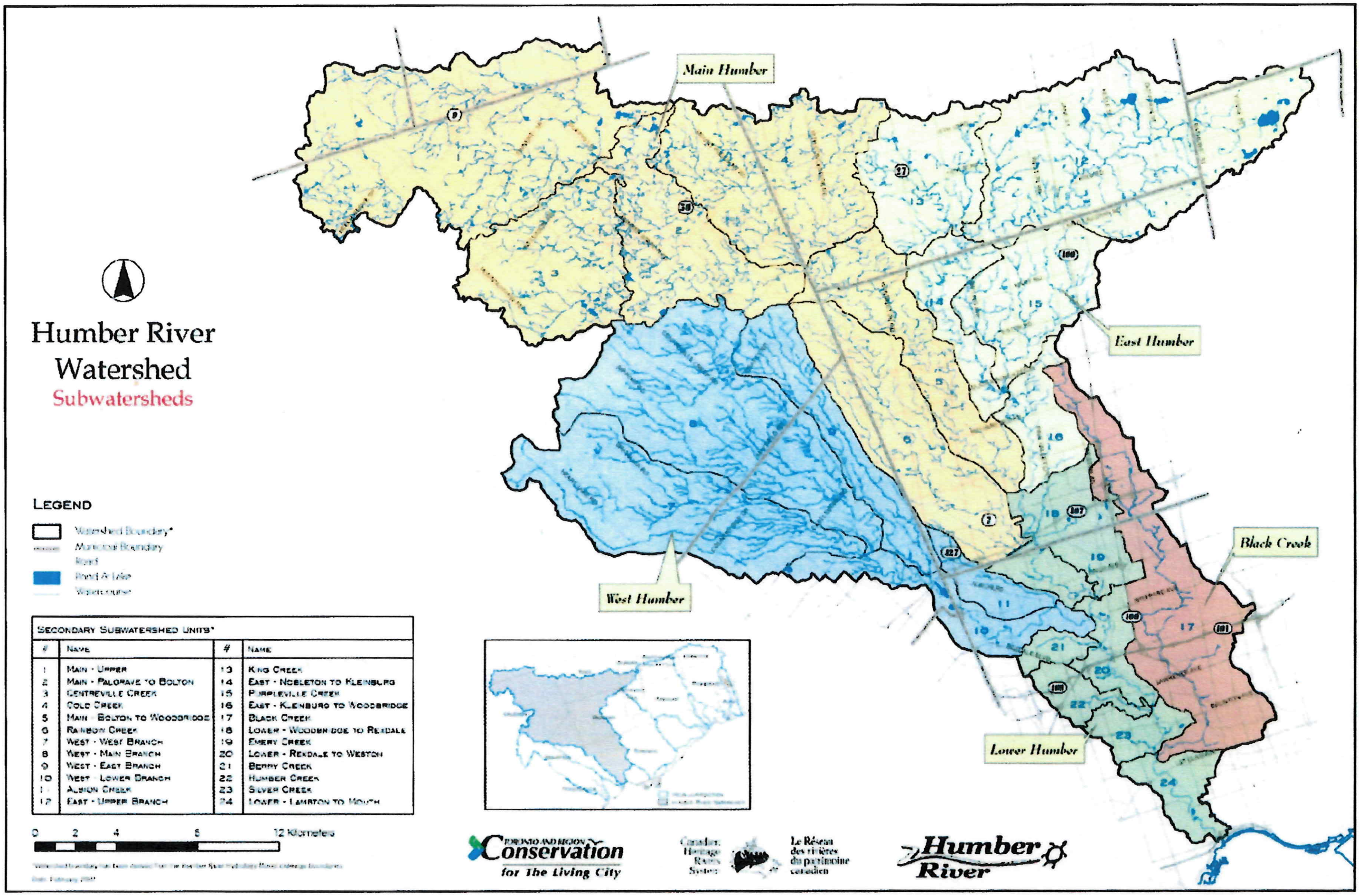
Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

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

APPENDIX "D"

Figure 4 Subwatershed Boundary - Humber River Watershed, Toronto and Region Conservation

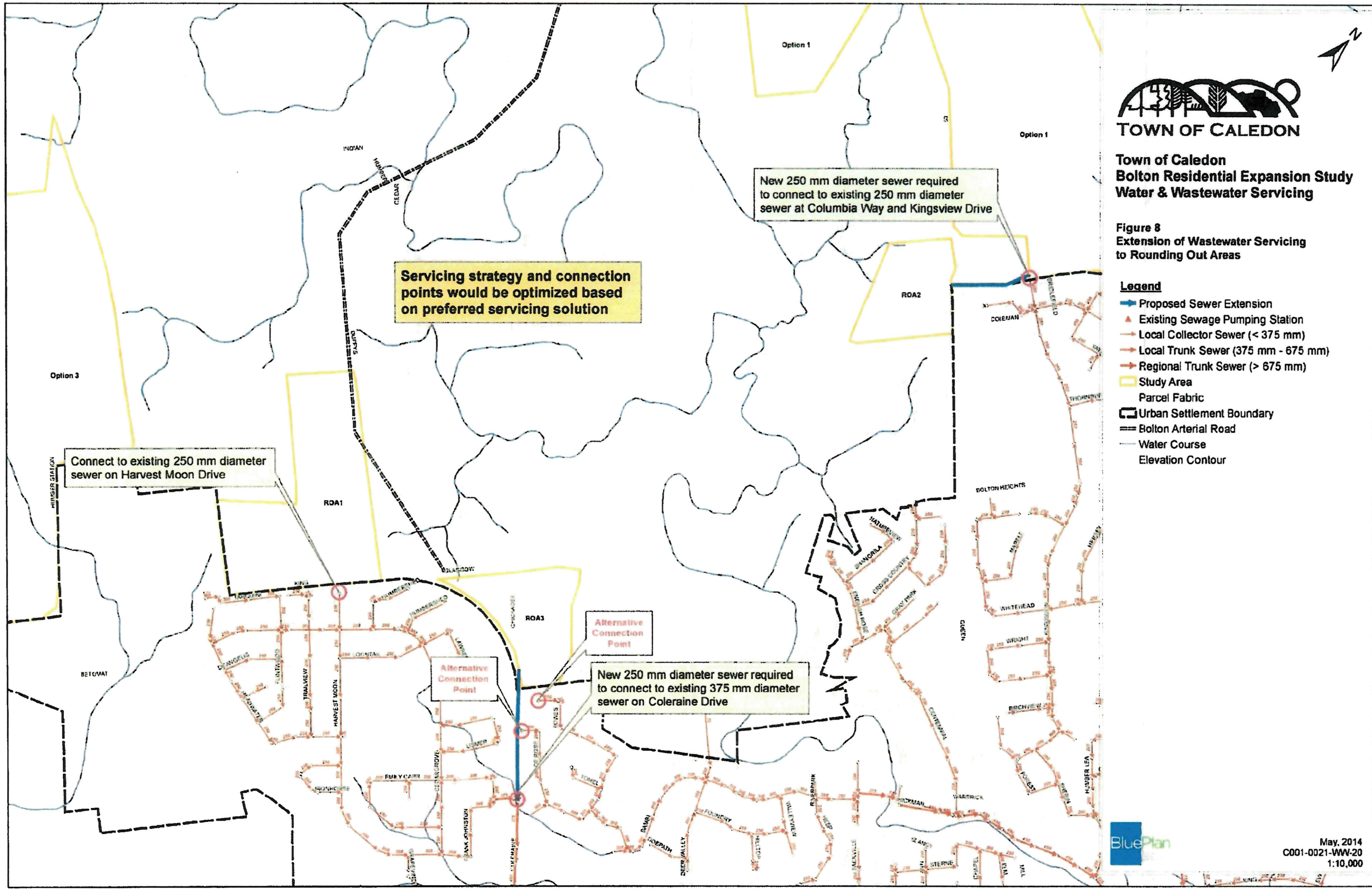
Figure 3-2: Subwatersheds



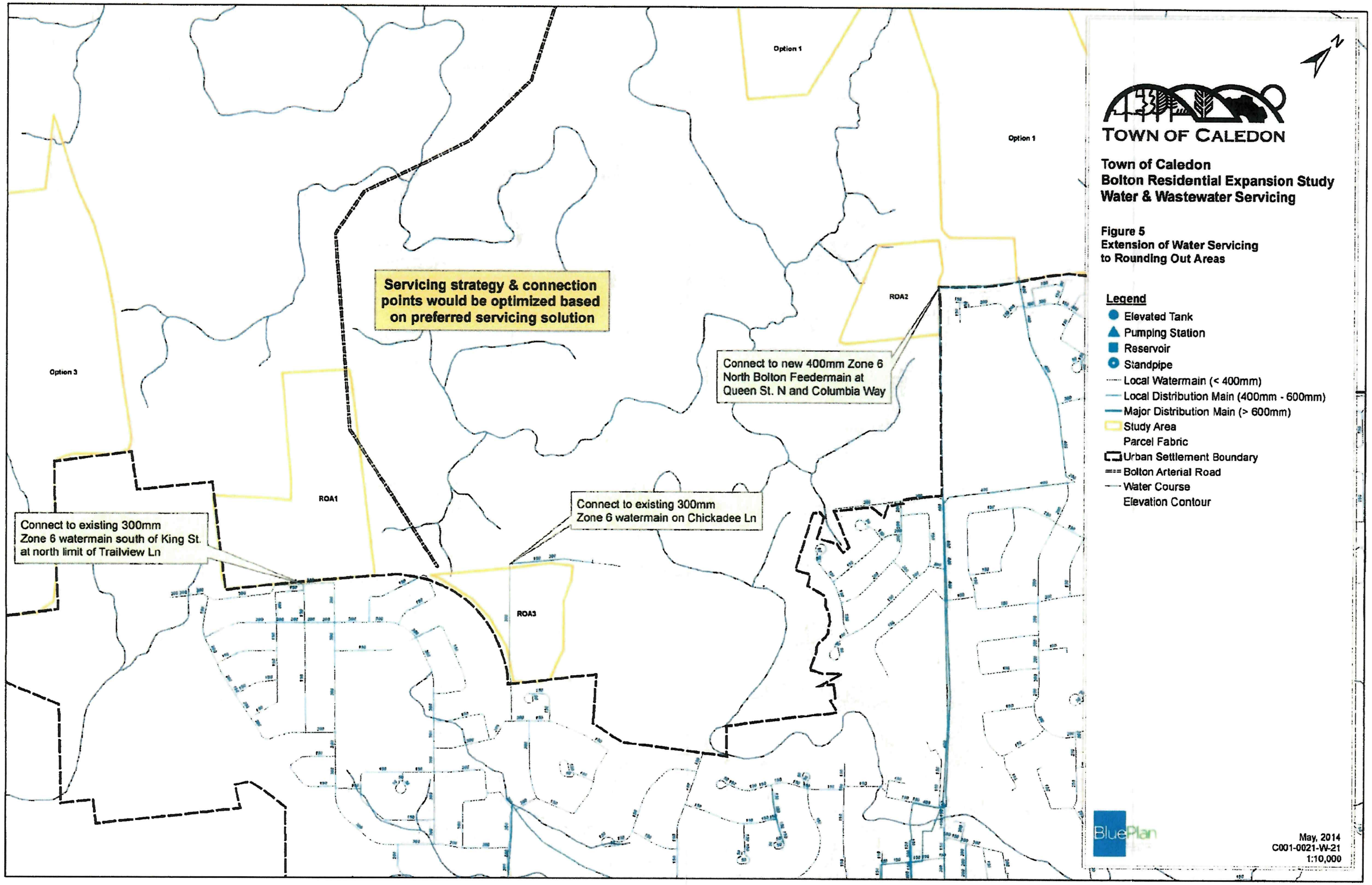
#	Name	#	Name
1	Main - Upper	13	King Creek
2	Main - Palgrave to Bolton	14	East - Nobleton to Kleinburg
3	Centreville Creek	15	Purpleville Creek
4	Cold Creek	16	East - Kleinburg to Woodbridge
5	Main - Bolton to Woodbridge	17	Black Creek
6	Rainbow Creek	18	Lower - Woodbridge to Rexdale
7	West - West Branch	19	Emery Creek
8	West - Main Branch	20	Lower - Rexdale to Weston
9	West - East Branch	21	Berry Creek
10	West - Lower Branch	22	Humber Creek
11	Albion Creek	23	Silver Creek
12	East - Upper Branch	24	Lower - Lambton to Mouth

APPENDIX "E"

Region of Peel, Figures 5 and 8, Bolton Residential Expansion Study, Infrastructure Report, Blue Plan Engineering Consultants Limited, June 16th 2014



TOWN OF CALEDON
Town of Caledon
Bolton Residential Expansion Study
Water & Wastewater Servicing
Figure 8
Extension of Wastewater Servicing
to Rounding Out Areas
Legend
Proposed Sewer Extension
Existing Sewage Pumping Station
Local Collector Sewer (< 375 mm)
Local Trunk Sewer (375 mm - 675 mm)
Regional Trunk Sewer (> 675 mm)
Study Area
Parcel Fabric
Urban Settlement Boundary
Bolton Arterial Road
Water Course
Elevation Contour
Servicing strategy and connection points would be optimized based on preferred servicing solution
New 250 mm diameter sewer required to connect to existing 250 mm diameter sewer at Columbia Way and Kingsview Drive
Connect to existing 250 mm diameter sewer on Harvest Moon Drive
New 250 mm diameter sewer required to connect to existing 375 mm diameter sewer on Coleraine Drive
Alternative Connection Point
Alternative Connection Point
Option 1
Option 1
Option 3
ROA1
ROA2
ROA3
HARVEST MOON
TRAILVIEW
BOLTON HEIGHTS
COLEMAN
WHITEHEAD
WRIGHT
QUEEN
HUMBER STATION
CEDAR
BlueP1an
May, 2014
C001-0021-WW-20
1:10,000


Option 1
Option 1
Option 3
Servicing strategy & connection points would be optimized based on preferred servicing solution
Connect to new 400mm Zone 6 North Bolton Feedermain at Queen St. N and Columbia Way
ROA2
ROA1
ROA3
Connect to existing 300mm Zone 6 watermain on Chickadee Ln
Connect to existing 300mm Zone 6 watermain south of King St. at north limit of Trailview Ln
N
TOWN OF CALEDON
Town of Caledon
Bolton Residential Expansion Study
Water & Wastewater Servicing
Figure 5
Extension of Water Servicing to Rounding Out Areas
Legend
Elevated Tank
Pumping Station
Reservoir
Standpipe
Local Watermain (< 400mm)
Local Distribution Main (400mm - 600mm)
Major Distribution Main (> 600mm)
Study Area
Parcel Fabric
Urban Settlement Boundary
Bolton Arterial Road
Water Course
Elevation Contour
BluePlan
May, 2014
C001-0021-W-21
1:10,000

APPENDIX "F"

Sanitary Sewer Design Sheets for Proposed Subdivision; Region of Peel *Connections Multi-Use Demand Tables*

CANDEVCON LIMITED
CONSULTING ENGINEERS AND PLANNERS
9358 GOREWAY DRIVE TEL (905) 794-0600
BRAMPTON ON. L6P-0M7 FAX (905) 794-0611

Subdivision:	**CHICKADEE GROVE COMMUNITY**	**TOWN OF CALEDON**	**Project No.:** W17003
File No.:	REGION:21T-XX / TOWN:	**SANITARY DRAINAGE AREA PLAN**	**DATE :** AUG/26/2021
Consultant:	**Candevcon Limited**	**DESIGN SHEET-FSR**	**Prepared By:** RAJAH
Drainage Area Plan	SA-1		**Checked By:** DKH

Location	From MH	To MH	Area No.	Area (ha)	Density (ppha)	Population (Equivalent)	Cumulative Area (ha)	Cumulative Population	Sewage Flow (m3/s)	Infiltration Flow (m3/s)	Total Flow (m3/s)	Length (m)	Pipe Diameter (mm)	Gradient %	Manning (n)	Velocity (full) (m/s)	Capacity (m3/s)	Qpipe/Qfull %	REMARK
STREET A	MH1A	MH2A	1	0.19	75	14	0.19	14	0.013	0.000038	0.013038	23	250	1.00%	0.013	1.21	0.059	22%	
STREET A	MH2A	MH3A	2	0.39	75	29	0.58	44	0.013	0.000116	0.013116	78.2	250	0.50%	0.013	0.86	0.042	31%	
STREET A	MH3A	MH4A	3	0.66	75	50	1.24	93	0.013	0.000248	0.013248	78.2	250	0.50%	0.013	0.86	0.042	32%	
STREET A	MH4A	MH5A	4	0.28	75	21	1.52	114	0.013	0.000304	0.013304	36.6	250	0.50%	0.013	0.86	0.042	32%	
STREET A	MH5A	MH6A	5	0.45	75	34	1.97	148	0.013	0.000394	0.013394	67.8	250	0.50%	0.013	0.86	0.042	32%	
STREET B	MH10A	M11A	6	0.22	75	17	0.22	17	0.013	0.000044	0.013044	26.2	250	1.00%	0.013	1.21	0.059	22%	
STREET B	MH11A	MH12A	15	0.5	75	38	0.72	54	0.013	0.000144	0.013144	100	250	0.50%	0.013	0.86	0.042	31%	
GLASGOW RD	MH7A	MH8A	14	0.21	75	16	0.21	16	0.013	0.000042	0.013042	32.6	250	1.00%	0.013	1.21	0.059	22%	
GLASGOW RD	MH8A	MH9A	7	0.37	75	28	0.58	44	0.013	0.000116	0.013116	100	250	0.50%	0.013	0.86	0.042	31%	
STREET C	MH14A	MH13A	13	0.25	75	19	0.25	19	0.013	0.00005	0.01305	42	250	1.00%	0.013	1.21	0.059	22%	
STREET C	MH13A	MH9A	16	0.48	75	36	0.73	55	0.013	0.000146	0.013146	100	250	0.50%	0.013	0.86	0.042	31%	
CHICKADEE LANE	MH9A	MH12A	8	0.37	75	28	1.68	126	0.013	0.000336	0.013336	88.5	250	0.50%	0.013	0.86	0.042	32%	
STREET D	MH15A	MH12A	11	0.55	75	41	0.55	41	0.013	0.00011	0.01311	57.7	250	1.00%	0.013	1.21	0.059	22%	
CHICKADEE LANE	MH12A	MH6A	9	0.44	75	33	3.39	254	0.013	0.000678	0.013678	98	250	0.50%	0.013	0.86	0.042	33%	
STREET C	MH16A	MH17A	12	0.51	75	38	0.51	38	0.013	0.000102	0.013102	58.8	250	1.00%	0.013	1.21	0.059	22%	
STREET C	MH17A	MH18A	10	0.38	75	29	0.89	67	0.013	0.000178	0.013178	83.3	250	0.50%	0.013	0.86	0.042	31%	
STREET C	MH18A	MH6A			75	0	0.89	67	0.013	0.000178	0.013178	28.8	250	0.50%	0.013	0.86	0.042	31%	
CHICKADEE LANE	MH6A	MH19A			75	0	6.25	469	0.013	0.00125	0.01425	75	250	0.50%	0.013	0.86	0.042	34%	
CHICKADEE LANE	MH19A	MH20A			75	0	6.25	469	0.013	0.00125	0.01425	100	250	0.50%	0.013	0.86	0.042	34%	
CHICKADEE LANE	MH20A	MH21A			75	0	6.25	469	0.013	0.00125	0.01425	100	250	0.50%	0.013	0.86	0.042	34%	
CHICKADEE LANE	MH21A	MH22A			75	0	6.25	469	0.013	0.00125	0.01425	100	250	0.50%	0.013	0.86	0.042	34%	
CHICKADEE LANE	MH22A	MH23A			75	0	6.25	469	0.013	0.00125	0.01425	46	250	0.50%	0.013	0.86	0.042	34%	
CHICKADEE LANE	MH23A	EX.MH100A			75	0	6.25	469	0.013	0.00125	0.01425	100	250	0.50%	0.013	0.86	0.042	34%	

REGION OF PEEL DESIGN CRITERIA (STD.DWG.2-9-2)

Unit Sewage flow :	Resid. =	302.8	L/c/day
Sewage flow for less than 1000 persons = 0.013m3/s			
Peaking Factor:	1+14/(4+(P)^0.5)		P = Pop. in 1000's
Infiltration:	pipe	0.0002	$m^3/s/ha$
Manning's Co-eff.:		n =	0.013

APPENDIX “G”

Hydrant Flow Test

Region of Peel Connections Multi-Use Demand Table

HYDRATEST

7-325 Nantucket Blvd, Scarborough ON M1P 4V5

JOB NO. BROOKVALLEY DATE FEBRUARY 2ND, 2022

LOCATION CHICKADEE LANE, CALEDON

TEST DATA

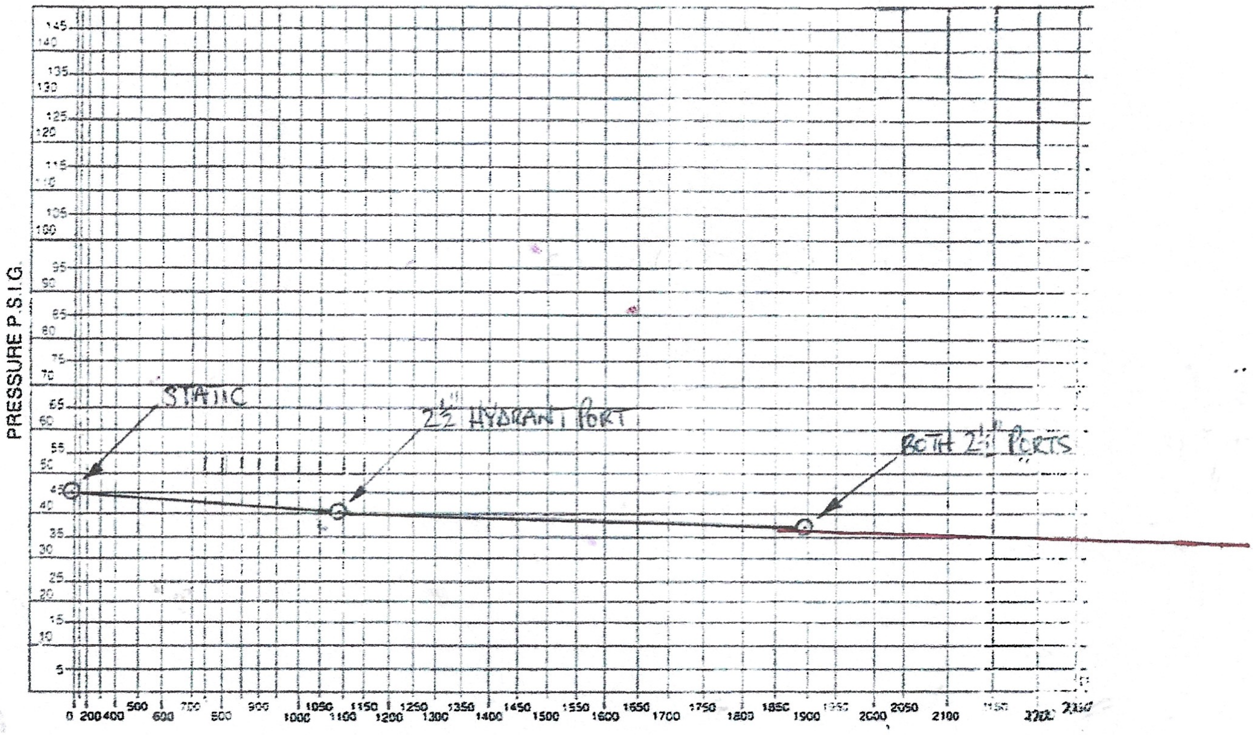
TIME OF TEST 10 10 AM

LOCATION OF TEST (FLOW) SE CORNER CHICKADEE LN/GLASGOW RD.

(RESIDUAL) HYDRANT @ 13921 CHICKADEE LANE

MAIN SIZE 12"-300mm STATIC PRESSURE 45 PSI.

NUMBER OF OUTLETS & ORIFICE SIZE	PITOT PRESSURE	FLOW (U.S.G.P.M.)	RESIDUAL PRESSURE
#1 2½" HYDRANT PORT	42	1088	40
#2 2×2½ HYDRANT PORTS	32	1899	37



COMMENTS HYDRANT RATED CLASS AA - LIGHT BLUE

Authorized Signature ____________ Hydratest Ltd. Signature

Connection Single Use Demand Table

WATER CONNECTION

Connection point [3]			
Existing 300mm dia water-main on Chickadee Lane			
Pressure zone of connection point		Pressure Zone 6	
Total equivalent population to be serviced [1]		500	
Total lands to be serviced		6.25 ha	
Hydrant flow test			
Hydrant flow test location		13921 CHICKADEE LANE	
	Pressure (kPa)	Flow (in l/s)	Time
Minimum water pressure	275 (40psi)	68.54	10:10 AM
Maximum water pressure	255 (37psi)	119.64	10:10 AM

No.	Water demands		
	Demand type	Demand	Units
1	Average day flow	1.62	l/s
2	Maximum day flow	3.24	l/s
3	Peak hour flow	4.86	l/s
4	Fire flow [2]	180*	l/s
Analysis			
5	Maximum day plus fire flow	184.86	l/s

*Typical for residential development

WASTEWATER CONNECTION

Connection point [4] Existing 375mm dia sewer on Emil Kolb Parkway	
Total equivalent population to be serviced [1]	500
Total lands to be serviced	6.25 ha
6 Wastewater sewer effluent (in l/s)	3.25**

**Peak Sewage flow including infiltration

1) The calculations should be based on the development estimated population (employment or residential).
2) Please reference the Fire Underwriters Survey Document
3) Please specify the connection point ID
4) Please specify the connection point (wastewater line or manhole ID)
Also, the "total equivalent popopulation to be serviced" and the "total lands to be serviced" should reference the connection point. (The FSR should contain one copy of Site Servicing Plan)

Please include the graphs associated with the hydrant flow test information table
Please provide Professional Engineer's signature and stamp on the demand table
All required calculations must be submitted with the demand table submission.

APPENDIX “H”

Storm Sewer Design Sheets

Stormwater Management Calculations - OTTHYMO Modelling

APPENDIX “H”

Storm Sewer Design Sheets

Stormwater Management Calculations - OTTHYMO Modelling

STORM DESIGN SHEETS

CHICKADEE GROVE COMMUNITY
W17003

CANDEVCON LIMITED
CONSULTING ENGINEERS & PLANNERS
TEL (905) 794-0600 FAX (905) 794-0611

For 2-yr storm I2 = 1070* (T+7.85) ^ (-.8759)
For 10-yr storm I_{10} = 2221* (T+12) ^ (-.9080)
For 100-yr storm I_{100} = 4688* (T+17) ^ (-.9624)

Location	Area No.	Up-stream	Down-stream	Contributing Area (ha)			Breakdown of Areas				Area x Storm Co-eff				Total	Time (min)		I_{10}	I_{100}	FLOW Q= 2.78ACI/1000		PIPE						% Full
		MH	MH	In Area	Control	Total	0.25	0.50	0.75	0.90	0.25	0.50	0.75	0.90	A x C	In Area	Total			Q_{10}	Q_{100}	Length (m)	Size (mm)	Grade (%)	**Capacity (m^3/sec)**	Velocity (m/s)	Time (min)	Q10/Ca
STREET A	2	MH11	MH2	0.40	0.00	0.40			0.40		0.000	0.000	0.300	0.000	0.300	10.0	10.8	134.2	196.5	**0.112**	0.164	56.23	450	0.40	**0.180**	1.13	0.83	62%
STREET A	3	MH1	MH2	0.21	0.00	0.21			0.21		0.000	0.000	0.158	0.000	0.158	10.0	10.7	134.2	196.5	**0.059**	0.086	40.26	375	0.40	**0.111**	1.00	0.67	53%
STREET B	8	MH2	MH3	0.18	0.61	0.79			0.18		0.000	0.000	0.135	0.000	0.593	10.7	11.1	130.6	192.0	**0.215**	0.316	32.84	600	0.40	**0.388**	1.37	0.40	55%
STREET B	7	MH3	MH4	0.53	0.79	1.32			0.53		0.000	0.000	0.398	0.000	0.990	11.1	12.2	128.5	189.3	**0.354**	0.521	100	675	0.40	**0.531**	1.49	1.12	67%
STREET A	1, EXT-1	MH11	MH12	0.25	0.00	0.25			0.25		0.000	0.000	0.188	0.000	0.188	10.0	10.7	134.2	196.5	**0.070**	0.102	41.8	375	0.40	**0.111**	1.00	0.69	63%
GLASGOW	11	MH12	MH13	0.24	0.25	0.49			0.24		0.000	0.000	0.180	0.000	0.368	10.7	11.5	130.4	191.8	**0.133**	0.196	55.3	450	0.40	**0.180**	1.13	0.81	74%
GLASGOW	10	MH13	MH5	0.33	0.49	0.82			0.33		0.000	0.000	0.248	0.000	0.615	11.5	12.6	126.3	186.5	**0.216**	0.319	93	600	0.40	**0.388**	1.37	1.13	56%
STREET A	20	MH1	MH8	0.30	0.00	0.30			0.30		0.000	0.000	0.225	0.000	0.225	10.0	11.0	134.2	196.5	**0.084**	0.123	57.6	375	0.40	**0.111**	1.00	0.96	76%
STREET A	4	MH8	MH9	0.26	0.30	0.56			0.26		0.000	0.000	0.195	0.000	0.420	11.0	11.4	129.1	190.1	**0.151**	0.222	34.6	525	0.40	**0.272**	1.26	0.46	55%
STREET A	5	MH9	MH10	0.55	0.56	1.11			0.55		0.000	0.000	0.413	0.000	0.833	11.4	12.2	126.8	187.1	**0.293**	0.433	64.5	600	0.40	**0.388**	1.37	0.78	76%
STREET C	12	MH15	MH16	0.36	0.00	0.36			0.36		0.000	0.000	0.270	0.000	0.270	10.0	10.6	134.2	196.5	**0.101**	0.148	48.6	450	0.50	**0.202**	1.27	0.64	50%
STREET C		MH16	MH10	0.00	0.36	0.36			0.00		0.000	0.000	0.000	0.000	0.270	10.6	11.1	130.7	192.2	**0.098**	0.144	30.3	375	0.50	**0.124**	1.12	0.45	79%
CHICKADE LA	6	MH10	MH4	0.39	1.47	1.86			0.39		0.000	0.000	0.293	0.000	1.395	12.2	13.2	123.1	182.3	**0.477**	0.707	98.2	750	0.40	**0.704**	1.59	1.03	68%
STREET D	13,14	MH14	MH4	0.78	0.00	0.78			0.78		0.000	0.000	0.585	0.000	0.585	10.0	10.7	134.2	196.5	**0.218**	0.320	62	525	0.50	**0.304**	1.40	0.74	72%
CHICKADE LA	9	MH4	MH5	0.36	3.96	4.32			0.36		0.000	0.000	0.270	0.000	3.240	13.2	13.9	118.5	176.3	**1.067**	1.588	82.2	975	0.40	**1.417**	1.90	0.72	75%
STREET C		MH5	MH6	0.00	5.14	5.14					0.000	0.000	0.000	0.000	3.855	13.9	14.1	115.5	172.4	**1.238**	1.847	23.7	1050	0.50	**1.930**	2.23	0.18	64%
STREET C	15	MH17	MH18	0.33	0.00	0.33			0.33		0.000	0.000	0.248	0.000	0.248	10.0	11.4	134.2	196.5	**0.092**	0.135	94.4	450	0.40	**0.180**	1.13	1.39	51%
STREET C	18	MH18	MH19	0.09	0.33	0.42			0.09		0.000	0.000	0.068	0.000	0.315	11.4	11.8	126.9	187.3	**0.111**	0.164	31.6	525	0.40	**0.272**	1.26	0.42	41%
STREET C		MH19	MH20	0.00	0.42	0.42					0.000	0.000	0.000	0.000	0.315	11.8	12.0	124.9	184.7	**0.109**	0.162	12	525	0.40	**0.272**	1.26	0.16	40%
STREET C	16	MH20	MH21	0.47	0.42	0.89			0.47		0.000	0.000	0.353	0.000	0.668	12.0	13.0	124.1	183.7	**0.230**	0.341	86.4	600	0.40	**0.388**	1.37	1.05	59%
STREET C	17	MH21	MH6	0.28	0.89	1.17			0.28		0.000	0.000	0.210	0.000	0.878	13.0	13.5	119.4	177.5	**0.291**	0.433	38.3	600	0.40	**0.388**	1.37	0.46	75%
POND		MH6	MH22	0.00	6.31	6.31					0.000	0.000	0.000	0.000	4.733	14.1	14.4	114.8	171.4	**1.510**	2.255	36.1	1050	0.50	**1.930**	2.23	0.27	78%
POND		MH22	OUTFALL	0.00	6.31	6.31					0.000	0.000	0.000	0.000	4.733	14.4	14.5	113.7	170.0	**1.496**	2.237	10.5	1050	0.50	**1.930**	2.23	0.08	78%
																		I2		**Q2**								Q2/Ca
BYPASS		MH22	MH23	0.00	6.31	6.31					0.000	0.000	0.000	0.000	4.733	14.4	14.6	70.7	170.0	**0.930**	2.237	19.9	825	0.50	**1.015**	1.90	0.17	92%
BYPASS		MH23	MH P1	0.00	6.31	6.31					0.000	0.000	0.000	0.000	4.733	14.6	15.4	70.2	169.1	**0.924**	2.225	89.5	825	0.50	**1.015**	1.90	0.79	91%

RELEASE RATE REQUIREMENT FOR SWM POND

Project Number :	W17003	**Prepared By :**	S.S
Project Name :	CHICKADEE LANE	**Checked By:**	D.K.H
Date :	30/08/2021		

Total Site Area (Ha) = 6.98

Outlet Location : Innis Lake (Humber River)

Humber River SWM Quantity Control Release Rates based on Equation F (Sub Basin 36)

EVENT	HUMBER RIVER Sub-Basin	B	C	ln(A)	Rel. Rate (L/S/ha)	Rel. Rate (L/S)
100 - Year	Q= 29.912 - 2.316*ln(A)	29.91	2.316	1.94	25.4	177
50 - Year	Q= 26.566 - 2.082*ln(A)	26.57	2.082	1.94	22.5	157
25-Year	Q= 22.639 - 1.741*ln(A)	22.64	1.741	1.94	19.3	134
10-Year	Q= 17.957 - 1.373*ln(A)	17.96	1.373	1.94	15.3	107
5-Year	Q= 14.652 - 1.136*ln(A)	14.65	1.136	1.94	12.4	87
2-Year	Q= 9.506 - 0.719*ln(A)	9.506	0.719	1.94	8.11	57

Summary of SWM Pond Release Rate targets for different Storm Events

Return Period	Release Rates (L/s)
100 - Year	***177***
50 - Year	***157***
25-Year	***134***
10-Year	***107***
5-Year	***87***
2-Year	***57***

SWM POND STORAGE CALCS

Project Number :	W17003	**Prepared By :**	S.S
Project Name :	CHICKADEE LANE	**Checked By:**	D.K.H
Date :	02/05/2022		

Permanent Pool and Extended Storage Volume Requirements ;

Total Site Area draining to Proposed SWM Pond = 6.98 Ha
Total Site Imperviousness = 75%
MOE Standard Requirements = 233.33 m^3/ha (includes 40m^3/ha Extended Detention)
Permanent Pool Volume Requirement = 193.33 m^3/ha (233.33 - 40)
PP Storage Required in proposed Pond = 1349 m^3

Elevations (m)	Surface Area (m^2)	Average Area (m^2)	Depth (m)	Delta Volume (m^3)	Total Volume (m^3)	
253.50	541					
		877	1.00	877		
254.50	1213				877	
		1612	0.50	806		
255.00	**2010**				**1683**	**(Permanent Pool Storage)**
255.00	2010					
		2461	0.50	1231		
255.50	2912				1231	
		3423	1.00	3423		
256.50	3934				4654	
		4208	0.50	2104		
257.00	4482				6758	**Total Active Storage**

Visual Otthymo Results for AES storm, 2 to 100-Year storm events for 6 & 12 Hour Runs - SWM Pond

6 - HOUR RUN						
Storm Event	**2-Year**	**5-Year**	**10-Year**	**25-Year**	**50-Year**	**100-Year**
Target Release	**57**	**87**	**107**	**134**	**157**	**177**
Release Rate (L/s)	28	73	102	128	144	159
Storage Volume	1687	2215	**2558**	**3040**	**3417**	**3791**

12 - HOUR RUN						
Storm Event	**2-Year**	**5-Year**	**10-Year**	**25-Year**	**50-Year**	**100-Year**
Target Release	**57**	**87**	**107**	**135**	**157**	**177**
Release Rate (L/s)	34	74	100	124	139	152
Storage Volume	**1765**	**2224**	2530	2962	3288	3632

TRCA's 25mm Erosion Control Requirement ;

Contributing Drainage Area (ha) = 6.98 Ha

25mm 4Hr Chicago Post Development Runoff Volume in Depth = 18.206 mm (Refer to VO Results)

(R. V x Drainage Area)

25mm 4Hr Chicago Post Development Storage Volume = **1,271 m^3**

25mm 4-hour Chicago storm to be stored and released over a min. of 48-hour period ;

Erosion Target Rate = 26.47 m^3/hr 7.4 L/s

Water Quality Volume Requirement

Project Number :	W17003	**Prepared By :**	S.S
Project Name :	CHICKADEE LANE	**Checked By:**	D.K.H
Date :	02/05/2022		

Drawdown Time for Water Quality Level ;

Based on Equation 4.11 MOE SWM Planning and Design Manual

$$t = \frac{0.66\,C_2 h^{1.5} + 2\,C_3 h^{0.5}}{2.75\,A_o}$$

t = Drawdown time in seconds

A_p = Surface area of the pond (m^2)

C = Discharge Coefficient (typically 0.63)

A_o = Cross-sectional area of the orifice (m^2)

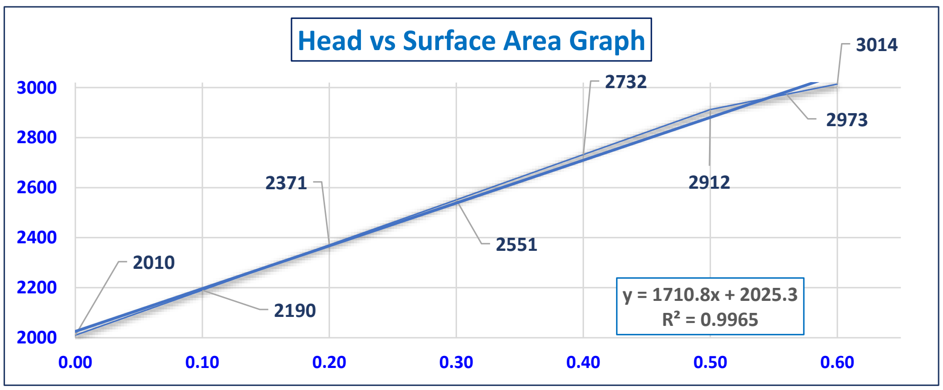
g = Gravitational acceleration constant (9.81 m/s)

h_1 = Starting water elevation above the orifice (m)

h_2 = Ending water elevation above the orifice (m)

C_2 = Slope coefficient from the area-depth linear regression

C_3 = Intercept from the area-depth linear regression



Elevation(m)	Head (m)	AREA (m^2)
255.00	0.00	2010
255.10	0.10	2190
255.20	0.20	2371
255.30	0.30	2551
255.40	0.40	2732
255.50	0.50	2912
255.56	0.56	2973
255.60	0.60	3014

Intercept of Regression , C_3 =	2025.3
Slope coef. of Regression, C_2 =	1710.8
Ultimate Ponding Elevation =	255.56 m (25mm Water Quality Level)
Depth over orifice =	0.56 m (25mm Level - Permanent Pool Elevation) (255.56 - 255.00)
Orifice Diameter =	**75 mm**
Orifice Area =	0.00442 m^2
Drawdown Time (t)=	288446 seconds
	80.1 hours

FOREBAY DESIGN CALCULATIONS

Project Number :	W17003	**Prepared By :**	S.S
Project Name :	CHICKADEE LANE	**Checked By:**	D.K.H
Date :	30/08/2021		

Settling Calculations

Forebay Settling Length (MOE Equation 4.5)

$$\text{Dist} = \sqrt{\frac{r\,Q_p}{V_s}}$$

For Forebay

Length-to-width ratio of forebay (r) = 2.0 : 1 (INLET-1)

Peak Quality flowrate (Qp) from pond based on release rate and volume of extended detention.

Peak flow rate from the pond during design quality storm (Q_p)= 16.818182 m^3/Hr 0.004672 m^3/s

= $\frac{\text{25mm-Storage Volume } (m^3)}{\text{Drawdown Time (hrs)}}$

Settling Velocity (V_s) = 0.0003 m/s (Recommended from MOEE Manual)

Forebay Settling Length Required = 5.6 m

Total Forebay Length Provided = 22.0 m

Dispersion Length Calculations

Length of Dispersion (MOE Equation 4.6)

$$\text{Dist} = \frac{8Q}{d\,V_f}$$

Inlet flow rate - 10 yr. (Q) = 1.451 m^3/s (Refer to Storm Design Sheet)

Depth of permanent pool in the forebay (d) = 1.5 m

Desired velocity in the forebay (V_f) = 0.5 m/s (Recommended from MOEE Manual)

Length of Dispersion) = 15.5 m

Minimum Forebay Deep Zone Bottom Width

Minimum Forebay Deep Zone Bottom Width (MOE Equation 4.7)

$$\text{Width} = \frac{\text{Dist}}{8}$$

Distance (D_R) = 15.5 m (Required Dispersion Length)

Width (W_R) = 1.93 m (Required Forebay Bottom Width)

Forebay Bottom Width (W_P) = 7.00 m (Provided Forebay Bottom Width)

SWM POND CONTROL STRUCTURE DESIGN

Project Number :	W17003	**Prepared By :**	S.S
Project Name :	CHICKADEE LANE	**Checked By:**	D.K.H
Date :	02/05/2022		

Orifice No. 1 (To Control 25mm Erosion)

Orifice Plate Diameter =	0.075 m
	75 mm
Area =	0.0044 m^2
Orifice Coeff. (C)=	0.63
Invert =	255 m
Orifice Plate Centroid =	255.05 m

Submerged Orifice Equation = **$Qo = 0.63 \times A \times [2 \times g \times H]^{1/2}$**

Where,

Q = Flow rate (m^3/s)
C = Constant
A = Area of opening (m^2)
H = Net head above the orifice (m)
g = Acceleration due to gravity (m/s)

Weir/Orifice No.2 (To Control 2 - 100-Year)

Orifice Width =	0.36 m
Orifice Height =	0.19 m
Area =	0.0684 m^2
Orifice Coeff. (C)=	0.63
Invert =	255.60 m
Orifice Centroid =	255.70 m

BOX CUT-OUT DETAILS

Weir Equation = **$Q = 1.67 \times L \times H^{1.5}$**

Weir Specifications

Length of Weir =	0.36 m
Weir Sill =	255.60 m
Weir Top =	255.79 m
Weir Coefficient =	1.67

Where,

Q_w = Flow rate (m^3/s)
C = Constant
L = Weir Length (m)
H = Net Head on the Orifice (m)

Stage (m): 0.05

			ORIFICE CONTROL-1 (ORIFICE PLATE)		ORIFICE/WEIR CONTROL-2 (BOX CUT-OUT)					Flows from Emergency Spillway Design	
	STORAGE IN POND (m^3)	Elevation	Depth above orifice Centroid (m)	Orifice No.1 Flow (m^3/s)	Depth above orifice Centroid (m)	Orifice No.2 Flow (m^3/s)	Depth Above Weir (m)	Weir No.2 Flow (m^3/s)	Total Flow (m^3/s)		
	0	255.00	0	0					0.000		
	105	255.05	0.01	0.001					0.001		
	210	255.10	0.06	0.003					0.003		
	322	255.15	0.11	0.004					0.004		
	438	255.20	0.16	0.005					0.005		
	559	255.25	0.21	0.006					0.006		
	684	255.30	0.26	0.006					0.006		
	814	255.35	0.31	0.007					0.007		
	948	255.40	0.36	0.007					0.007		
	1087	255.45	0.41	0.008					0.008		
	1230	255.50	0.46	0.008					0.008		
	1377	255.55	0.51	0.009					0.009		
25mm Erosion Control	**1412**	**255.56**	**0.52**	**0.009**					**0.009**		
	1527	255.60	0.56	0.009					0.009		
	1679	255.65	0.61	0.009					0.009		
	1833	255.70	0.66	0.010			0.10	0.019	0.029		
	1990	255.75	0.71	0.010			0.15	0.035	0.045		
2-YR Control	**2086**	**255.78**	**0.74**	**0.010**			**0.18**	**0.046**	**0.056**		
	2150	255.80	0.76	0.011			0.20	0.054	0.064		
5-YR Control	**2312**	**255.85**	**0.81**	**0.011**	**0.16**	**0.075**			**0.086**		
	2477	255.90	0.86	0.011	0.21	0.086			0.098		
10-YR Control	**2611**	**255.94**	**0.90**	**0.012**	**0.25**	**0.094**			**0.106**		
	2644	255.95	0.91	0.012	0.26	0.096			0.108		
	2814	256.00	0.96	0.012	0.31	0.105			0.117		
	2986	256.05	1.01	0.012	0.36	0.114			0.126		
25-YR Control	**3161**	**256.10**	**1.06**	**0.012**	**0.41**	**0.121**			**0.134**		
	3339	256.15	1.11	0.013	0.46	0.129			0.142		
	3519	256.20	1.16	0.013	0.51	0.136			0.149		
	3701	256.25	1.21	0.013	0.56	0.142			0.156		
50-YR Control	**3775**	**256.27**	**1.22**	**0.013**	**0.57**	**0.145**			**0.158**		
	3887	256.30	1.26	0.014	0.61	0.148			0.162		
	4074	256.35	1.31	0.014	0.66	0.154			0.168		
	4265	256.40	1.36	0.014	0.71	0.160			0.174		
100-YR Control	**4341**	**256.42**	**1.38**	**0.014**	**0.73**	**0.163**			**0.177**		
	4457	256.45	1.41	0.014	0.76	0.166			0.180	0.108	**0.29**
	4653	256.50	1.46	0.015	0.81	0.171			0.186	0.472	**0.66**
Regional	**4851**	**256.55**	**1.51**	**0.015**	**0.86**	**0.176**			**0.191**	**0.978**	**1.17**
	5052	256.60	1.56	0.015	0.91	0.182			0.197	1.594	**1.79**
	5255	256.65	1.61	0.02	0.96	0.187			0.202	2.303	**2.50**
	5461	256.70	1.66	0.016	1.01	0.191			0.207	3.093	**3.30**
	5670	256.75	1.71	0.016	1.06	0.196			0.212	3.957	**4.17**

Emergency Spillway Design

N A MOE S M M E S
( )

A V R 100- P R S
100-

The Emergency spillway is proposed at 100-year Elevation = **256.42 m**

100-Year Storm Peak Flows (Qinflow) =	**1.3**	**m^3/s**	**(Refer to 100-Yr, 6 Hr Vo Results)**
Regional Peak Flows (Qinflow) =	0.98	m^3/s	(Refer to Hurrican Hazel-Regional VO Results)

Emergency Spillway Weir Parameters

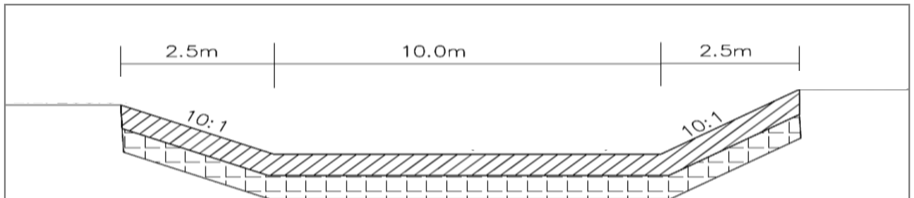
Top Width of Weir =	15	m
Downstream Width of Weir =	10	m
Median Width (B) =	12.5	m
Weir Sill Elevation (At 100-Year) =	256.42	m
Weir Top Elevation =	256.72	m
Depth of Weir =	0.30	m
Weir Side Slopes =	10	: 1

Weir Equation;

$$Q_w = (CL(H^{3/2})$$

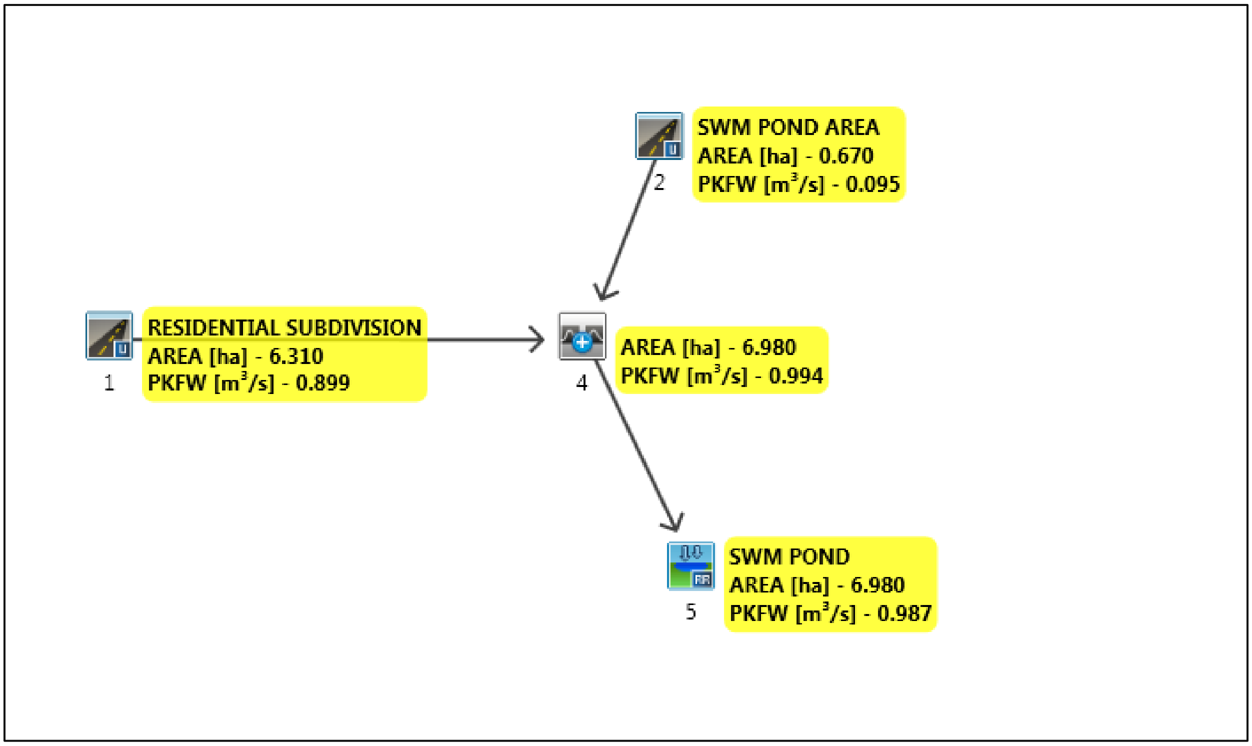
Stage :	0.05		
	Depth	**Cd**	**Q**
256.42	0	1.67	0.000
256.47	0.05	1.67	0.233
256.52	0.10	1.67	0.660
256.57	0.15	1.67	1.213
256.62	0.20	1.67	1.867
256.67	0.25	1.67	2.609
256.72	0.30	1.67	3.430

Therefore, Maximum capacity of Spillway is = **3.430** **m^3/s** **>** **1.3** **m^3/s**
(100-Year Storm Peak Flows)



EMERGENCY SPILLWAY LAYOUT

Visual Otthymo Schematic – Post – Development (6 & 12 Hr AES)



```
 ************************************************
 ** SIMULATION : 2 Year 6 Hour AES (Bloor, TRC **
 ************************************************


--------------------
|    READ STORM    |    Filename: C:\Users\shuchi\AppD
|                  |              ata\Local\Temp\
|                  |              30893ebc-4193-4b18-94cb-
f8ff69101a04\11f53043
| Ptotal= 36.00 mm |    Comments: 2 Year 6 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                 0.00    0.00 |  1.75   12.24 |  3.50    5.04 |  5.25
0.72
                 0.25    0.72 |  2.00   12.24 |  3.75    2.88 |  5.50
0.72
                 0.50    0.72 |  2.25   33.12 |  4.00    2.88 |  5.75
0.72
                 0.75    0.72 |  2.50   33.12 |  4.25    1.44 |  6.00
0.72
                 1.00    0.72 |  2.75    9.36 |  4.50    1.44 |
                 1.25    4.32 |  3.00    9.36 |  4.75    0.72 |
                 1.50    4.32 |  3.25    5.04 |  5.00    0.72 |

---------------------------------------------------------------------------
-----

--------------------
| CALIB            |
| STANDHYD (  0001)|   Area    (ha)=   6.31
|ID= 1 DT=10.0 min |   Total Imp(%)=  80.00   Dir. Conn.(%)=  75.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.05         1.26
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     205.10        40.00
     Mannings n          =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO  10.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                0.167    0.00 | 1.833    8.28 | 3.500    5.04 |  5.17
0.72
```

```
                0.333    0.36 | 2.000   12.24 | 3.667    5.04 |  5.33
0.72
                0.500    0.72 | 2.167   12.24 | 3.833    3.96 |  5.50
0.72
                0.667    0.72 | 2.333   22.68 | 4.000    2.88 |  5.67
0.72
                0.833    0.72 | 2.500   33.12 | 4.167    2.88 |  5.83
0.72
                1.000    0.72 | 2.667   33.12 | 4.333    2.16 |  6.00
0.72
                1.167    0.72 | 2.833   21.24 | 4.500    1.44 |  6.17
0.72
                1.333    2.52 | 3.000    9.36 | 4.667    1.44 |  6.33
0.36
                1.500    4.32 | 3.167    9.36 | 4.833    1.08 |
                1.667    4.32 | 3.333    7.20 | 5.000    0.72 |

     Max.Eff.Inten.(mm/hr)=      33.12        16.49
                over (min)       10.00        30.00
     Storage Coeff.  (min)=       6.12 (ii)   20.63 (ii)
     Unit Hyd. Tpeak (min)=      10.00        30.00
     Unit Hyd. peak  (cms)=       0.14         0.05
                                                          *  TOTALS*
     PEAK FLOW       (cms)=       0.43         0.03          0.442 (iii)
     TIME TO PEAK    (hrs)=       2.67         3.00           2.67
     RUNOFF VOLUME    (mm)=      35.00         5.55          27.64
     TOTAL RAINFALL   (mm)=      36.00        36.00          36.00
     RUNOFF COEFFICIENT   =       0.97         0.15           0.77

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00          K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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-----
--------------------
| CALIB            |
| STANDHYD (  0002)|   Area    (ha)=   0.67
|ID= 1 DT=10.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  40.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.50         0.17
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      66.83        40.00
     Mannings n           =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO  10.0 MIN. TIME STEP.
```

```
                                 ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                0.167   0.00 | 1.833    8.28 | 3.500    5.04 |  5.17
0.72
                0.333   0.36 | 2.000   12.24 | 3.667    5.04 |  5.33
0.72
                0.500   0.72 | 2.167   12.24 | 3.833    3.96 |  5.50
0.72
                0.667   0.72 | 2.333   22.68 | 4.000    2.88 |  5.67
0.72
                0.833   0.72 | 2.500   33.12 | 4.167    2.88 |  5.83
0.72
                1.000   0.72 | 2.667   33.12 | 4.333    2.16 |  6.00
0.72
                1.167   0.72 | 2.833   21.24 | 4.500    1.44 |  6.17
0.72
                1.333   2.52 | 3.000    9.36 | 4.667    1.44 |  6.33
0.36
                1.500   4.32 | 3.167    9.36 | 4.833    1.08 |
                1.667   4.32 | 3.333    7.20 | 5.000    0.72 |

     Max.Eff.Inten.(mm/hr)=      33.12        65.81
                over (min)       10.00        20.00
     Storage Coeff.  (min)=       3.12 (ii)   11.46 (ii)
     Unit Hyd. Tpeak (min)=      10.00        20.00
     Unit Hyd. peak  (cms)=       0.16         0.08
                                                           *  TOTALS*
     PEAK FLOW       (cms)=       0.02         0.02           0.048 (iii)
     TIME TO PEAK    (hrs)=       2.67         2.83            2.67
     RUNOFF VOLUME    (mm)=      35.00        16.70           24.02
     TOTAL RAINFALL   (mm)=      36.00        36.00           36.00
     RUNOFF COEFFICIENT   =       0.97         0.46            0.67

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo    (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc    (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

---------------------------------------------------------------------------
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--------------------
| ADD HYD  (  0004)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     6.31   0.442     2.67    27.64
```

```
      + ID2= 2 (  0002):     0.67   0.048     2.67    24.02
        ==================================================
        ID = 3 (  0004):     6.98   0.490     2.67    27.29

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
---------------------------------------------------------------------------
-----
--------------------
| RESERVOIR(  0005)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT= 10.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1340      0.3161
                          0.0090     0.1412   |   0.1580      0.3775
                          0.0560     0.2086   |   0.1770      0.4341
                          0.0860     0.2312   |   1.1690      0.4851
                          0.1060     0.2611   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0004)      6.980      0.490      2.67      27.29
   OUTFLOW: ID= 1 (  0005)      6.980      0.028      4.33      26.72

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  5.74
                   TIME SHIFT OF PEAK FLOW         (min)=100.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.1687

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  **********************************************
  ** SIMULATION : 2 Year 12 Hour AES (Bloor, TR **
  **********************************************


--------------------
|    READ STORM    |    Filename: C:\Users\shuchi\AppD
|                  |              ata\Local\Temp\
|                  |              30893ebc-4193-4b18-94cb-
f8ff69101a04\eb1a22c0
| Ptotal= 42.00 mm |    Comments: 2 Year 12 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                 0.00    0.00 |  3.25    7.14 |  6.50    2.94 |  9.75
0.42
                 0.25    0.42 |  3.50    7.14 |  6.75    2.94 | 10.00
0.42
                 0.50    0.42 |  3.75    7.14 |  7.00    2.94 | 10.25
0.42
                 0.75    0.42 |  4.00    7.14 |  7.25    1.68 | 10.50
0.42
                 1.00    0.42 |  4.25   19.32 |  7.50    1.68 | 10.75
0.42
                 1.25    0.42 |  4.50   19.32 |  7.75    1.68 | 11.00
0.42
                 1.50    0.42 |  4.75   19.32 |  8.00    1.68 | 11.25
0.42
                 1.75    0.42 |  5.00   19.32 |  8.25    0.84 | 11.50
0.42
                 2.00    0.42 |  5.25    5.46 |  8.50    0.84 | 11.75
0.42
                 2.25    2.52 |  5.50    5.46 |  8.75    0.84 | 12.00
0.42
                 2.50    2.52 |  5.75    5.46 |  9.00    0.84 |
                 2.75    2.52 |  6.00    5.46 |  9.25    0.42 |
                 3.00    2.52 |  6.25    2.94 |  9.50    0.42 |

---------------------------------------------------------------------------
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--------------------
| CALIB            |
| STANDHYD (  0001)|   Area    (ha)=   6.31
|ID= 1 DT=10.0 min |   Total Imp(%)=  80.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area      (ha)=       5.05         1.26
     Dep. Storage      (mm)=       1.00         1.50
```

Average Slope	(%)=	1.00	2.00
Length	(m)=	205.10	40.00
Mannings n	=	0.013	0.250

NOTE: RAINFALL WAS TRANSFORMED TO 10.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.167	0.00	3.333	4.83	6.500	2.94	9.67	0.42
0.333	0.21	3.500	7.14	6.667	2.94	9.83	0.42
0.500	0.42	3.667	7.14	6.833	2.94	10.00	0.42
0.667	0.42	3.833	7.14	7.000	2.94	10.17	0.42
0.833	0.42	4.000	7.14	7.167	2.94	10.33	0.42
1.000	0.42	4.167	7.14	7.333	2.31	10.50	0.42
1.167	0.42	4.333	13.23	7.500	1.68	10.67	0.42
1.333	0.42	4.500	19.32	7.667	1.68	10.83	0.42
1.500	0.42	4.667	19.32	7.833	1.68	11.00	0.42
1.667	0.42	4.833	19.32	8.000	1.68	11.17	0.42
1.833	0.42	5.000	19.32	8.167	1.68	11.33	0.42
2.000	0.42	5.167	19.32	8.333	1.26	11.50	0.42
2.167	0.42	5.333	12.39	8.500	0.84	11.67	0.42
2.333	1.47	5.500	5.46	8.667	0.84	11.83	0.42
2.500	2.52	5.667	5.46	8.833	0.84	12.00	0.42
2.667	2.52	5.833	5.46	9.000	0.84	12.17	0.42
2.833	2.52	6.000	5.46	9.167	0.84	12.33	0.21
3.000	2.52	6.167	5.46	9.333	0.63		
3.167	2.52	6.333	4.20	9.500	0.42		

Max.Eff.Inten.(mm/hr)=		19.32	11.69
over	(min)	10.00	30.00
Storage Coeff.	(min)=	7.59 (ii)	24.24 (ii)
Unit Hyd. Tpeak	(min)=	10.00	30.00
Unit Hyd. peak	(cms)=	0.12	0.04

```
                                                              *  TOTALS*
     PEAK FLOW        (cms)=       0.25          0.02           0.269 (iii)
     TIME TO PEAK     (hrs)=       5.17          5.50            5.17
     RUNOFF VOLUME     (mm)=      41.00          4.58           31.89
     TOTAL RAINFALL    (mm)=      42.00         42.00           42.00
     RUNOFF COEFFICIENT    =       0.98          0.11            0.76

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo    (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc    (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD (  0002)|   Area    (ha)=   0.67
|ID= 1 DT=10.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  40.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.50          0.17
     Dep. Storage     (mm)=       1.00          1.50
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      66.83         40.00
     Mannings n           =      0.013         0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO  10.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                0.167    0.00 | 3.333    4.83 | 6.500    2.94 |  9.67
0.42
                0.333    0.21 | 3.500    7.14 | 6.667    2.94 |  9.83
0.42
                0.500    0.42 | 3.667    7.14 | 6.833    2.94 | 10.00
0.42
                0.667    0.42 | 3.833    7.14 | 7.000    2.94 | 10.17
0.42
                0.833    0.42 | 4.000    7.14 | 7.167    2.94 | 10.33
0.42
                1.000    0.42 | 4.167    7.14 | 7.333    2.31 | 10.50
0.42
                1.167    0.42 | 4.333   13.23 | 7.500    1.68 | 10.67
0.42
                1.333    0.42 | 4.500   19.32 | 7.667    1.68 | 10.83
0.42
```

```
               1.500    0.42 | 4.667   19.32 | 7.833    1.68 | 11.00
0.42
               1.667    0.42 | 4.833   19.32 | 8.000    1.68 | 11.17
0.42
               1.833    0.42 | 5.000   19.32 | 8.167    1.68 | 11.33
0.42
               2.000    0.42 | 5.167   19.32 | 8.333    1.26 | 11.50
0.42
               2.167    0.42 | 5.333   12.39 | 8.500    0.84 | 11.67
0.42
               2.333    1.47 | 5.500    5.46 | 8.667    0.84 | 11.83
0.42
               2.500    2.52 | 5.667    5.46 | 8.833    0.84 | 12.00
0.42
               2.667    2.52 | 5.833    5.46 | 9.000    0.84 | 12.17
0.42
               2.833    2.52 | 6.000    5.46 | 9.167    0.84 | 12.33
0.21
               3.000    2.52 | 6.167    5.46 | 9.333    0.63 |
               3.167    2.52 | 6.333    4.20 | 9.500    0.42 |

     Max.Eff.Inten.(mm/hr)=      19.32        37.37
               over (min)        10.00        20.00
     Storage Coeff.  (min)=       3.87 (ii)   14.34 (ii)
     Unit Hyd. Tpeak (min)=      10.00        20.00
     Unit Hyd. peak  (cms)=       0.16         0.07
                                                           *  TOTALS*
     PEAK FLOW       (cms)=       0.01         0.02          0.031 (iii)
     TIME TO PEAK    (hrs)=       5.17         5.17           5.17
     RUNOFF VOLUME    (mm)=      41.00        16.65          26.39
     TOTAL RAINFALL   (mm)=      42.00        42.00          42.00
     RUNOFF COEFFICIENT   =       0.98         0.40           0.63

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo    (mm/hr)= 50.00          K  (1/hr)=  2.00
            Fc    (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0004)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     6.31   0.269     5.17    31.89
      + ID2= 2 (  0002):     0.67   0.031     5.17    26.39
        ====================================================
        ID = 3 (  0004):     6.98   0.300     5.17    31.36
```

```
     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------
-----
--------------------
| RESERVOIR(  0005)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT= 10.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1340      0.3161
                          0.0090     0.1412   |   0.1580      0.3775
                          0.0560     0.2086   |   0.1770      0.4341
                          0.0860     0.2312   |   1.1690      0.4851
                          0.1060     0.2611   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK        R.V.
                                (ha)     (cms)     (hrs)        (mm)
   INFLOW : ID= 2 (  0004)      6.980      0.300      5.17      31.36
   OUTFLOW: ID= 1 (  0005)      6.980      0.034      7.33      30.79

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 11.20
                   TIME SHIFT OF PEAK FLOW         (min)=130.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.1765

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  ************************************************
  ** SIMULATION : 5 Year 6 Hour AES (Bloor, TRC **
  ************************************************


--------------------
|    READ STORM    |    Filename: C:\Users\shuchi\AppD
|                  |              ata\Local\Temp\
|                  |              30893ebc-4193-4b18-94cb-
f8ff69101a04\34c151e3
| Ptotal= 47.81 mm |    Comments: 5 Year 6 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                 0.00    0.00 |  1.75   16.25 |  3.50    6.69 |  5.25
0.96
                 0.25    0.96 |  2.00   16.25 |  3.75    3.82 |  5.50
0.96
                 0.50    0.96 |  2.25   43.98 |  4.00    3.82 |  5.75
0.96
                 0.75    0.96 |  2.50   43.98 |  4.25    1.91 |  6.00
0.96
                 1.00    0.96 |  2.75   12.43 |  4.50    1.91 |
                 1.25    5.74 |  3.00   12.43 |  4.75    0.96 |
                 1.50    5.74 |  3.25    6.69 |  5.00    0.96 |

----------------------------------------------------------------------------
-----


--------------------
| CALIB            |
| STANDHYD (  0001)|   Area    (ha)=   6.31
|ID= 1 DT=10.0 min |   Total Imp(%)=  80.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.05         1.26
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     205.10        40.00
     Mannings n           =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO  10.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
```

```
               0.167    0.00 | 1.833   10.99 | 3.500    6.69 |  5.17
0.96
               0.333    0.48 | 2.000   16.25 | 3.667    6.69 |  5.33
0.96
               0.500    0.96 | 2.167   16.25 | 3.833    5.25 |  5.50
0.96
               0.667    0.96 | 2.333   30.11 | 4.000    3.82 |  5.67
0.96
               0.833    0.96 | 2.500   43.98 | 4.167    3.82 |  5.83
0.96
               1.000    0.96 | 2.667   43.98 | 4.333    2.86 |  6.00
0.96
               1.167    0.96 | 2.833   28.20 | 4.500    1.91 |  6.17
0.96
               1.333    3.35 | 3.000   12.43 | 4.667    1.91 |  6.33
0.48
               1.500    5.74 | 3.167   12.43 | 4.833    1.43 |
               1.667    5.74 | 3.333    9.56 | 5.000    0.96 |

     Max.Eff.Inten.(mm/hr)=      43.98        36.38
               over (min)        10.00        20.00
     Storage Coeff.  (min)=       5.46 (ii)   16.04 (ii)
     Unit Hyd. Tpeak (min)=      10.00        20.00
     Unit Hyd. peak  (cms)=       0.14         0.06
                                                          *  TOTALS*
     PEAK FLOW       (cms)=       0.57         0.09         0.646 (iii)
     TIME TO PEAK    (hrs)=       2.67         2.83          2.67
     RUNOFF VOLUME    (mm)=      46.81        14.26         38.67
     TOTAL RAINFALL   (mm)=      47.81        47.81         47.81
     RUNOFF COEFFICIENT   =       0.98         0.30          0.81

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo    (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc    (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

---------------------------------------------------------------------------
-----
--------------------
| CALIB              |
| STANDHYD (  0002)|   Area    (ha)=   0.67
|ID= 1 DT=10.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  40.00
--------------------
                                  IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.50         0.17
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      66.83        40.00
     Mannings n           =      0.013        0.250
```

NOTE: RAINFALL WAS TRANSFORMED TO 10.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME	RAIN	TIME	RAIN	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	hrs	mm/hr
0.167	0.00	1.833	10.99	3.500	6.69	5.17	0.96
0.333	0.48	2.000	16.25	3.667	6.69	5.33	0.96
0.500	0.96	2.167	16.25	3.833	5.25	5.50	0.96
0.667	0.96	2.333	30.11	4.000	3.82	5.67	0.96
0.833	0.96	2.500	43.98	4.167	3.82	5.83	0.96
1.000	0.96	2.667	43.98	4.333	2.86	6.00	0.96
1.167	0.96	2.833	28.20	4.500	1.91	6.17	0.96
1.333	3.35	3.000	12.43	4.667	1.91	6.33	0.48
1.500	5.74	3.167	12.43	4.833	1.43		
1.667	5.74	3.333	9.56	5.000	0.96		

```
     Max.Eff.Inten.(mm/hr)=      43.98        93.03
                over (min)       10.00        20.00
     Storage Coeff.  (min)=       2.79 (ii)   10.05 (ii)
     Unit Hyd. Tpeak (min)=      10.00        20.00
     Unit Hyd. peak  (cms)=       0.17         0.08
                                                        *  TOTALS*
     PEAK FLOW       (cms)=       0.03         0.04          0.069 (iii)
     TIME TO PEAK    (hrs)=       2.67         2.83           2.67
     RUNOFF VOLUME    (mm)=      46.81        27.37          35.15
     TOTAL RAINFALL   (mm)=      47.81        47.81          47.81
     RUNOFF COEFFICIENT   =       0.98         0.57           0.74

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0004)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
```

```
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):      6.31   0.646     2.67    38.67
      + ID2= 2 (  0002):      0.67   0.069     2.67    35.15
        ==================================================
        ID = 3 (  0004):      6.98   0.714     2.67    38.33

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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-----
--------------------
| RESERVOIR(  0005)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT= 10.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           0.0000     0.0000   |   0.1340      0.3161
                           0.0090     0.1412   |   0.1580      0.3775
                           0.0560     0.2086   |   0.1770      0.4341
                           0.0860     0.2312   |   1.1690      0.4851
                           0.1060     0.2611   |   0.0000      0.0000

                                 AREA     QPEAK     TPEAK       R.V.
                                 (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0004)      6.980      0.714      2.67      38.33
   OUTFLOW: ID= 1 (  0005)      6.980      0.073      4.00      37.76

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 10.17
                   TIME SHIFT OF PEAK FLOW         (min)= 80.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.2215

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--------------------------------
  ************************************************
  ** SIMULATION : 5 Year 12 Hour AES (Bloor, TR **
  ************************************************


--------------------
|    READ STORM    |    Filename: C:\Users\shuchi\AppD
|                  |              ata\Local\Temp\
|                  |              30893ebc-4193-4b18-94cb-
f8ff69101a04\47504536
| Ptotal= 54.38 mm |    Comments: 5 Year 12 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                 0.00    0.00 |  3.25    9.25 |  6.50    3.81 |  9.75
0.54
                 0.25    0.54 |  3.50    9.25 |  6.75    3.81 | 10.00
0.54
                 0.50    0.54 |  3.75    9.25 |  7.00    3.81 | 10.25
0.54
                 0.75    0.54 |  4.00    9.25 |  7.25    2.18 | 10.50
0.54
                 1.00    0.54 |  4.25   25.02 |  7.50    2.18 | 10.75
0.54
                 1.25    0.54 |  4.50   25.02 |  7.75    2.18 | 11.00
0.54
                 1.50    0.54 |  4.75   25.02 |  8.00    2.18 | 11.25
0.54
                 1.75    0.54 |  5.00   25.02 |  8.25    1.09 | 11.50
0.54
                 2.00    0.54 |  5.25    7.07 |  8.50    1.09 | 11.75
0.54
                 2.25    3.26 |  5.50    7.07 |  8.75    1.09 | 12.00
0.54
                 2.50    3.26 |  5.75    7.07 |  9.00    1.09 |
                 2.75    3.26 |  6.00    7.07 |  9.25    0.54 |
                 3.00    3.26 |  6.25    3.81 |  9.50    0.54 |

---------------------------------------------------------------------------
-----

--------------------
| CALIB            |
| STANDHYD (  0001)|   Area    (ha)=   6.31
|ID= 1 DT=10.0 min |   Total Imp(%)=  80.00   Dir. Conn.(%)=  75.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.05         1.26
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
```

Length	(m)=	205.10	40.00
Mannings n	=	0.013	0.250

NOTE: RAINFALL WAS TRANSFORMED TO 10.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.167	0.00	3.333	6.26	6.500	3.81	9.67	0.54
0.333	0.27	3.500	9.25	6.667	3.81	9.83	0.54
0.500	0.54	3.667	9.25	6.833	3.81	10.00	0.54
0.667	0.54	3.833	9.25	7.000	3.81	10.17	0.54
0.833	0.54	4.000	9.25	7.167	3.81	10.33	0.54
1.000	0.54	4.167	9.25	7.333	3.00	10.50	0.54
1.167	0.54	4.333	17.14	7.500	2.18	10.67	0.54
1.333	0.54	4.500	25.02	7.667	2.18	10.83	0.54
1.500	0.54	4.667	25.02	7.833	2.18	11.00	0.54
1.667	0.54	4.833	25.02	8.000	2.18	11.17	0.54
1.833	0.54	5.000	25.02	8.167	2.18	11.33	0.54
2.000	0.54	5.167	25.02	8.333	1.64	11.50	0.54
2.167	0.54	5.333	16.05	8.500	1.09	11.67	0.54
2.333	1.90	5.500	7.07	8.667	1.09	11.83	0.54
2.500	3.26	5.667	7.07	8.833	1.09	12.00	0.54
2.667	3.26	5.833	7.07	9.000	1.09	12.17	0.54
2.833	3.26	6.000	7.07	9.167	1.09	12.33	0.27
3.000	3.26	6.167	7.07	9.333	0.82		
3.167	3.26	6.333	5.44	9.500	0.54		

Max.Eff.Inten.(mm/hr)=	25.02	20.42	
over (min)	10.00	30.00	
Storage Coeff. (min)=	6.84 (ii)	20.17 (ii)	
Unit Hyd. Tpeak (min)=	10.00	30.00	
Unit Hyd. peak (cms)=	0.13	0.05	
			* TOTALS*

```
     PEAK FLOW       (cms)=       0.33          0.05             0.378 (iii)
     TIME TO PEAK    (hrs)=       5.17          5.33              5.17
     RUNOFF VOLUME    (mm)=      53.38         12.35             43.12
     TOTAL RAINFALL   (mm)=      54.38         54.38             54.38
     RUNOFF COEFFICIENT   =       0.98          0.23              0.79

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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-----
--------------------
| CALIB             |
| STANDHYD (  0002)|   Area    (ha)=   0.67
|ID= 1 DT=10.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  40.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.50          0.17
     Dep. Storage     (mm)=       1.00          1.50
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      66.83         40.00
     Mannings n          =      0.013         0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO  10.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                0.167    0.00 | 3.333    6.26 | 6.500    3.81 |  9.67
0.54
                0.333    0.27 | 3.500    9.25 | 6.667    3.81 |  9.83
0.54
                0.500    0.54 | 3.667    9.25 | 6.833    3.81 | 10.00
0.54
                0.667    0.54 | 3.833    9.25 | 7.000    3.81 | 10.17
0.54
                0.833    0.54 | 4.000    9.25 | 7.167    3.81 | 10.33
0.54
                1.000    0.54 | 4.167    9.25 | 7.333    3.00 | 10.50
0.54
                1.167    0.54 | 4.333   17.14 | 7.500    2.18 | 10.67
0.54
                1.333    0.54 | 4.500   25.02 | 7.667    2.18 | 10.83
0.54
```

```
              1.500    0.54 | 4.667   25.02 | 7.833    2.18 | 11.00
0.54
              1.667    0.54 | 4.833   25.02 | 8.000    2.18 | 11.17
0.54
              1.833    0.54 | 5.000   25.02 | 8.167    2.18 | 11.33
0.54
              2.000    0.54 | 5.167   25.02 | 8.333    1.64 | 11.50
0.54
              2.167    0.54 | 5.333   16.05 | 8.500    1.09 | 11.67
0.54
              2.333    1.90 | 5.500    7.07 | 8.667    1.09 | 11.83
0.54
              2.500    3.26 | 5.667    7.07 | 8.833    1.09 | 12.00
0.54
              2.667    3.26 | 5.833    7.07 | 9.000    1.09 | 12.17
0.54
              2.833    3.26 | 6.000    7.07 | 9.167    1.09 | 12.33
0.27
              3.000    3.26 | 6.167    7.07 | 9.333    0.82 |
              3.167    3.26 | 6.333    5.44 | 9.500    0.54 |

     Max.Eff.Inten.(mm/hr)=      25.02        51.82
               over (min)        10.00        20.00
     Storage Coeff.  (min)=       3.49 (ii)   12.67 (ii)
     Unit Hyd. Tpeak (min)=      10.00        20.00
     Unit Hyd. peak  (cms)=       0.16         0.07
                                                          *  TOTALS*
     PEAK FLOW       (cms)=       0.02         0.02         0.042 (iii)
     TIME TO PEAK    (hrs)=       5.17         5.17          5.17
     RUNOFF VOLUME    (mm)=      53.38        26.83         37.45
     TOTAL RAINFALL   (mm)=      54.38        54.38         54.38
     RUNOFF COEFFICIENT   =       0.98         0.49          0.69

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00          K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0004)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     6.31   0.378     5.17    43.12
      + ID2= 2 (  0002):     0.67   0.042     5.17    37.45
        ====================================================
        ID = 3 (  0004):     6.98   0.420     5.17    42.58
```

```
     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
---------------------------------------------------------------------------
-----
--------------------
| RESERVOIR(  0005)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT= 10.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1340      0.3161
                          0.0090     0.1412   |   0.1580      0.3775
                          0.0560     0.2086   |   0.1770      0.4341
                          0.0860     0.2312   |   1.1690      0.4851
                          0.1060     0.2611   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0004)      6.980      0.420      5.17      42.58
   OUTFLOW: ID= 1 (  0005)      6.980      0.074      6.50      42.01

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 17.63
                   TIME SHIFT OF PEAK FLOW        (min)= 80.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.2224

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  ************************************************
  ** SIMULATION : 10 Year 6 Hour AES (Bloor, TR **
  ************************************************


--------------------
|    READ STORM    |    Filename: C:\Users\shuchi\AppD
|                  |              ata\Local\Temp\
|                  |              30893ebc-4193-4b18-94cb-
f8ff69101a04\9430055c
| Ptotal= 55.69 mm |    Comments: 10 Year 6 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                 0.00    0.00 |  1.75   18.94 |  3.50    7.80 |  5.25
1.11
                 0.25    1.11 |  2.00   18.94 |  3.75    4.46 |  5.50
1.11
                 0.50    1.11 |  2.25   51.24 |  4.00    4.46 |  5.75
1.11
                 0.75    1.11 |  2.50   51.24 |  4.25    2.23 |  6.00
1.11
                 1.00    1.11 |  2.75   14.48 |  4.50    2.23 |
                 1.25    6.68 |  3.00   14.48 |  4.75    1.11 |
                 1.50    6.68 |  3.25    7.80 |  5.00    1.11 |

--------------------------------------------------------------------------
-----

--------------------
| CALIB            |
| STANDHYD (  0001)|   Area    (ha)=   6.31
|ID= 1 DT=10.0 min |   Total Imp(%)=  80.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.05         1.26
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     205.10        40.00
     Mannings n           =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO  10.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
```

```
                0.167    0.00 | 1.833   12.81 | 3.500    7.80 |  5.17
1.11
                0.333    0.56 | 2.000   18.94 | 3.667    7.80 |  5.33
1.11
                0.500    1.11 | 2.167   18.94 | 3.833    6.13 |  5.50
1.11
                0.667    1.11 | 2.333   35.09 | 4.000    4.46 |  5.67
1.11
                0.833    1.11 | 2.500   51.24 | 4.167    4.46 |  5.83
1.11
                1.000    1.11 | 2.667   51.24 | 4.333    3.34 |  6.00
1.11
                1.167    1.11 | 2.833   32.86 | 4.500    2.23 |  6.17
1.11
                1.333    3.89 | 3.000   14.48 | 4.667    2.23 |  6.33
0.56
                1.500    6.68 | 3.167   14.48 | 4.833    1.67 |
                1.667    6.68 | 3.333   11.14 | 5.000    1.11 |

     Max.Eff.Inten.(mm/hr)=      51.24        48.66
                over (min)       10.00        20.00
     Storage Coeff.  (min)=       5.14 (ii)   14.55 (ii)
     Unit Hyd. Tpeak (min)=      10.00        20.00
     Unit Hyd. peak  (cms)=       0.15         0.07
                                                           *  TOTALS*
     PEAK FLOW       (cms)=       0.67         0.12          0.775 (iii)
     TIME TO PEAK    (hrs)=       2.67         2.83           2.67
     RUNOFF VOLUME    (mm)=      54.69        20.62          46.17
     TOTAL RAINFALL   (mm)=      55.69        55.69          55.69
     RUNOFF COEFFICIENT   =       0.98         0.37           0.83

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo    (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc    (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

---------------------------------------------------------------------------
-----
--------------------
| CALIB            |
| STANDHYD (  0002)|   Area    (ha)=   0.67
|ID= 1 DT=10.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  40.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area      (ha)=       0.50         0.17
     Dep. Storage      (mm)=       1.00         1.50
     Average Slope      (%)=       1.00         2.00
     Length             (m)=      66.83        40.00
     Mannings n           =      0.013        0.250
```

```
          NOTE:  RAINFALL WAS TRANSFORMED TO  10.0 MIN. TIME STEP.

                              ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                0.167    0.00 | 1.833   12.81 | 3.500    7.80 |  5.17
1.11
                0.333    0.56 | 2.000   18.94 | 3.667    7.80 |  5.33
1.11
                0.500    1.11 | 2.167   18.94 | 3.833    6.13 |  5.50
1.11
                0.667    1.11 | 2.333   35.09 | 4.000    4.46 |  5.67
1.11
                0.833    1.11 | 2.500   51.24 | 4.167    4.46 |  5.83
1.11
                1.000    1.11 | 2.667   51.24 | 4.333    3.34 |  6.00
1.11
                1.167    1.11 | 2.833   32.86 | 4.500    2.23 |  6.17
1.11
                1.333    3.89 | 3.000   14.48 | 4.667    2.23 |  6.33
0.56
                1.500    6.68 | 3.167   14.48 | 4.833    1.67 |
                1.667    6.68 | 3.333   11.14 | 5.000    1.11 |

     Max.Eff.Inten.(mm/hr)=      51.24       111.11
                over (min)       10.00        10.00
     Storage Coeff.  (min)=       2.62 (ii)    9.39 (ii)
     Unit Hyd. Tpeak (min)=      10.00        10.00
     Unit Hyd. peak  (cms)=       0.17         0.11
                                                          *  TOTALS*
     PEAK FLOW       (cms)=       0.04         0.05         0.086 (iii)
     TIME TO PEAK    (hrs)=       2.67         2.67          2.67
     RUNOFF VOLUME    (mm)=      54.69        34.61         42.64
     TOTAL RAINFALL   (mm)=      55.69        55.69         55.69
     RUNOFF COEFFICIENT   =       0.98         0.62          0.77

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

---------------------------------------------------------------------------
-----

--------------------
| ADD HYD  (  0004)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
```

```
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):      6.31   0.775     2.67    46.17
      + ID2= 2 (  0002):      0.67   0.086     2.67    42.64
        ====================================================
        ID = 3 (  0004):      6.98   0.861     2.67    45.83

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------
-----
--------------------
| RESERVOIR(  0005)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT= 10.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           0.0000     0.0000   |   0.1340      0.3161
                           0.0090     0.1412   |   0.1580      0.3775
                           0.0560     0.2086   |   0.1770      0.4341
                           0.0860     0.2312   |   1.1690      0.4851
                           0.1060     0.2611   |   0.0000      0.0000

                                 AREA     QPEAK     TPEAK       R.V.
                                 (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0004)      6.980      0.861      2.67      45.83
   OUTFLOW: ID= 1 (  0005)      6.980      0.102      3.83      45.26

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 11.90
                   TIME SHIFT OF PEAK FLOW        (min)= 70.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.2558

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-----------------------------------
  ************************************************
  ** SIMULATION : 10 Year 12 Hour AES (Bloor, T **
  ************************************************


--------------------
|    READ STORM    |    Filename: C:\Users\shuchi\AppD
|                  |              ata\Local\Temp\
|                  |              30893ebc-4193-4b18-94cb-
f8ff69101a04\7836d271
| Ptotal= 62.71 mm |    Comments: 10 Year 12 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                 0.00    0.00 |  3.25   10.66 |  6.50    4.39 |  9.75
0.63
                 0.25    0.63 |  3.50   10.66 |  6.75    4.39 | 10.00
0.63
                 0.50    0.63 |  3.75   10.66 |  7.00    4.39 | 10.25
0.63
                 0.75    0.63 |  4.00   10.66 |  7.25    2.51 | 10.50
0.63
                 1.00    0.63 |  4.25   28.84 |  7.50    2.51 | 10.75
0.63
                 1.25    0.63 |  4.50   28.84 |  7.75    2.51 | 11.00
0.63
                 1.50    0.63 |  4.75   28.84 |  8.00    2.51 | 11.25
0.63
                 1.75    0.63 |  5.00   28.84 |  8.25    1.25 | 11.50
0.63
                 2.00    0.63 |  5.25    8.15 |  8.50    1.25 | 11.75
0.63
                 2.25    3.76 |  5.50    8.15 |  8.75    1.25 | 12.00
0.63
                 2.50    3.76 |  5.75    8.15 |  9.00    1.25 |
                 2.75    3.76 |  6.00    8.15 |  9.25    0.63 |
                 3.00    3.76 |  6.25    4.39 |  9.50    0.63 |

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--------------------
| CALIB            |
| STANDHYD (  0001)|   Area    (ha)=   6.31
|ID= 1 DT=10.0 min |   Total Imp(%)=  80.00   Dir. Conn.(%)=  75.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.05          1.26
     Dep. Storage     (mm)=       1.00          1.50
```

Average Slope (%)=	1.00	2.00
Length (m)=	205.10	40.00
Mannings n =	0.013	0.250

NOTE: RAINFALL WAS TRANSFORMED TO 10.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.167	0.00	3.333	7.21	6.500	4.39	9.67	0.63
0.333	0.32	3.500	10.66	6.667	4.39	9.83	0.63
0.500	0.63	3.667	10.66	6.833	4.39	10.00	0.63
0.667	0.63	3.833	10.66	7.000	4.39	10.17	0.63
0.833	0.63	4.000	10.66	7.167	4.39	10.33	0.63
1.000	0.63	4.167	10.66	7.333	3.45	10.50	0.63
1.167	0.63	4.333	19.75	7.500	2.51	10.67	0.63
1.333	0.63	4.500	28.84	7.667	2.51	10.83	0.63
1.500	0.63	4.667	28.84	7.833	2.51	11.00	0.63
1.667	0.63	4.833	28.84	8.000	2.51	11.17	0.63
1.833	0.63	5.000	28.84	8.167	2.51	11.33	0.63
2.000	0.63	5.167	28.84	8.333	1.88	11.50	0.63
2.167	0.63	5.333	18.50	8.500	1.25	11.67	0.63
2.333	2.19	5.500	8.15	8.667	1.25	11.83	0.63
2.500	3.76	5.667	8.15	8.833	1.25	12.00	0.63
2.667	3.76	5.833	8.15	9.000	1.25	12.17	0.63
2.833	3.76	6.000	8.15	9.167	1.25	12.33	0.31
3.000	3.76	6.167	8.15	9.333	0.94		
3.167	3.76	6.333	6.27	9.500	0.63		

Max.Eff.Inten.(mm/hr)=	28.84	25.88
over (min)	10.00	20.00
Storage Coeff. (min)=	6.46 (ii)	18.58 (ii)
Unit Hyd. Tpeak (min)=	10.00	20.00
Unit Hyd. peak (cms)=	0.13	0.06

```
                                                           *  TOTALS*
     PEAK FLOW        (cms)=       0.38         0.08          0.456 (iii)
     TIME TO PEAK     (hrs)=       5.17         5.17           5.17
     RUNOFF VOLUME     (mm)=      61.71        18.56          50.92
     TOTAL RAINFALL    (mm)=      62.71        62.71          62.71
     RUNOFF COEFFICIENT   =        0.98         0.30           0.81

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB              |
| STANDHYD (  0002)|   Area    (ha)=   0.67
|ID= 1 DT=10.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  40.00
--------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.50         0.17
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      66.83        40.00
     Mannings n           =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO  10.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
               0.167    0.00 | 3.333    7.21 | 6.500    4.39 |  9.67
0.63
               0.333    0.32 | 3.500   10.66 | 6.667    4.39 |  9.83
0.63
               0.500    0.63 | 3.667   10.66 | 6.833    4.39 | 10.00
0.63
               0.667    0.63 | 3.833   10.66 | 7.000    4.39 | 10.17
0.63
               0.833    0.63 | 4.000   10.66 | 7.167    4.39 | 10.33
0.63
               1.000    0.63 | 4.167   10.66 | 7.333    3.45 | 10.50
0.63
               1.167    0.63 | 4.333   19.75 | 7.500    2.51 | 10.67
0.63
               1.333    0.63 | 4.500   28.84 | 7.667    2.51 | 10.83
0.63
```

```
               1.500    0.63 | 4.667   28.84 | 7.833    2.51 | 11.00
0.63
               1.667    0.63 | 4.833   28.84 | 8.000    2.51 | 11.17
0.63
               1.833    0.63 | 5.000   28.84 | 8.167    2.51 | 11.33
0.63
               2.000    0.63 | 5.167   28.84 | 8.333    1.88 | 11.50
0.63
               2.167    0.63 | 5.333   18.50 | 8.500    1.25 | 11.67
0.63
               2.333    2.19 | 5.500    8.15 | 8.667    1.25 | 11.83
0.63
               2.500    3.76 | 5.667    8.15 | 8.833    1.25 | 12.00
0.63
               2.667    3.76 | 5.833    8.15 | 9.000    1.25 | 12.17
0.63
               2.833    3.76 | 6.000    8.15 | 9.167    1.25 | 12.33
0.31
               3.000    3.76 | 6.167    8.15 | 9.333    0.94 |
               3.167    3.76 | 6.333    6.27 | 9.500    0.63 |

     Max.Eff.Inten.(mm/hr)=      28.84        61.11
               over (min)        10.00        20.00
     Storage Coeff.  (min)=       3.30 (ii)   11.89 (ii)
     Unit Hyd. Tpeak (min)=      10.00        20.00
     Unit Hyd. peak  (cms)=       0.16         0.08
                                                           *  TOTALS*
     PEAK FLOW       (cms)=       0.02         0.03          0.049 (iii)
     TIME TO PEAK    (hrs)=       5.17         5.17           5.17
     RUNOFF VOLUME     (mm)=     61.71        34.10          45.14
     TOTAL RAINFALL    (mm)=     62.71        62.71          62.71
     RUNOFF COEFFICIENT   =       0.98         0.54           0.72

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00          K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0004)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     6.31   0.456     5.17    50.92
      + ID2= 2 (  0002):     0.67   0.049     5.17    45.14
        ====================================================
        ID = 3 (  0004):     6.98   0.505     5.17    50.37
```

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     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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--------------------
| RESERVOIR(  0005)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT= 10.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1340     0.3161
                          0.0090     0.1412   |   0.1580     0.3775
                          0.0560     0.2086   |   0.1770     0.4341
                          0.0860     0.2312   |   1.1690     0.4851
                          0.1060     0.2611   |   0.0000     0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0004)      6.980      0.505      5.17      50.37
   OUTFLOW: ID= 1 (  0005)      6.980      0.100      6.33      49.80

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 19.89
                   TIME SHIFT OF PEAK FLOW        (min)= 70.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.2530

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  ************************************************
  ** SIMULATION : 25 Year 6 Hour AES (Bloor, TR **
  ************************************************


--------------------
|    READ STORM    |    Filename: C:\Users\shuchi\AppD
|                  |              ata\Local\Temp\
|                  |              30893ebc-4193-4b18-94cb-
f8ff69101a04\484539e2
| Ptotal= 65.59 mm |    Comments: 25 Year 6 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                 0.00    0.00 |  1.75   22.30 |  3.50    9.18 |  5.25
1.31
                 0.25    1.31 |  2.00   22.30 |  3.75    5.25 |  5.50
1.31
                 0.50    1.31 |  2.25   60.35 |  4.00    5.25 |  5.75
1.31
                 0.75    1.31 |  2.50   60.35 |  4.25    2.62 |  6.00
1.31
                 1.00    1.31 |  2.75   17.06 |  4.50    2.62 |
                 1.25    7.87 |  3.00   17.06 |  4.75    1.31 |
                 1.50    7.87 |  3.25    9.18 |  5.00    1.31 |

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--------------------
| CALIB            |
| STANDHYD (  0001)|   Area    (ha)=   6.31
|ID= 1 DT=10.0 min |   Total Imp(%)=  80.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.05         1.26
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     205.10        40.00
     Mannings n          =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO  10.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
```

```
                0.167    0.00 | 1.833   15.08 | 3.500    9.18 |  5.17
1.31
                0.333    0.65 | 2.000   22.30 | 3.667    9.18 |  5.33
1.31
                0.500    1.31 | 2.167   22.30 | 3.833    7.21 |  5.50
1.31
                0.667    1.31 | 2.333   41.32 | 4.000    5.25 |  5.67
1.31
                0.833    1.31 | 2.500   60.35 | 4.167    5.25 |  5.83
1.31
                1.000    1.31 | 2.667   60.35 | 4.333    3.93 |  6.00
1.31
                1.167    1.31 | 2.833   38.70 | 4.500    2.62 |  6.17
1.31
                1.333    4.59 | 3.000   17.06 | 4.667    2.62 |  6.33
0.66
                1.500    7.87 | 3.167   17.06 | 4.833    1.97 |
                1.667    7.87 | 3.333   13.12 | 5.000    1.31 |

     Max.Eff.Inten.(mm/hr)=      60.35        61.43
               over (min)        10.00        20.00
     Storage Coeff.  (min)=       4.81 (ii)   13.39 (ii)
     Unit Hyd. Tpeak (min)=      10.00        20.00
     Unit Hyd. peak  (cms)=       0.15         0.07
                                                          *  TOTALS*
     PEAK FLOW       (cms)=       0.79         0.17          0.937 (iii)
     TIME TO PEAK    (hrs)=       2.67         2.83           2.67
     RUNOFF VOLUME    (mm)=      64.59        29.00          55.69
     TOTAL RAINFALL   (mm)=      65.59        65.59          65.59
     RUNOFF COEFFICIENT   =       0.98         0.44           0.85

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo    (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc    (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB              |
| STANDHYD (  0002)|   Area    (ha)=   0.67
|ID= 1 DT=10.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  40.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.50         0.17
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      66.83        40.00
     Mannings n           =      0.013        0.250
```

```
          NOTE:  RAINFALL WAS TRANSFORMED TO  10.0 MIN. TIME STEP.

                              ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                0.167    0.00 | 1.833   15.08 | 3.500    9.18 |  5.17
1.31
                0.333    0.65 | 2.000   22.30 | 3.667    9.18 |  5.33
1.31
                0.500    1.31 | 2.167   22.30 | 3.833    7.21 |  5.50
1.31
                0.667    1.31 | 2.333   41.32 | 4.000    5.25 |  5.67
1.31
                0.833    1.31 | 2.500   60.35 | 4.167    5.25 |  5.83
1.31
                1.000    1.31 | 2.667   60.35 | 4.333    3.93 |  6.00
1.31
                1.167    1.31 | 2.833   38.70 | 4.500    2.62 |  6.17
1.31
                1.333    4.59 | 3.000   17.06 | 4.667    2.62 |  6.33
0.66
                1.500    7.87 | 3.167   17.06 | 4.833    1.97 |
                1.667    7.87 | 3.333   13.12 | 5.000    1.31 |

     Max.Eff.Inten.(mm/hr)=      60.35       133.39
                over (min)       10.00        10.00
     Storage Coeff.  (min)=       2.46 (ii)    8.74 (ii)
     Unit Hyd. Tpeak (min)=      10.00        10.00
     Unit Hyd. peak  (cms)=       0.17         0.12
                                                        *  TOTALS*
     PEAK FLOW       (cms)=       0.04         0.06         0.104 (iii)
     TIME TO PEAK    (hrs)=       2.67         2.67          2.67
     RUNOFF VOLUME    (mm)=      64.59        43.89         52.17
     TOTAL RAINFALL   (mm)=      65.59        65.59         65.59
     RUNOFF COEFFICIENT   =       0.98         0.67          0.80

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00          K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0004)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
```

```
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):      6.31   0.937     2.67    55.69
      + ID2= 2 (  0002):      0.67   0.104     2.67    52.17
        ====================================================
        ID = 3 (  0004):      6.98   1.041     2.67    55.35

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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-----
--------------------
| RESERVOIR(  0005)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT= 10.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1340      0.3161
                          0.0090     0.1412   |   0.1580      0.3775
                          0.0560     0.2086   |   0.1770      0.4341
                          0.0860     0.2312   |   1.1690      0.4851
                          0.1060     0.2611   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0004)      6.980      1.041      2.67       55.35
   OUTFLOW: ID= 1 (  0005)      6.980      0.128      3.83       54.78

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 12.27
                   TIME SHIFT OF PEAK FLOW         (min)= 70.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.3040

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  *********************************************
  ** SIMULATION : 25 Year 12 Hour AES (Bloor, T **
  *********************************************


--------------------
|    READ STORM    |    Filename: C:\Users\shuchi\AppD
|                  |              ata\Local\Temp\
|                  |              30893ebc-4193-4b18-94cb-
f8ff69101a04\32ec7dbe
| Ptotal= 73.10 mm |    Comments: 25 Year 12 Hour AES (Bloor, TRCA)
--------------------
                  TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                   hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                  0.00    0.00 |  3.25   12.43 |  6.50    5.12 |  9.75
0.73
                  0.25    0.73 |  3.50   12.43 |  6.75    5.12 | 10.00
0.73
                  0.50    0.73 |  3.75   12.43 |  7.00    5.12 | 10.25
0.73
                  0.75    0.73 |  4.00   12.43 |  7.25    2.92 | 10.50
0.73
                  1.00    0.73 |  4.25   33.63 |  7.50    2.92 | 10.75
0.73
                  1.25    0.73 |  4.50   33.63 |  7.75    2.92 | 11.00
0.73
                  1.50    0.73 |  4.75   33.63 |  8.00    2.92 | 11.25
0.73
                  1.75    0.73 |  5.00   33.63 |  8.25    1.46 | 11.50
0.73
                  2.00    0.73 |  5.25    9.50 |  8.50    1.46 | 11.75
0.73
                  2.25    4.39 |  5.50    9.50 |  8.75    1.46 | 12.00
0.73
                  2.50    4.39 |  5.75    9.50 |  9.00    1.46 |
                  2.75    4.39 |  6.00    9.50 |  9.25    0.73 |
                  3.00    4.39 |  6.25    5.12 |  9.50    0.73 |

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--------------------
| CALIB            |
| STANDHYD (  0001)|   Area    (ha)=   6.31
|ID= 1 DT=10.0 min |   Total Imp(%)=  80.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.05          1.26
     Dep. Storage     (mm)=       1.00          1.50
```

Average Slope	(%)=	1.00	2.00
Length	(m)=	205.10	40.00
Mannings n	=	0.013	0.250

NOTE: RAINFALL WAS TRANSFORMED TO 10.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.167	0.00	3.333	8.41	6.500	5.12	9.67	0.73
0.333	0.37	3.500	12.43	6.667	5.12	9.83	0.73
0.500	0.73	3.667	12.43	6.833	5.12	10.00	0.73
0.667	0.73	3.833	12.43	7.000	5.12	10.17	0.73
0.833	0.73	4.000	12.43	7.167	5.12	10.33	0.73
1.000	0.73	4.167	12.43	7.333	4.02	10.50	0.73
1.167	0.73	4.333	23.03	7.500	2.92	10.67	0.73
1.333	0.73	4.500	33.63	7.667	2.92	10.83	0.73
1.500	0.73	4.667	33.63	7.833	2.92	11.00	0.73
1.667	0.73	4.833	33.63	8.000	2.92	11.17	0.73
1.833	0.73	5.000	33.63	8.167	2.92	11.33	0.73
2.000	0.73	5.167	33.63	8.333	2.19	11.50	0.73
2.167	0.73	5.333	21.57	8.500	1.46	11.67	0.73
2.333	2.56	5.500	9.50	8.667	1.46	11.83	0.73
2.500	4.39	5.667	9.50	8.833	1.46	12.00	0.73
2.667	4.39	5.833	9.50	9.000	1.46	12.17	0.73
2.833	4.39	6.000	9.50	9.167	1.46	12.33	0.36
3.000	4.39	6.167	9.50	9.333	1.10		
3.167	4.39	6.333	7.31	9.500	0.73		

Max.Eff.Inten.(mm/hr)=	33.63	32.59	
over (min)	10.00	20.00	
Storage Coeff. (min)=	6.08 (ii)	17.13 (ii)	
Unit Hyd. Tpeak (min)=	10.00	20.00	
Unit Hyd. peak (cms)=	0.14	0.06	

```
                                                      *  TOTALS*
     PEAK FLOW        (cms)=       0.44          0.10           0.545 (iii)
     TIME TO PEAK     (hrs)=       5.17          5.17            5.17
     RUNOFF VOLUME     (mm)=      72.10         26.39           60.67
     TOTAL RAINFALL    (mm)=      73.10         73.10           73.10
     RUNOFF COEFFICIENT   =        0.99          0.36            0.83

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB             |
| STANDHYD (  0002)|   Area    (ha)=   0.67
|ID= 1 DT=10.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  40.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.50          0.17
     Dep. Storage     (mm)=       1.00          1.50
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      66.83         40.00
     Mannings n           =      0.013         0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO  10.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN | TIME    RAIN |' TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |  hrs   mm/hr |'  hrs   mm/hr |   hrs
mm/hr
                0.167    0.00 | 3.333    8.41 | 6.500    5.12 |  9.67
0.73
                0.333    0.37 | 3.500   12.43 | 6.667    5.12 |  9.83
0.73
                0.500    0.73 | 3.667   12.43 | 6.833    5.12 | 10.00
0.73
                0.667    0.73 | 3.833   12.43 | 7.000    5.12 | 10.17
0.73
                0.833    0.73 | 4.000   12.43 | 7.167    5.12 | 10.33
0.73
                1.000    0.73 | 4.167   12.43 | 7.333    4.02 | 10.50
0.73
                1.167    0.73 | 4.333   23.03 | 7.500    2.92 | 10.67
0.73
                1.333    0.73 | 4.500   33.63 | 7.667    2.92 | 10.83
0.73
```

```
               1.500    0.73 | 4.667   33.63 | 7.833    2.92 | 11.00
0.73
               1.667    0.73 | 4.833   33.63 | 8.000    2.92 | 11.17
0.73
               1.833    0.73 | 5.000   33.63 | 8.167    2.92 | 11.33
0.73
               2.000    0.73 | 5.167   33.63 | 8.333    2.19 | 11.50
0.73
               2.167    0.73 | 5.333   21.57 | 8.500    1.46 | 11.67
0.73
               2.333    2.56 | 5.500    9.50 | 8.667    1.46 | 11.83
0.73
               2.500    4.39 | 5.667    9.50 | 8.833    1.46 | 12.00
0.73
               2.667    4.39 | 5.833    9.50 | 9.000    1.46 | 12.17
0.73
               2.833    4.39 | 6.000    9.50 | 9.167    1.46 | 12.33
0.36
               3.000    4.39 | 6.167    9.50 | 9.333    1.10 |
               3.167    4.39 | 6.333    7.31 | 9.500    0.73 |

     Max.Eff.Inten.(mm/hr)=      33.63        72.71
               over (min)        10.00        20.00
     Storage Coeff.  (min)=       3.10 (ii)   11.12 (ii)
     Unit Hyd. Tpeak (min)=      10.00        20.00
     Unit Hyd. peak  (cms)=       0.16         0.08
                                                               *  TOTALS*
     PEAK FLOW       (cms)=       0.03         0.03           0.058 (iii)
     TIME TO PEAK    (hrs)=       5.00         5.17            5.17
     RUNOFF VOLUME    (mm)=      72.10        43.32           54.83
     TOTAL RAINFALL   (mm)=      73.10        73.10           73.10
     RUNOFF COEFFICIENT   =       0.99         0.59            0.75

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo    (mm/hr)= 50.00          K  (1/hr)=  2.00
            Fc    (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0004)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     6.31   0.545     5.17    60.67
      + ID2= 2 (  0002):     0.67   0.058     5.17    54.83
        ====================================================
        ID = 3 (  0004):     6.98   0.603     5.17    60.11
```

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     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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--------------------
| RESERVOIR(  0005)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT= 10.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1340     0.3161
                          0.0090     0.1412   |   0.1580     0.3775
                          0.0560     0.2086   |   0.1770     0.4341
                          0.0860     0.2312   |   1.1690     0.4851
                          0.1060     0.2611   |   0.0000     0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0004)      6.980      0.603      5.17      60.11
   OUTFLOW: ID= 1 (  0005)      6.980      0.124      6.33      59.54

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 20.53
                   TIME SHIFT OF PEAK FLOW        (min)= 70.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.2962

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  ************************************************
  ** SIMULATION : 50 Year 6 Hour AES (Bloor, TR **
  ************************************************


--------------------
|    READ STORM    |    Filename: C:\Users\shuchi\AppD
|                  |              ata\Local\Temp\
|                  |              30893ebc-4193-4b18-94cb-
f8ff69101a04\e90de704
| Ptotal= 73.00 mm |    Comments: 50 Year 6 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                 0.00    0.00 |  1.75   24.82 |  3.50   10.22 |  5.25
1.46
                 0.25    1.46 |  2.00   24.82 |  3.75    5.84 |  5.50
1.46
                 0.50    1.46 |  2.25   67.16 |  4.00    5.84 |  5.75
1.46
                 0.75    1.46 |  2.50   67.16 |  4.25    2.92 |  6.00
1.46
                 1.00    1.46 |  2.75   18.98 |  4.50    2.92 |
                 1.25    8.76 |  3.00   18.98 |  4.75    1.46 |
                 1.50    8.76 |  3.25   10.22 |  5.00    1.46 |

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--------------------
| CALIB            |
| STANDHYD (  0001)|   Area    (ha)=   6.31
|ID= 1 DT=10.0 min |   Total Imp(%)=  80.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.05         1.26
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     205.10        40.00
     Mannings n           =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO  10.0 MIN. TIME STEP.


                                ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
```

```
               0.167    0.00 | 1.833   16.79 | 3.500   10.22 |  5.17
1.46
               0.333    0.73 | 2.000   24.82 | 3.667   10.22 |  5.33
1.46
               0.500    1.46 | 2.167   24.82 | 3.833    8.03 |  5.50
1.46
               0.667    1.46 | 2.333   45.99 | 4.000    5.84 |  5.67
1.46
               0.833    1.46 | 2.500   67.16 | 4.167    5.84 |  5.83
1.46
               1.000    1.46 | 2.667   67.16 | 4.333    4.38 |  6.00
1.46
               1.167    1.46 | 2.833   43.07 | 4.500    2.92 |  6.17
1.46
               1.333    5.11 | 3.000   18.98 | 4.667    2.92 |  6.33
0.73
               1.500    8.76 | 3.167   18.98 | 4.833    2.19 |
               1.667    8.76 | 3.333   14.60 | 5.000    1.46 |

     Max.Eff.Inten.(mm/hr)=      67.16        70.55
               over (min)        10.00        20.00
     Storage Coeff.  (min)=       4.61 (ii)   12.72 (ii)
     Unit Hyd. Tpeak (min)=      10.00        20.00
     Unit Hyd. peak  (cms)=       0.15         0.07
                                                          *  TOTALS*
     PEAK FLOW       (cms)=       0.88         0.20          1.060 (iii)
     TIME TO PEAK    (hrs)=       2.67         2.83           2.67
     RUNOFF VOLUME    (mm)=      72.00        35.47          62.87
     TOTAL RAINFALL   (mm)=      73.00        73.00          73.00
     RUNOFF COEFFICIENT   =       0.99         0.49           0.86

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo    (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc    (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB              |
| STANDHYD (  0002)|   Area    (ha)=   0.67
|ID= 1 DT=10.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  40.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area      (ha)=       0.50         0.17
     Dep. Storage      (mm)=       1.00         1.50
     Average Slope      (%)=       1.00         2.00
     Length             (m)=      66.83        40.00
     Mannings n           =      0.013        0.250
```

NOTE: RAINFALL WAS TRANSFORMED TO 10.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.167	0.00	1.833	16.79	3.500	10.22	5.17	1.46
0.333	0.73	2.000	24.82	3.667	10.22	5.33	1.46
0.500	1.46	2.167	24.82	3.833	8.03	5.50	1.46
0.667	1.46	2.333	45.99	4.000	5.84	5.67	1.46
0.833	1.46	2.500	67.16	4.167	5.84	5.83	1.46
1.000	1.46	2.667	67.16	4.333	4.38	6.00	1.46
1.167	1.46	2.833	43.07	4.500	2.92	6.17	1.46
1.333	5.11	3.000	18.98	4.667	2.92	6.33	0.73
1.500	8.76	3.167	18.98	4.833	2.19		
1.667	8.76	3.333	14.60	5.000	1.46		

Max.Eff.Inten.(mm/hr)=	67.16	150.04	
over (min)	10.00	10.00	
Storage Coeff. (min)=	2.35 (ii)	8.35 (ii)	
Unit Hyd. Tpeak (min)=	10.00	10.00	
Unit Hyd. peak (cms)=	0.17	0.12	
			* TOTALS*
PEAK FLOW (cms)=	0.05	0.07	0.117 (iii)
TIME TO PEAK (hrs)=	2.67	2.67	2.67
RUNOFF VOLUME (mm)=	72.00	50.82	59.29
TOTAL RAINFALL (mm)=	73.00	73.00	73.00
RUNOFF COEFFICIENT =	0.99	0.70	0.81

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

(i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
Fo (mm/hr)= 50.00 K (1/hr)= 2.00
Fc (mm/hr)= 7.50 Cum.Inf. (mm)= 0.00
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

| ADD HYD (0004)|
| 1 + 2 = 3 | AREA QPEAK TPEAK R.V.

```
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):      6.31   1.060     2.67    62.87
      + ID2= 2 (  0002):      0.67   0.117     2.67    59.29
        ====================================================
        ID = 3 (  0004):      6.98   1.177     2.67    62.52

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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--------------------
| RESERVOIR(  0005)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT= 10.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1340      0.3161
                          0.0090     0.1412   |   0.1580      0.3775
                          0.0560     0.2086   |   0.1770      0.4341
                          0.0860     0.2312   |   1.1690      0.4851
                          0.1060     0.2611   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0004)      6.980      1.177      2.67      62.52
   OUTFLOW: ID= 1 (  0005)      6.980      0.144      3.83      61.95

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 12.24
                   TIME SHIFT OF PEAK FLOW         (min)= 70.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.3417

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****
** SIMULATION : 50 Year 12 Hour AES (Bloor, T **
****

```
--------------------
|    READ STORM    |    Filename: C:\Users\shuchi\AppD
|                  |              ata\Local\Temp\
|                  |              30893ebc-4193-4b18-94cb-
f8ff69101a04\786fcac4
| Ptotal= 80.82 mm |    Comments: 50 Year 12 Hour AES (Bloor, TRCA)
--------------------
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.00	0.00	3.25	13.74	6.50	5.66	9.75	0.81
0.25	0.81	3.50	13.74	6.75	5.66	10.00	0.81
0.50	0.81	3.75	13.74	7.00	5.66	10.25	0.81
0.75	0.81	4.00	13.74	7.25	3.23	10.50	0.81
1.00	0.81	4.25	37.17	7.50	3.23	10.75	0.81
1.25	0.81	4.50	37.17	7.75	3.23	11.00	0.81
1.50	0.81	4.75	37.17	8.00	3.23	11.25	0.81
1.75	0.81	5.00	37.17	8.25	1.62	11.50	0.81
2.00	0.81	5.25	10.50	8.50	1.62	11.75	0.81
2.25	4.85	5.50	10.50	8.75	1.62	12.00	0.81
2.50	4.85	5.75	10.50	9.00	1.62		
2.75	4.85	6.00	10.50	9.25	0.81		
3.00	4.85	6.25	5.66	9.50	0.81		

```
--------------------
| CALIB            |
| STANDHYD ( 0001)|   Area    (ha)=   6.31
|ID= 1 DT=10.0 min |   Total Imp(%)=  80.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.05          1.26
     Dep. Storage     (mm)=       1.00          1.50
```

Average Slope	(%)=	1.00	2.00
Length	(m)=	205.10	40.00
Mannings n	=	0.013	0.250

NOTE: RAINFALL WAS TRANSFORMED TO 10.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.167	0.00	3.333	9.30	6.500	5.66	9.67	0.81
0.333	0.41	3.500	13.74	6.667	5.66	9.83	0.81
0.500	0.81	3.667	13.74	6.833	5.66	10.00	0.81
0.667	0.81	3.833	13.74	7.000	5.66	10.17	0.81
0.833	0.81	4.000	13.74	7.167	5.66	10.33	0.81
1.000	0.81	4.167	13.74	7.333	4.45	10.50	0.81
1.167	0.81	4.333	25.46	7.500	3.23	10.67	0.81
1.333	0.81	4.500	37.17	7.667	3.23	10.83	0.81
1.500	0.81	4.667	37.17	7.833	3.23	11.00	0.81
1.667	0.81	4.833	37.17	8.000	3.23	11.17	0.81
1.833	0.81	5.000	37.17	8.167	3.23	11.33	0.81
2.000	0.81	5.167	37.17	8.333	2.43	11.50	0.81
2.167	0.81	5.333	23.84	8.500	1.62	11.67	0.81
2.333	2.83	5.500	10.50	8.667	1.62	11.83	0.81
2.500	4.85	5.667	10.50	8.833	1.62	12.00	0.81
2.667	4.85	5.833	10.50	9.000	1.62	12.17	0.81
2.833	4.85	6.000	10.50	9.167	1.62	12.33	0.40
3.000	4.85	6.167	10.50	9.333	1.22		
3.167	4.85	6.333	8.08	9.500	0.81		

Max.Eff.Inten.(mm/hr)=		37.17	37.47
over	(min)	10.00	20.00
Storage Coeff.	(min)=	5.84 (ii)	16.29 (ii)
Unit Hyd. Tpeak	(min)=	10.00	20.00
Unit Hyd. peak	(cms)=	0.14	0.06

```
                                                         *  TOTALS*
    PEAK FLOW       (cms)=       0.49          0.12          0.610 (iii)
    TIME TO PEAK    (hrs)=       5.17          5.17           5.17
    RUNOFF VOLUME    (mm)=      79.82         32.09          67.89
    TOTAL RAINFALL   (mm)=      80.82         80.82          80.82
    RUNOFF COEFFICIENT   =       0.99          0.40           0.84

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

      (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
           Fo   (mm/hr)= 50.00           K  (1/hr)=  2.00
           Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD (  0002)|   Area    (ha)=   0.67
|ID= 1 DT=10.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  40.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
    Surface Area     (ha)=       0.50          0.17
    Dep. Storage     (mm)=       1.00          1.50
    Average Slope     (%)=       1.00          2.00
    Length            (m)=      66.83         40.00
    Mannings n          =      0.013         0.250

        NOTE:  RAINFALL WAS TRANSFORMED TO  10.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
               TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
              0.167    0.00 | 3.333    9.30 | 6.500    5.66 |  9.67
0.81
              0.333    0.41 | 3.500   13.74 | 6.667    5.66 |  9.83
0.81
              0.500    0.81 | 3.667   13.74 | 6.833    5.66 | 10.00
0.81
              0.667    0.81 | 3.833   13.74 | 7.000    5.66 | 10.17
0.81
              0.833    0.81 | 4.000   13.74 | 7.167    5.66 | 10.33
0.81
              1.000    0.81 | 4.167   13.74 | 7.333    4.45 | 10.50
0.81
              1.167    0.81 | 4.333   25.46 | 7.500    3.23 | 10.67
0.81
              1.333    0.81 | 4.500   37.17 | 7.667    3.23 | 10.83
0.81
```

```
                1.500    0.81 | 4.667   37.17 | 7.833    3.23 | 11.00
0.81
                1.667    0.81 | 4.833   37.17 | 8.000    3.23 | 11.17
0.81
                1.833    0.81 | 5.000   37.17 | 8.167    3.23 | 11.33
0.81
                2.000    0.81 | 5.167   37.17 | 8.333    2.43 | 11.50
0.81
                2.167    0.81 | 5.333   23.84 | 8.500    1.62 | 11.67
0.81
                2.333    2.83 | 5.500   10.50 | 8.667    1.62 | 11.83
0.81
                2.500    4.85 | 5.667   10.50 | 8.833    1.62 | 12.00
0.81
                2.667    4.85 | 5.833   10.50 | 9.000    1.62 | 12.17
0.81
                2.833    4.85 | 6.000   10.50 | 9.167    1.62 | 12.33
0.40
                3.000    4.85 | 6.167   10.50 | 9.333    1.22 |
                3.167    4.85 | 6.333    8.08 | 9.500    0.81 |

     Max.Eff.Inten.(mm/hr)=      37.17        81.28
                over (min)       10.00        20.00
     Storage Coeff.  (min)=       2.98 (ii)   10.65 (ii)
     Unit Hyd. Tpeak (min)=      10.00        20.00
     Unit Hyd. peak  (cms)=       0.16         0.08
                                                          *  TOTALS*
     PEAK FLOW       (cms)=       0.03         0.04         0.065 (iii)
     TIME TO PEAK    (hrs)=       5.00         5.17          5.17
     RUNOFF VOLUME    (mm)=      79.82        50.20         62.05
     TOTAL RAINFALL   (mm)=      80.82        80.82         80.82
     RUNOFF COEFFICIENT   =       0.99         0.62          0.77

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00          K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| ADD HYD  (  0004)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     6.31   0.610     5.17    67.89
      + ID2= 2 (  0002):     0.67   0.065     5.17    62.05
        ====================================================
        ID = 3 (  0004):     6.98   0.675     5.17    67.33
```

```
     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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--------------------
| RESERVOIR(  0005)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT= 10.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1340      0.3161
                          0.0090     0.1412   |   0.1580      0.3775
                          0.0560     0.2086   |   0.1770      0.4341
                          0.0860     0.2312   |   1.1690      0.4851
                          0.1060     0.2611   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK        R.V.
                                (ha)     (cms)     (hrs)        (mm)
   INFLOW : ID= 2 (  0004)      6.980     0.675      5.17       67.33
   OUTFLOW: ID= 1 (  0005)      6.980     0.139      6.33       66.76

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 20.59
                   TIME SHIFT OF PEAK FLOW         (min)= 70.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.3288

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  ************************************************
  ** SIMULATION : 100 Year 6 Hour AES (Bloor, T **
  ************************************************


--------------------
|    READ STORM    |    Filename: C:\Users\shuchi\AppD
|                  |              ata\Local\Temp\
|                  |              30893ebc-4193-4b18-94cb-
f8ff69101a04\57b24d9f
| Ptotal= 80.31 mm |    Comments: 100 Year 6 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                 0.00    0.00 |  1.75   27.30 |  3.50   11.24 |  5.25
1.61
                 0.25    1.61 |  2.00   27.30 |  3.75    6.42 |  5.50
1.61
                 0.50    1.61 |  2.25   73.88 |  4.00    6.42 |  5.75
1.61
                 0.75    1.61 |  2.50   73.88 |  4.25    3.21 |  6.00
1.61
                 1.00    1.61 |  2.75   20.88 |  4.50    3.21 |
                 1.25    9.64 |  3.00   20.88 |  4.75    1.61 |
                 1.50    9.64 |  3.25   11.24 |  5.00    1.61 |

----------------------------------------------------------------------------
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--------------------
| CALIB            |
| STANDHYD (  0001)|   Area     (ha)=   6.31
|ID= 1 DT=10.0 min |   Total Imp(%)=  80.00   Dir. Conn.(%)=  75.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area      (ha)=       5.05         1.26
     Dep. Storage      (mm)=       1.00         1.50
     Average Slope      (%)=       1.00         2.00
     Length             (m)=     205.10        40.00
     Mannings n            =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO  10.0 MIN. TIME STEP.


                                ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
```

```
               0.167    0.00 | 1.833   18.47 | 3.500   11.24 |  5.17
1.61
               0.333    0.81 | 2.000   27.30 | 3.667   11.24 |  5.33
1.61
               0.500    1.61 | 2.167   27.30 | 3.833    8.83 |  5.50
1.61
               0.667    1.61 | 2.333   50.59 | 4.000    6.42 |  5.67
1.61
               0.833    1.61 | 2.500   73.88 | 4.167    6.42 |  5.83
1.61
               1.000    1.61 | 2.667   73.88 | 4.333    4.81 |  6.00
1.61
               1.167    1.61 | 2.833   47.38 | 4.500    3.21 |  6.17
1.61
               1.333    5.62 | 3.000   20.88 | 4.667    3.21 |  6.33
0.81
               1.500    9.64 | 3.167   20.88 | 4.833    2.41 |
               1.667    9.64 | 3.333   16.06 | 5.000    1.61 |

     Max.Eff.Inten.(mm/hr)=      73.88        79.29
               over (min)       10.00        20.00
     Storage Coeff.  (min)=       4.44 (ii)   12.18 (ii)
     Unit Hyd. Tpeak (min)=      10.00        20.00
     Unit Hyd. peak  (cms)=       0.15         0.07
                                                          *  TOTALS*
     PEAK FLOW       (cms)=       0.97         0.22          1.179 (iii)
     TIME TO PEAK    (hrs)=       2.67         2.83           2.67
     RUNOFF VOLUME    (mm)=      79.31        42.03          69.99
     TOTAL RAINFALL   (mm)=      80.31        80.31          80.31
     RUNOFF COEFFICIENT   =       0.99         0.52           0.87

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo    (mm/hr)= 50.00           K  (1/hr)=  2.00
            Fc    (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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-----
--------------------
| CALIB             |
| STANDHYD (  0002)|   Area    (ha)=   0.67
|ID= 1 DT=10.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  40.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.50         0.17
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      66.83        40.00
     Mannings n           =      0.013        0.250
```

```
         NOTE:  RAINFALL WAS TRANSFORMED TO  10.0 MIN. TIME STEP.


                           ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN | TIME    RAIN |' TIME    RAIN |  TIME
RAIN
                 hrs   mm/hr |  hrs   mm/hr |'  hrs   mm/hr |   hrs
mm/hr
                0.167   0.00 | 1.833   18.47 | 3.500   11.24 |  5.17
1.61
                0.333   0.81 | 2.000   27.30 | 3.667   11.24 |  5.33
1.61
                0.500   1.61 | 2.167   27.30 | 3.833    8.83 |  5.50
1.61
                0.667   1.61 | 2.333   50.59 | 4.000    6.42 |  5.67
1.61
                0.833   1.61 | 2.500   73.88 | 4.167    6.42 |  5.83
1.61
                1.000   1.61 | 2.667   73.88 | 4.333    4.81 |  6.00
1.61
                1.167   1.61 | 2.833   47.38 | 4.500    3.21 |  6.17
1.61
                1.333   5.62 | 3.000   20.88 | 4.667    3.21 |  6.33
0.81
                1.500   9.64 | 3.167   20.88 | 4.833    2.41 |
                1.667   9.64 | 3.333   16.06 | 5.000    1.61 |

     Max.Eff.Inten.(mm/hr)=      73.88       166.47
                over (min)       10.00        10.00
     Storage Coeff.  (min)=       2.26 (ii)    8.02 (ii)
     Unit Hyd. Tpeak (min)=      10.00        10.00
     Unit Hyd. peak  (cms)=       0.17         0.12
                                                          *  TOTALS*
     PEAK FLOW       (cms)=       0.05         0.07          0.129 (iii)
     TIME TO PEAK    (hrs)=       2.67         2.67           2.67
     RUNOFF VOLUME    (mm)=      79.31        57.67          66.33
     TOTAL RAINFALL   (mm)=      80.31        80.31          80.31
     RUNOFF COEFFICIENT   =       0.99         0.72           0.83

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00          K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0004)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
```

```
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):      6.31   1.179     2.67    69.99
      + ID2= 2 (  0002):      0.67   0.129     2.67    66.33
        ====================================================
        ID = 3 (  0004):      6.98   1.309     2.67    69.64

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------
-----
--------------------
| RESERVOIR(  0005)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT= 10.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1340      0.3161
                          0.0090     0.1412   |   0.1580      0.3775
                          0.0560     0.2086   |   0.1770      0.4341
                          0.0860     0.2312   |   1.1690      0.4851
                          0.1060     0.2611   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK        R.V.
                                (ha)     (cms)     (hrs)        (mm)
   INFLOW : ID= 2 (  0004)      6.980      1.309      2.67       69.64
   OUTFLOW: ID= 1 (  0005)      6.980      0.159      3.83       69.07

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 12.11
                   TIME SHIFT OF PEAK FLOW         (min)= 70.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.3791

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  ************************************************
  ** SIMULATION : 100 Year 12 Hour AES (Bloor,  **
  ************************************************


--------------------
|    READ STORM    |    Filename: C:\Users\shuchi\AppD
|                  |              ata\Local\Temp\
|                  |              30893ebc-4193-4b18-94cb-
f8ff69101a04\313bbea9
| Ptotal= 88.54 mm |    Comments: 100 Year 12 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                 0.00    0.00 |  3.25   15.05 |  6.50    6.20 |  9.75
0.89
                 0.25    0.89 |  3.50   15.05 |  6.75    6.20 | 10.00
0.89
                 0.50    0.89 |  3.75   15.05 |  7.00    6.20 | 10.25
0.89
                 0.75    0.89 |  4.00   15.05 |  7.25    3.54 | 10.50
0.89
                 1.00    0.89 |  4.25   40.71 |  7.50    3.54 | 10.75
0.89
                 1.25    0.89 |  4.50   40.71 |  7.75    3.54 | 11.00
0.89
                 1.50    0.89 |  4.75   40.71 |  8.00    3.54 | 11.25
0.89
                 1.75    0.89 |  5.00   40.71 |  8.25    1.77 | 11.50
0.89
                 2.00    0.89 |  5.25   11.51 |  8.50    1.77 | 11.75
0.89
                 2.25    5.31 |  5.50   11.51 |  8.75    1.77 | 12.00
0.89
                 2.50    5.31 |  5.75   11.51 |  9.00    1.77 |
                 2.75    5.31 |  6.00   11.51 |  9.25    0.89 |
                 3.00    5.31 |  6.25    6.20 |  9.50    0.89 |

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--------------------
| CALIB            |
| STANDHYD (  0001)|   Area     (ha)=   6.31
|ID= 1 DT=10.0 min |   Total Imp(%)=  80.00   Dir. Conn.(%)=  75.00
--------------------
                         IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.05         1.26
     Dep. Storage     (mm)=       1.00         1.50
```

Average Slope	(%)=	1.00	2.00
Length	(m)=	205.10	40.00
Mannings n	=	0.013	0.250

NOTE: RAINFALL WAS TRANSFORMED TO 10.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.167	0.00	3.333	10.18	6.500	6.20	9.67	0.89
0.333	0.45	3.500	15.05	6.667	6.20	9.83	0.89
0.500	0.89	3.667	15.05	6.833	6.20	10.00	0.89
0.667	0.89	3.833	15.05	7.000	6.20	10.17	0.89
0.833	0.89	4.000	15.05	7.167	6.20	10.33	0.89
1.000	0.89	4.167	15.05	7.333	4.87	10.50	0.89
1.167	0.89	4.333	27.88	7.500	3.54	10.67	0.89
1.333	0.89	4.500	40.71	7.667	3.54	10.83	0.89
1.500	0.89	4.667	40.71	7.833	3.54	11.00	0.89
1.667	0.89	4.833	40.71	8.000	3.54	11.17	0.89
1.833	0.89	5.000	40.71	8.167	3.54	11.33	0.89
2.000	0.89	5.167	40.71	8.333	2.66	11.50	0.89
2.167	0.89	5.333	26.11	8.500	1.77	11.67	0.89
2.333	3.10	5.500	11.51	8.667	1.77	11.83	0.89
2.500	5.31	5.667	11.51	8.833	1.77	12.00	0.89
2.667	5.31	5.833	11.51	9.000	1.77	12.17	0.89
2.833	5.31	6.000	11.51	9.167	1.77	12.33	0.44
3.000	5.31	6.167	11.51	9.333	1.33		
3.167	5.31	6.333	8.86	9.500	0.89		

Max.Eff.Inten.(mm/hr)=		40.71	42.38
over	(min)	10.00	20.00
Storage Coeff.	(min)=	5.63 (ii)	15.58 (ii)
Unit Hyd. Tpeak	(min)=	10.00	20.00
Unit Hyd. peak	(cms)=	0.14	0.07

```
                                                   *  TOTALS*
     PEAK FLOW        (cms)=       0.54         0.14          0.674 (iii)
     TIME TO PEAK     (hrs)=       5.17         5.17           5.17
     RUNOFF VOLUME     (mm)=      87.54        38.10          75.18
     TOTAL RAINFALL    (mm)=      88.54        88.54          88.54
     RUNOFF COEFFICIENT   =        0.99         0.43           0.85

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00          K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB             |
| STANDHYD (  0002)|   Area    (ha)=   0.67
|ID= 1 DT=10.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  40.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area      (ha)=       0.50         0.17
     Dep. Storage      (mm)=       1.00         1.50
     Average Slope      (%)=       1.00         2.00
     Length             (m)=      66.83        40.00
     Mannings n            =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO  10.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                0.167    0.00 | 3.333   10.18 | 6.500    6.20 |  9.67
0.89
                0.333    0.45 | 3.500   15.05 | 6.667    6.20 |  9.83
0.89
                0.500    0.89 | 3.667   15.05 | 6.833    6.20 | 10.00
0.89
                0.667    0.89 | 3.833   15.05 | 7.000    6.20 | 10.17
0.89
                0.833    0.89 | 4.000   15.05 | 7.167    6.20 | 10.33
0.89
                1.000    0.89 | 4.167   15.05 | 7.333    4.87 | 10.50
0.89
                1.167    0.89 | 4.333   27.88 | 7.500    3.54 | 10.67
0.89
                1.333    0.89 | 4.500   40.71 | 7.667    3.54 | 10.83
0.89
```

```
                1.500    0.89 | 4.667   40.71 | 7.833    3.54 | 11.00
0.89
                1.667    0.89 | 4.833   40.71 | 8.000    3.54 | 11.17
0.89
                1.833    0.89 | 5.000   40.71 | 8.167    3.54 | 11.33
0.89
                2.000    0.89 | 5.167   40.71 | 8.333    2.66 | 11.50
0.89
                2.167    0.89 | 5.333   26.11 | 8.500    1.77 | 11.67
0.89
                2.333    3.10 | 5.500   11.51 | 8.667    1.77 | 11.83
0.89
                2.500    5.31 | 5.667   11.51 | 8.833    1.77 | 12.00
0.89
                2.667    5.31 | 5.833   11.51 | 9.000    1.77 | 12.17
0.89
                2.833    5.31 | 6.000   11.51 | 9.167    1.77 | 12.33
0.44
                3.000    5.31 | 6.167   11.51 | 9.333    1.33 |
                3.167    5.31 | 6.333    8.86 | 9.500    0.89 |

     Max.Eff.Inten.(mm/hr)=      40.71        89.83
                over (min)       10.00        20.00
     Storage Coeff.  (min)=       2.87 (ii)   10.24 (ii)
     Unit Hyd. Tpeak (min)=      10.00        20.00
     Unit Hyd. peak  (cms)=       0.16         0.08
                                                          *  TOTALS*
     PEAK FLOW       (cms)=       0.03         0.04         0.072 (iii)
     TIME TO PEAK    (hrs)=       5.00         5.17          5.17
     RUNOFF VOLUME    (mm)=      87.54        57.30         69.39
     TOTAL RAINFALL   (mm)=      88.54        88.54         88.54
     RUNOFF COEFFICIENT   =       0.99         0.65          0.78

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00          K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0004)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     6.31   0.674     5.17    75.18
      + ID2= 2 (  0002):     0.67   0.072     5.17    69.39
        ====================================================
        ID = 3 (  0004):     6.98   0.746     5.17    74.63
```

```
     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
---------------------------------------------------------------------------
-----
--------------------
| RESERVOIR(  0005)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT= 10.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           0.0000     0.0000   |   0.1340      0.3161
                           0.0090     0.1412   |   0.1580      0.3775
                           0.0560     0.2086   |   0.1770      0.4341
                           0.0860     0.2312   |   1.1690      0.4851
                           0.1060     0.2611   |   0.0000      0.0000

                                 AREA     QPEAK     TPEAK        R.V.
                                 (ha)     (cms)     (hrs)        (mm)
   INFLOW : ID= 2 (  0004)      6.980      0.746      5.17       74.63
   OUTFLOW: ID= 1 (  0005)      6.980      0.152      6.33       74.05

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 20.42
                   TIME SHIFT OF PEAK FLOW         (min)= 70.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.3632

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  *********************************************
  ** SIMULATION : Hurricane Hazel-Regional     **
  *********************************************


--------------------
|    READ STORM    |    Filename: C:\Users\shuchi\AppD
|                  |              ata\Local\Temp\
|                  |              30893ebc-4193-4b18-94cb-
f8ff69101a04\6f3a7341
| Ptotal=285.00 mm |    Comments: Hurricane Hazel-Regional
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                 0.00    6.00 | 12.00    2.00 | 24.00    2.00 | 36.00
2.00
                 1.00    4.00 | 13.00    2.00 | 25.00    2.00 | 37.00
2.00
                 2.00    6.00 | 14.00    2.00 | 26.00    2.00 | 38.00
2.00
                 3.00   13.00 | 15.00    2.00 | 27.00    2.00 | 39.00
2.00
                 4.00   17.00 | 16.00    2.00 | 28.00    2.00 | 40.00
2.00
                 5.00   13.00 | 17.00    2.00 | 29.00    2.00 | 41.00
2.00
                 6.00   23.00 | 18.00    2.00 | 30.00    2.00 | 42.00
2.00
                 7.00   13.00 | 19.00    2.00 | 31.00    2.00 | 43.00
2.00
                 8.00   13.00 | 20.00    2.00 | 32.00    2.00 | 44.00
2.00
                 9.00   53.00 | 21.00    2.00 | 33.00    2.00 | 45.00
2.00
                10.00   38.00 | 22.00    2.00 | 34.00    2.00 | 46.00
2.00
                11.00   13.00 | 23.00    2.00 | 35.00    2.00 | 47.00
3.00

----------------------------------------------------------------------------
-----

--------------------
| CALIB            |
| STANDHYD (  0001)|   Area    (ha)=   6.31
|ID= 1 DT=10.0 min |   Total Imp(%)=  80.00   Dir. Conn.(%)=  75.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.05          1.26
```

Dep. Storage	(mm)=	1.00	1.50
Average Slope	(%)=	1.00	2.00
Length	(m)=	205.10	40.00
Mannings n	=	0.013	0.250

NOTE: RAINFALL WAS TRANSFORMED TO 10.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME	RAIN	TIME	RAIN	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	hrs	mm/hr
0.167	6.00	12.167	2.00	24.167	2.00	36.17	2.00
0.333	6.00	12.333	2.00	24.333	2.00	36.33	2.00
0.500	6.00	12.500	2.00	24.500	2.00	36.50	2.00
0.667	6.00	12.667	2.00	24.667	2.00	36.67	2.00
0.833	6.00	12.833	2.00	24.833	2.00	36.83	2.00
1.000	6.00	13.000	2.00	25.000	2.00	37.00	2.00
1.167	4.00	13.167	2.00	25.167	2.00	37.17	2.00
1.333	4.00	13.333	2.00	25.333	2.00	37.33	2.00
1.500	4.00	13.500	2.00	25.500	2.00	37.50	2.00
1.667	4.00	13.667	2.00	25.667	2.00	37.67	2.00
1.833	4.00	13.833	2.00	25.833	2.00	37.83	2.00
2.000	4.00	14.000	2.00	26.000	2.00	38.00	2.00
2.167	6.00	14.167	2.00	26.167	2.00	38.17	2.00
2.333	6.00	14.333	2.00	26.333	2.00	38.33	2.00
2.500	6.00	14.500	2.00	26.500	2.00	38.50	2.00
2.667	6.00	14.667	2.00	26.667	2.00	38.67	2.00
2.833	6.00	14.833	2.00	26.833	2.00	38.83	2.00
3.000	6.00	15.000	2.00	27.000	2.00	39.00	2.00
3.167	13.00	15.167	2.00	27.167	2.00	39.17	2.00
3.333	13.00	15.333	2.00	27.333	2.00	39.33	2.00

3.500	13.00	15.500	2.00	27.500	2.00	39.50	2.00
3.667	13.00	15.667	2.00	27.667	2.00	39.67	2.00
3.833	13.00	15.833	2.00	27.833	2.00	39.83	2.00
4.000	13.00	16.000	2.00	28.000	2.00	40.00	2.00
4.167	17.00	16.167	2.00	28.167	2.00	40.17	2.00
4.333	17.00	16.333	2.00	28.333	2.00	40.33	2.00
4.500	17.00	16.500	2.00	28.500	2.00	40.50	2.00
4.667	17.00	16.667	2.00	28.667	2.00	40.67	2.00
4.833	17.00	16.833	2.00	28.833	2.00	40.83	2.00
5.000	17.00	17.000	2.00	29.000	2.00	41.00	2.00
5.167	13.00	17.167	2.00	29.167	2.00	41.17	2.00
5.333	13.00	17.333	2.00	29.333	2.00	41.33	2.00
5.500	13.00	17.500	2.00	29.500	2.00	41.50	2.00
5.667	13.00	17.667	2.00	29.667	2.00	41.67	2.00
5.833	13.00	17.833	2.00	29.833	2.00	41.83	2.00
6.000	13.00	18.000	2.00	30.000	2.00	42.00	2.00
6.167	23.00	18.167	2.00	30.167	2.00	42.17	2.00
6.333	23.00	18.333	2.00	30.333	2.00	42.33	2.00
6.500	23.00	18.500	2.00	30.500	2.00	42.50	2.00
6.667	23.00	18.667	2.00	30.667	2.00	42.67	2.00
6.833	23.00	18.833	2.00	30.833	2.00	42.83	2.00
7.000	23.00	19.000	2.00	31.000	2.00	43.00	2.00
7.167	13.00	19.167	2.00	31.167	2.00	43.17	2.00
7.333	13.00	19.333	2.00	31.333	2.00	43.33	2.00
7.500	13.00	19.500	2.00	31.500	2.00	43.50	2.00
7.667	13.00	19.667	2.00	31.667	2.00	43.67	2.00
7.833	13.00	19.833	2.00	31.833	2.00	43.83	2.00

8.000	13.00	20.000	2.00	32.000	2.00	44.00	2.00
8.167	13.00	20.167	2.00	32.167	2.00	44.17	2.00
8.333	13.00	20.333	2.00	32.333	2.00	44.33	2.00
8.500	13.00	20.500	2.00	32.500	2.00	44.50	2.00
8.667	13.00	20.667	2.00	32.667	2.00	44.67	2.00
8.833	13.00	20.833	2.00	32.833	2.00	44.83	2.00
9.000	13.00	21.000	2.00	33.000	2.00	45.00	2.00
9.167	53.00	21.167	2.00	33.167	2.00	45.17	2.00
9.333	53.00	21.333	2.00	33.333	2.00	45.33	2.00
9.500	53.00	21.500	2.00	33.500	2.00	45.50	2.00
9.667	53.00	21.667	2.00	33.667	2.00	45.67	2.00
9.833	53.00	21.833	2.00	33.833	2.00	45.83	2.00
10.000	53.00	22.000	2.00	34.000	2.00	46.00	2.00
10.167	38.00	22.167	2.00	34.167	2.00	46.17	2.00
10.333	38.00	22.333	2.00	34.333	2.00	46.33	2.00
10.500	38.00	22.500	2.00	34.500	2.00	46.50	2.00
10.667	38.00	22.667	2.00	34.667	2.00	46.67	2.00
10.833	38.00	22.833	2.00	34.833	2.00	46.83	2.00
11.000	38.00	23.000	2.00	35.000	2.00	47.00	2.00
11.167	13.00	23.167	2.00	35.167	2.00	47.17	3.00
11.333	13.00	23.333	2.00	35.333	2.00	47.33	3.00
11.500	13.00	23.500	2.00	35.500	2.00	47.50	3.00
11.667	13.00	23.667	2.00	35.667	2.00	47.67	3.00
11.833	13.00	23.833	2.00	35.833	2.00	47.83	3.00
12.000	13.00	24.000	2.00	36.000	2.00	48.00	3.00

```
Max.Eff.Inten.(mm/hr)=      53.00         58.75
           over (min)       10.00         20.00
Storage Coeff.  (min)=       5.07 (ii)    13.80 (ii)
```

```
     Unit Hyd. Tpeak (min)=      10.00        20.00
     Unit Hyd. peak  (cms)=       0.15         0.07
                                                           *  TOTALS*
     PEAK FLOW       (cms)=       0.70         0.20          0.899 (iii)
     TIME TO PEAK    (hrs)=      10.00        10.00          10.00
     RUNOFF VOLUME    (mm)=     284.00       136.09         247.02
     TOTAL RAINFALL   (mm)=     285.00       285.00         285.00
     RUNOFF COEFFICIENT   =       1.00         0.48           0.87

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
            Fo   (mm/hr)= 50.00          K  (1/hr)=  2.00
            Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| CALIB             |
| STANDHYD (  0002)|   Area    (ha)=   0.67
|ID= 1 DT=10.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  40.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.50         0.17
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      66.83        40.00
     Mannings n           =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO  10.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME
RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs
mm/hr
                0.167    6.00 |12.167    2.00 |24.167    2.00 | 36.17
2.00
                0.333    6.00 |12.333    2.00 |24.333    2.00 | 36.33
2.00
                0.500    6.00 |12.500    2.00 |24.500    2.00 | 36.50
2.00
                0.667    6.00 |12.667    2.00 |24.667    2.00 | 36.67
2.00
                0.833    6.00 |12.833    2.00 |24.833    2.00 | 36.83
2.00
                1.000    6.00 |13.000    2.00 |25.000    2.00 | 37.00
2.00
                1.167    4.00 |13.167    2.00 |25.167    2.00 | 37.17
2.00
```

1.333	4.00	13.333	2.00	25.333	2.00	37.33	2.00
1.500	4.00	13.500	2.00	25.500	2.00	37.50	2.00
1.667	4.00	13.667	2.00	25.667	2.00	37.67	2.00
1.833	4.00	13.833	2.00	25.833	2.00	37.83	2.00
2.000	4.00	14.000	2.00	26.000	2.00	38.00	2.00
2.167	6.00	14.167	2.00	26.167	2.00	38.17	2.00
2.333	6.00	14.333	2.00	26.333	2.00	38.33	2.00
2.500	6.00	14.500	2.00	26.500	2.00	38.50	2.00
2.667	6.00	14.667	2.00	26.667	2.00	38.67	2.00
2.833	6.00	14.833	2.00	26.833	2.00	38.83	2.00
3.000	6.00	15.000	2.00	27.000	2.00	39.00	2.00
3.167	13.00	15.167	2.00	27.167	2.00	39.17	2.00
3.333	13.00	15.333	2.00	27.333	2.00	39.33	2.00
3.500	13.00	15.500	2.00	27.500	2.00	39.50	2.00
3.667	13.00	15.667	2.00	27.667	2.00	39.67	2.00
3.833	13.00	15.833	2.00	27.833	2.00	39.83	2.00
4.000	13.00	16.000	2.00	28.000	2.00	40.00	2.00
4.167	17.00	16.167	2.00	28.167	2.00	40.17	2.00
4.333	17.00	16.333	2.00	28.333	2.00	40.33	2.00
4.500	17.00	16.500	2.00	28.500	2.00	40.50	2.00
4.667	17.00	16.667	2.00	28.667	2.00	40.67	2.00
4.833	17.00	16.833	2.00	28.833	2.00	40.83	2.00
5.000	17.00	17.000	2.00	29.000	2.00	41.00	2.00
5.167	13.00	17.167	2.00	29.167	2.00	41.17	2.00
5.333	13.00	17.333	2.00	29.333	2.00	41.33	2.00
5.500	13.00	17.500	2.00	29.500	2.00	41.50	2.00
5.667	13.00	17.667	2.00	29.667	2.00	41.67	2.00

5.833	13.00	17.833	2.00	29.833	2.00	41.83	2.00
6.000	13.00	18.000	2.00	30.000	2.00	42.00	2.00
6.167	23.00	18.167	2.00	30.167	2.00	42.17	2.00
6.333	23.00	18.333	2.00	30.333	2.00	42.33	2.00
6.500	23.00	18.500	2.00	30.500	2.00	42.50	2.00
6.667	23.00	18.667	2.00	30.667	2.00	42.67	2.00
6.833	23.00	18.833	2.00	30.833	2.00	42.83	2.00
7.000	23.00	19.000	2.00	31.000	2.00	43.00	2.00
7.167	13.00	19.167	2.00	31.167	2.00	43.17	2.00
7.333	13.00	19.333	2.00	31.333	2.00	43.33	2.00
7.500	13.00	19.500	2.00	31.500	2.00	43.50	2.00
7.667	13.00	19.667	2.00	31.667	2.00	43.67	2.00
7.833	13.00	19.833	2.00	31.833	2.00	43.83	2.00
8.000	13.00	20.000	2.00	32.000	2.00	44.00	2.00
8.167	13.00	20.167	2.00	32.167	2.00	44.17	2.00
8.333	13.00	20.333	2.00	32.333	2.00	44.33	2.00
8.500	13.00	20.500	2.00	32.500	2.00	44.50	2.00
8.667	13.00	20.667	2.00	32.667	2.00	44.67	2.00
8.833	13.00	20.833	2.00	32.833	2.00	44.83	2.00
9.000	13.00	21.000	2.00	33.000	2.00	45.00	2.00
9.167	53.00	21.167	2.00	33.167	2.00	45.17	2.00
9.333	53.00	21.333	2.00	33.333	2.00	45.33	2.00
9.500	53.00	21.500	2.00	33.500	2.00	45.50	2.00
9.667	53.00	21.667	2.00	33.667	2.00	45.67	2.00
9.833	53.00	21.833	2.00	33.833	2.00	45.83	2.00
10.000	53.00	22.000	2.00	34.000	2.00	46.00	2.00
10.167	38.00	22.167	2.00	34.167	2.00	46.17	2.00

```
              10.333   38.00 |22.333    2.00 |34.333    2.00 | 46.33
2.00
              10.500   38.00 |22.500    2.00 |34.500    2.00 | 46.50
2.00
              10.667   38.00 |22.667    2.00 |34.667    2.00 | 46.67
2.00
              10.833   38.00 |22.833    2.00 |34.833    2.00 | 46.83
2.00
              11.000   38.00 |23.000    2.00 |35.000    2.00 | 47.00
2.00
              11.167   13.00 |23.167    2.00 |35.167    2.00 | 47.17
3.00
              11.333   13.00 |23.333    2.00 |35.333    2.00 | 47.33
3.00
              11.500   13.00 |23.500    2.00 |35.500    2.00 | 47.50
3.00
              11.667   13.00 |23.667    2.00 |35.667    2.00 | 47.67
3.00
              11.833   13.00 |23.833    2.00 |35.833    2.00 | 47.83
3.00
              12.000   13.00 |24.000    2.00 |36.000    2.00 | 48.00
3.00

     Max.Eff.Inten.(mm/hr)=      53.00       119.70
               over (min)        10.00        10.00
     Storage Coeff.  (min)=       2.59 (ii)    9.15 (ii)
     Unit Hyd. Tpeak (min)=      10.00        10.00
     Unit Hyd. peak  (cms)=       0.17         0.11
                                                        *  TOTALS*
     PEAK FLOW       (cms)=       0.04         0.06          0.095 (iii)
     TIME TO PEAK    (hrs)=       9.83        10.00          10.00
     RUNOFF VOLUME    (mm)=     284.00       168.56         214.73
     TOTAL RAINFALL   (mm)=     285.00       285.00         285.00
     RUNOFF COEFFICIENT   =       1.00         0.59           0.75

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) HORTONS EQUATION SELECTED FOR PERVIOUS LOSSES:
           Fo   (mm/hr)= 50.00          K  (1/hr)=  2.00
           Fc   (mm/hr)=  7.50     Cum.Inf.   (mm)=  0.00
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0004)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     6.31   0.899    10.00   247.02
      + ID2= 2 (  0002):     0.67   0.095    10.00   214.73
        ====================================================
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     ID = 3 (  0004):     6.98   0.994    10.00   243.92

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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--------------------
| RESERVOIR(  0005)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT= 10.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1340      0.3161
                          0.0090     0.1412   |   0.1580      0.3775
                          0.0560     0.2086   |   0.1770      0.4341
                          0.0860     0.2312   |   1.1690      0.4851
                          0.1060     0.2611   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0004)      6.980      0.994     10.00     243.92
   OUTFLOW: ID= 1 (  0005)      6.980      0.987     10.00     243.35

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 99.34
                   TIME SHIFT OF PEAK FLOW        (min)=  0.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.4760

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APPENDIX "I"

Water Hydraulic Analysis for Chickadee Lane Rounding Out Area "B" Subdivision, Town of Caledon, prepared by AECOM dated October 28th 2020, Project No. 60643310

AECOM Technical Memorandum dated December 8th 2021

AECOM e-mail dated February 3rd 2022

Water Hydraulic Analysis for Chickadee Lane Rounding Out Area B Subdivision, Bolton, Town of Caledon, Ontario

Water Hydraulic analysis

Candevcon Limited
Consulting Engineers & Planners

Project number: 60643310

October 28 2020

Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("AECOM") for the benefit of the Client ("Client") in accordance with the agreement between AECOM and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations and conclusions contained in the Report (collectively, the "Information"):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations");
- represents AECOM's professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to AECOM which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time..

AECOM shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. AECOM accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

AECOM agrees that the Report represents its professional judgement as described above and that the Information has been prepared for the specific purpose and use described in the Report and the Agreement, but AECOM makes no other representations, or any guarantees or warranties whatsoever, whether express or implied, with respect to the Report, the Information or any part thereof.

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AECOM: 2015-04-13

Quality information

Prepared by	Checked by	Verified by	Approved by
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Revision History

Revision	Revision date	Details	Authorized	Name	Position

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1. Introduction

Candevcon Limited retained AECOM to undertake a hydraulic analysis study for a future development located in Bolton, Town of Caledon, Ontario. The purpose of the study is to evaluate the serviceability to the proposed development under existing and future conditions. The analysis also confirms the sizing of the proposed watermain within the development that can meet the Region's required level of service.

2. Background

The proposed development is located in Bolton; which is also a key Rural Service Centre in the Town of Caledon. The proposed development will be serviced by the Region's Zone 6 system via Tullamore Pumping Station and North Brampton Pumping Station; with the potable water originating from Arthur P. Kennedy Water Treatment. The Bolton water system (Zone 6) also includes two storage facilities location on Colerine Drive. These storage facilities will provide pressure modulation utilizing the equalization storage, supply fire flow utilizing fire storage and provide emergency supply using the emergency storage. The hydraulic analysis results presented in this report will include these water facilities as well as the existing linear infrastructure to confirming the serviceability available for the proposed development.

3. Methodology

The hydraulic analysis was completed by using the Peel Region's latest hydraulic model for their lake-based water supply system. The same hydraulic model was used for the Region's Water and Wastewater Master Plan Study Update (2019). The Region's hydraulic model includes existing water demands and future water demands that represent the expected growth projection in the Region.

For analyzing the serviceability for the proposed development, the following design criteria were applied.

- Minimum pressure under normal operating conditions = 40psi
- Maximum pressure under normal operating condition = 100psi
- Minimum pressure under maximum day demand conditions plus fire flow event = 20psi

The following subsections describe the approach that was applied in this study.

Hydraulic Analysis Scenarios

The following scenarios that were available in the Region's hydraulic model were utilized for analyzing the serviceability for the proposed development

- Existing (2021) Average Day Demand Scenario
- Existing (2021) Maximum Day Demand conditions
  - Fire Flow analysis was performed in this scenario
- Future (2041) Average Day Demand Scenario
- Future (2041) Maximum Day Demand conditions
  - Fire Flow analysis was performed in this scenario

Modelling Network Update

The hydraulic model was updated to include the proposed watermains within the development. The following figure shows the hydraulic model with the inclusion of the proposed watermains.

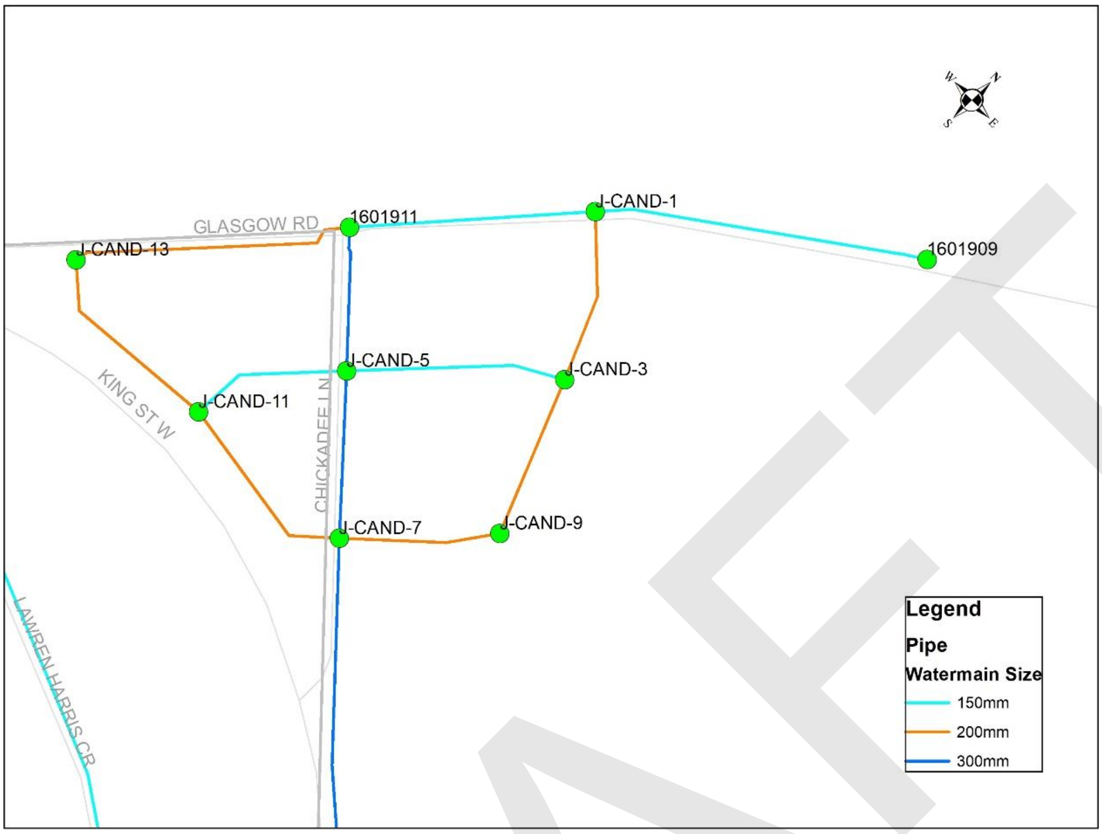

Figure 3-1: Modelling Network for Proposed Development

Water Demand and Allocation

The water demands for the proposed development was estimated based on the projected number of lots included in the preliminary site plan that was provided by Candevcon Limited and the Peel Region's water demand criteria as per Region's Master Plan Study. The following summarizes the information used for demand estimations.

- Proposed number of lot: 140
- Average population density: 4.0 person per unit
- Average domestic demand for single family dwelling (ADD): 270 L/ca/d
- Maximum day demand factor: 1.8 x ADD
- Peak hour demand factor: 3.0 x ADD

Based on the above noted demand estimation parameters, the following summarizes the water demands for the proposed development.

- Average Day Demand (ADD) = 1.75 L/s
- Maximum Day Demand (MDD) = 3.15 L/s
- Peak Hour Demand (PHD) = 5.25 L/s

The estimated water demands for the proposed development were allocated to the modelling network based on the proximity of the proposed lots to the water modelling junctions. The following figure shows the method for allocating the water demands to the modelling junctions and Table 3-1 summarizes the allocated water demands for each modelling junction.

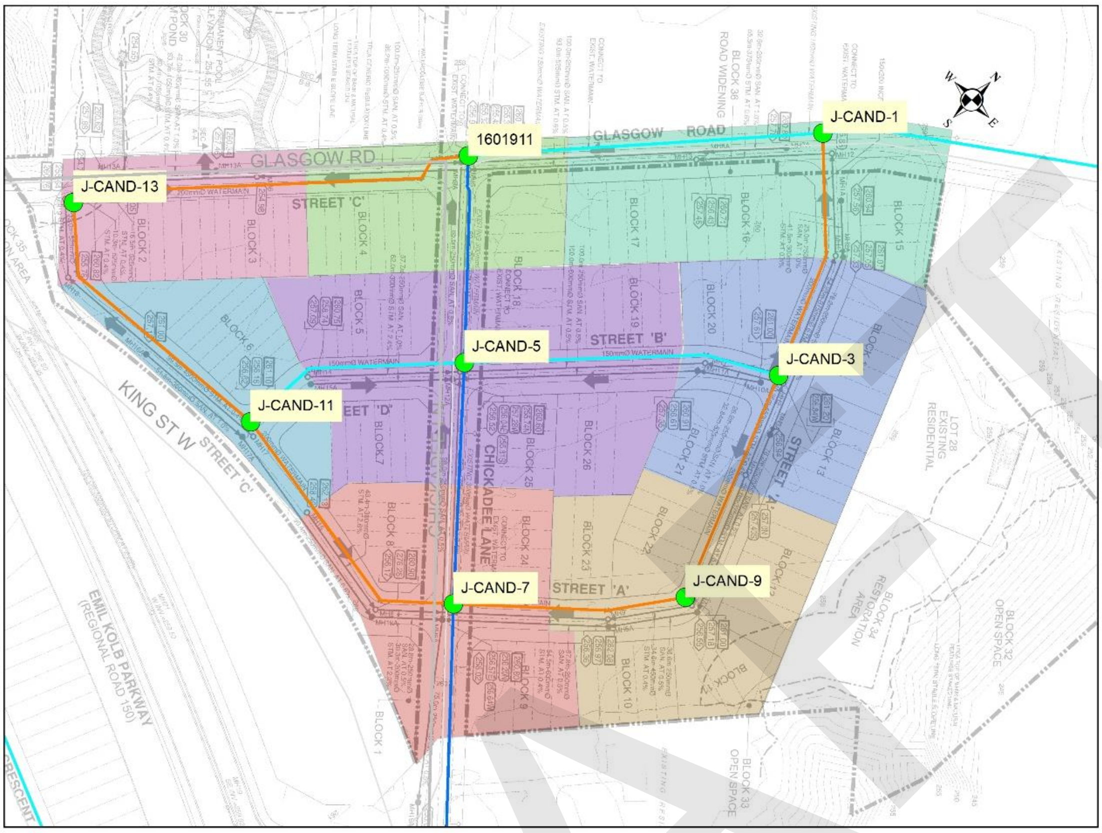

Figure 3-2: Water Demand Allocation

Table 3-1: Water Demand Estimation Results

Modelling Junction ID	Number of Lot	Estimated Population	Average Day Demand (L/s)	Maximum Day Demand (L/s)	Peak Hour Demand (L/s)
J-CAND-1	16	64	0.20	0.36	0.60
J-CAND-3	22	68	0.28	0.50	0.84
J-CAND-9	22	88	0.28	0.50	0.84
1601911	12	48	0.15	0.27	0.45
J-CAND-5	32	128	0.40	0.72	1.20
J-CAND-7	14	56	0.17	0.31	0.54
J-CAND-11	9	36	0.11	0.20	0.33
J-CAND-13	13	52	0.16	0.29	0.48
Total	140	560	1.75	3.15	5.28

4. Hydraulic Modelling Results

The hydraulic modelling analysis was completed in 2 days (48hrs) extended period simulation. The simulation considered the pump operations at the water supply facilities and the water storage facilities in the system.

Hydraulic Analysis for Normal Operating Conditions

Table 4-1 summarizes the system pressures under pre and post development conditions. The detailed modelling results are presented in Appendix A.

Table 4-1: Pressures for Proposed Development

Scenario	Maximum Pressure (psi)	Minimum Pressure (psi)
Existing ADD	56.86	46.90
Existing MDD	56.62	46.11
Future ADD	56.40	44.97
Future MDD	56.44	44.27

According to Table 4-1, the minimum pressures under existing and future demand conditions were above the Region's required level of service. The modelling results as presented above indicated that the Region's water supply would be capable to provide adequate water service for the proposed development.

Fire Flow Analysis

Fire flow analysis was completed to determine the available fire flow for the proposed development when maintaining a minimum pressure of 20psi. Table 4-2 shows the fire flow analysis results for existing and future scenarios. Appendix B shows the detailed fire flow analysis results.

Table 4-2: Fire Flow Analysis Results

Scenario	Maximum Allowable Fire Flow at 20psi (L/s)	Minimum Allowable Fire Flow at 20psi (L/s)
Existing MDD plus fire flow	259.18	230.00
Future MDD plus fire flow	294.59	256.36

The fire flow analysis results as summarized in Table 4-2 indicated that the Region's water system would provide adequate fire flow for typical residential development (180L/s) to the proposed development.

Proposed Watermains Sizing

In evaluating the sizing of the proposed watermains within the development, the simulated velocity was reviewed. Although the velocity criterion was not articulated in the Region design standards, a maximum velocity of 2.0m/s were used. Table 4-3 summarizes the simulated velocity for the proposed watermains. Appendix C presents the detailed modelling results.

Table 4-3: Hydraulic Performances for Proposed Watermains

Scenario	Maximum Velocity (m/s)
Existing ADD	0.025
Existing MDD	0.045
Future ADD	0.025
Future MDD	0.045

System Resiliency Review

The water service for the proposed development relies on a single existing 300mm watermain on Chickadee Lane. Under emergency condition, the water service for the proposed development would be significantly interrupted when the existing 300mm watermain on Chickadee Lane is out of service. To further improve the water supply security for the proposed development, a new watermain on Glasgow Road / King Street should be considered for providing a secondary feed for the proposed development. Figure 4-1 shows the recommended watermain.

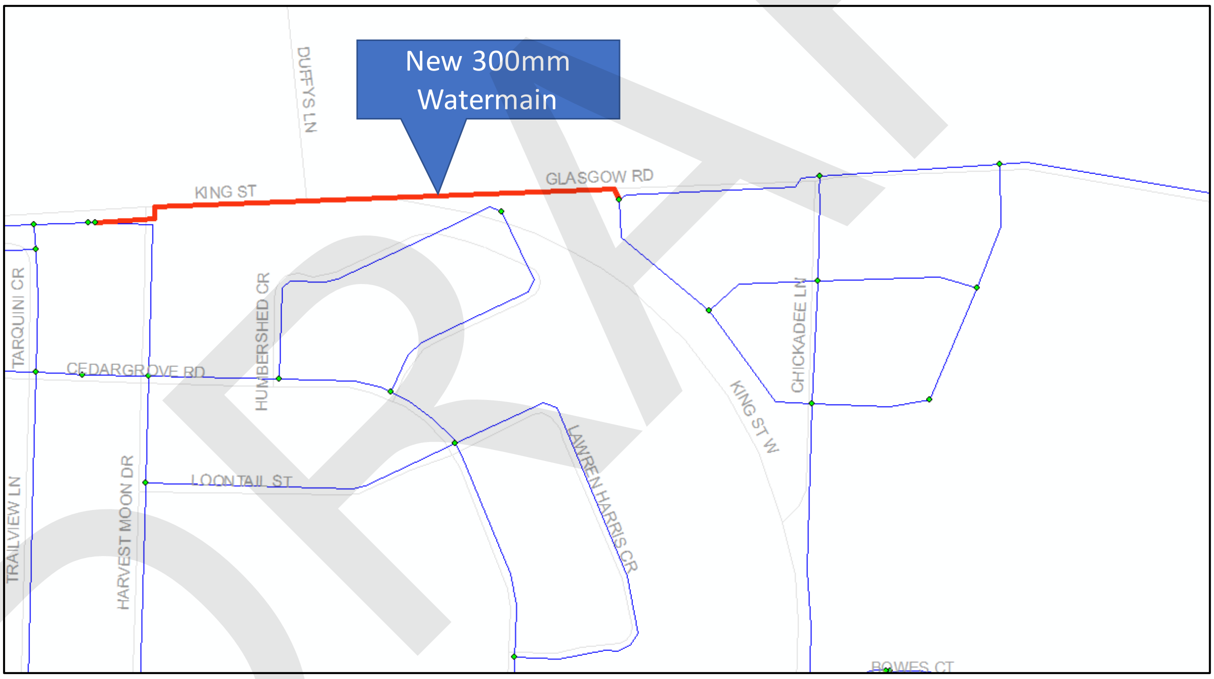

Figure 4-1: Recommended Watermain for Improving Supply Security

5. Conclusion and Recommendations

The completion of the hydraulic analysis lead to the following conclusions and recommendations.

- According to the modelling results, the Region's Zone 6 water system is able to provide adequate water service for the proposed development under existing and future demand scenarios
- The fire flow analysis confirmed that sufficient fire flow would be available to meet the typical residential fire flow development needs for the proposed developments
- To further improve the water supply security for the proposed development, a new watermain on Glasgow Road / King Street is recommended.

Appendix A – Hydraulic Modelling Results

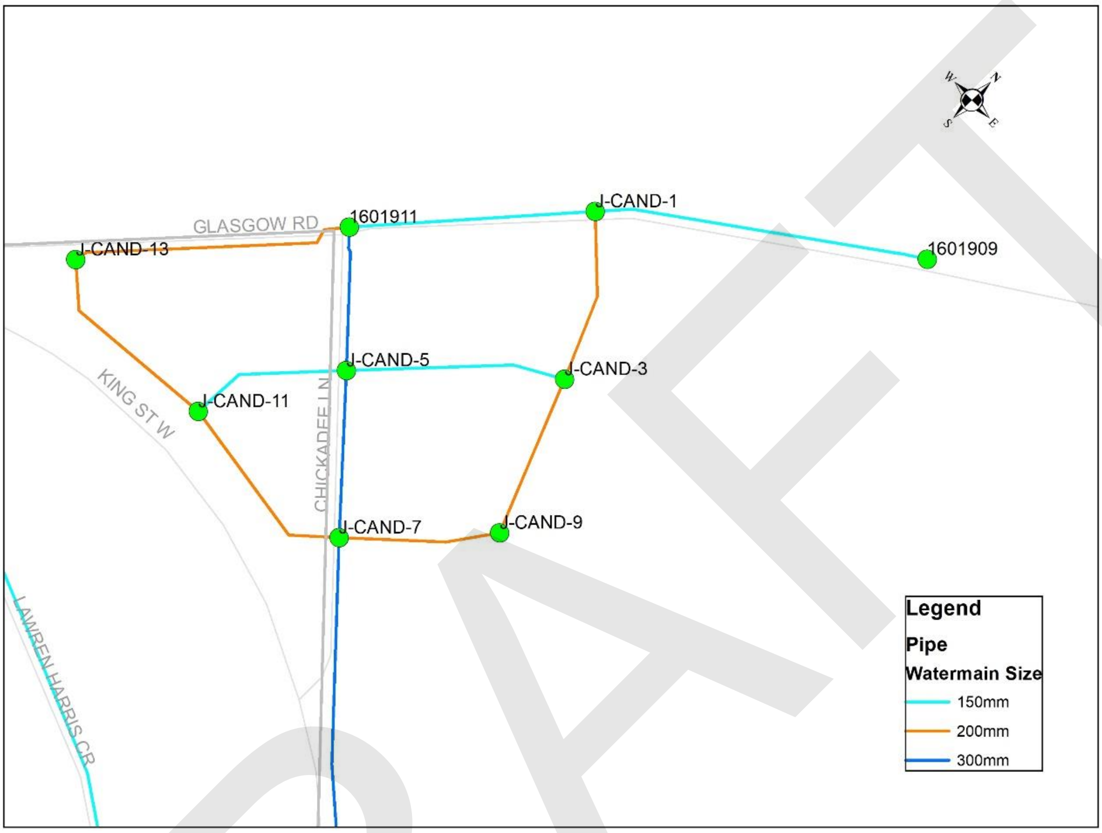

Figure A.1 – Modelling Junction ID

Table A.1 – Pressure under Existing ADD conditions

ID	Max.Value (psi)	Max.Time (hrs.)	Min.Value (psi)	Min.Time (hrs.)	Average (psi)	Difference (psi)
1601911	51.788	3:00	48.0348	44:00:00	50.1362	3.7532
J-CAND-1	56.863	3:00	53.1093	44:00:00	55.211	3.7537
J-CAND-11	50.7929	3:00	47.0397	44:00:00	49.1411	3.7531
J-CAND-13	51.4752	3:00	47.722	44:00:00	49.8234	3.7532
J-CAND-3	50.6506	3:00	46.897	44:00:00	48.9987	3.7536
J-CAND-5	51.5037	3:00	47.7505	44:00:00	49.8519	3.7532
J-CAND-7	51.2194	3:00	47.4665	44:00:00	49.5677	3.7529
J-CAND-9	50.935	3:00	47.1815	44:00:00	49.2831	3.7535

Table A.2 – Pressure under Existing MDD conditions

ID	Max.Value (psi)	Max.Time (hrs.)	Min.Value (psi)	Min.Time (hrs.)	Average (psi)	Difference (psi)
1601911	51.5414	3:00	47.2455	45:00:00	49.6366	4.2959
J-CAND-1	56.6162	3:00	52.3191	45:00:00	54.711	4.2971
J-CAND-11	50.5463	3:00	46.2506	45:00:00	48.6416	4.2957
J-CAND-13	51.2287	3:00	46.9328	45:00:00	49.3239	4.2959
J-CAND-3	50.4039	3:00	46.1069	45:00:00	48.4988	4.297
J-CAND-5	51.2571	3:00	46.9613	45:00:00	49.3524	4.2958
J-CAND-7	50.973	3:00	46.678	45:00:00	49.0685	4.295
J-CAND-9	50.6883	3:00	46.3917	45:00:00	48.7833	4.2967

Table A.3 – Pressure under Future ADD conditions

ID	Max.Value (psi)	Max.Time (hrs.)	Min.Value (psi)	Min.Time (hrs.)	Average (psi)	Difference (psi)
1601911	51.3209	4:00	46.1056	21:00	49.202	5.2153
J-CAND-1	56.3959	4:00	51.1801	21:00	54.2768	5.2157
J-CAND-11	50.3258	4:00	45.1105	21:00	48.2069	5.2152
J-CAND-13	51.0081	4:00	45.7928	21:00	48.8892	5.2153
J-CAND-3	50.1835	4:00	44.9678	21:00	48.0645	5.2157
J-CAND-5	51.0366	4:00	45.8213	21:00	48.9177	5.2153
J-CAND-7	50.7523	4:00	45.5373	21:00	48.6335	5.215
J-CAND-9	50.4679	4:00	45.2523	21:00	48.3489	5.2155

Table A.4 – Pressure under Future MDD conditions

ID	Max.Value (psi)	Max.Time (hrs.)	Min.Value (psi)	Min.Time (hrs.)	Average (psi)	Difference (psi)
1601911	51.3601	2:00	45.4092	44:00:00	49.2421	5.9508
J-CAND-1	56.4349	2:00	50.4829	44:00:00	54.3166	5.952
J-CAND-11	50.365	2:00	44.4143	44:00:00	48.2471	5.9506
J-CAND-13	51.0473	2:00	45.0965	44:00:00	48.9294	5.9508
J-CAND-3	50.2226	2:00	44.2707	44:00:00	48.1043	5.9519
J-CAND-5	51.0758	2:00	45.1251	44:00:00	48.9579	5.9507
J-CAND-7	50.7916	2:00	44.8417	44:00:00	48.674	5.9499
J-CAND-9	50.5069	2:00	44.5554	44:00:00	48.3888	5.9516

Appendix B – Fire Flow Analysis Results

Table B.1: Fire Flow Analysis Results for Existing Scenario (Existing MDD + Fire Flow)

ID	Static Demand (L/s)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (L/s)	Residual Pressure (psi)	Available Flow at Hydrant (L/s)	Available Flow Pressure (psi)
1601911	0.241	49.8991	295.5009	79.9994	43.5525	253.5297	20.0018
J-CAND-1	0.306	54.9737	295.5006	79.9994	45.7421	258.5441	20.0018
J-CAND-11	0.1721	48.904	295.501	79.9994	41.9546	240.2046	20.0018
J-CAND-13	0.2486	49.5863	295.5009	79.9994	41.818	237.7996	20.0018
J-CAND-3	0.4207	48.7614	295.5007	79.9994	40.9629	229.0559	20.0018
J-CAND-5	0.612	49.6148	295.501	79.9994	43.5356	255.8362	20.0018
J-CAND-7	0.2677	49.3308	295.5012	79.9994	43.5732	259.1796	20.0018
J-CAND-9	0.4207	49.0458	295.5007	79.9994	41.6568	234.7351	20.0018

Table B.2: Fire Flow Analysis Results for Future Scenario (Future MDD + Fire Flow)

ID	Static Demand (L/s)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (L/s)	Residual Pressure (psi)	Available Flow at Hydrant (L/s)	Available Flow Pressure (psi)
1601911	0.241	49.9783	295.5567	79.9994	43.5286	281.2633	20.0018
J-CAND-1	0.306	55.053	295.5564	79.9994	45.7139	294.5898	20.0017
J-CAND-11	0.1721	48.9833	295.5568	79.9994	41.9765	267.779	20.0018
J-CAND-13	0.2486	49.6656	295.5567	79.9994	41.9437	267.4186	20.0018
J-CAND-3	0.4207	48.8407	295.5564	79.9994	40.9212	256.3575	20.0018
J-CAND-5	0.612	49.6941	295.5567	79.9994	43.5062	282.8271	20.0018
J-CAND-7	0.2677	49.41	295.5569	79.9994	43.5314	285.7399	20.0018
J-CAND-9	0.4207	49.1251	295.5565	79.9994	41.6167	262.0178	20.0018

Appendix C – Watermain Hydraulic Modelling Results

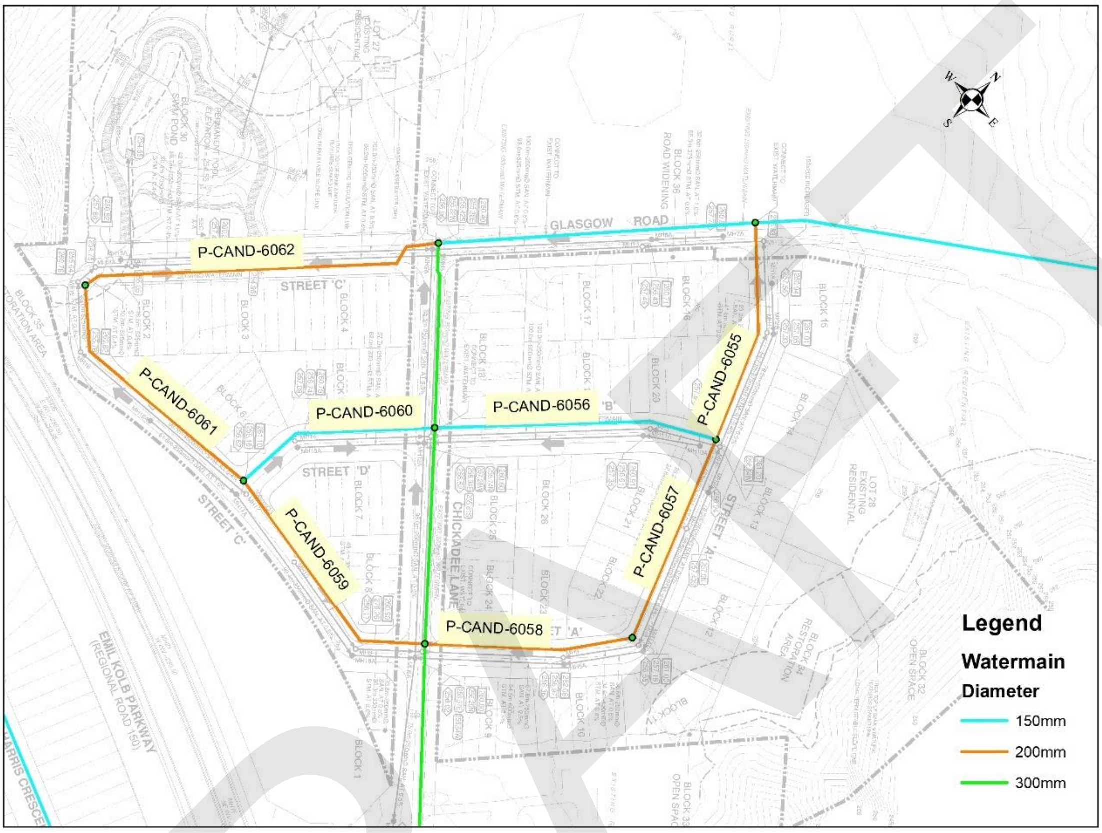

Table C-1: Watermain Velocity under Existing Average Day Demand Conditions

ID	Max.Value (m/s)	Max.Time (hrs.)	Min.Value (m/s)	Min.Time (hrs.)	Average (m/s)	Difference (m/s)
P-CAND-6062	0.0015	21:00	0.0005	1:00:00	0.001	0.001
P-CAND-6055	0.0056	20:00	0.0016	1:00:00	0.0032	0.004
P-CAND-6056	0.0152	20:00	0.0047	1:00:00	0.0093	0.0105
P-CAND-6057	0.011	20:00	0.0034	1:00:00	0.0067	0.0077
P-CAND-6058	0.0251	20:00	0.0078	1:00:00	0.0154	0.0173
P-CAND-6059	0.0143	20:00	0.0044	1:00:00	0.0088	0.0098
P-CAND-6060	0.0032	20:00	0.001	1:00:00	0.002	0.0022
P-CAND-6061	0.0067	20:00	0.0021	1:00:00	0.0041	0.0046

Table C-2: Watermain Velocity under Existing Maximum Day Demand Conditions

ID	Max.Value (m/s)	Max.Time (hrs.)	Min.Value (m/s)	Min.Time (hrs.)	Average (m/s)	Difference (m/s)
P-CAND-6062	0.0029	20:00	0.0009	1:00:00	0.0019	0.002

P-CAND-6055	0.0091	20:00	0.0027	1:00:00	0.0053	0.0064
P-CAND-6056	0.0267	20:00	0.0082	1:00:00	0.0164	0.0184
P-CAND-6057	0.0193	20:00	0.0059	1:00:00	0.0117	0.0134
P-CAND-6058	0.0445	20:00	0.0138	1:00:00	0.0274	0.0307
P-CAND-6059	0.0255	20:00	0.0079	1:00:00	0.0157	0.0176
P-CAND-6060	0.0056	20:00	0.0017	1:00:00	0.0035	0.0039
P-CAND-6061	0.012	20:00	0.0037	1:00:00	0.0074	0.0083

Table C-3: Watermain Velocity under Future Average Day Demand Conditions

ID	Max.Value (m/s)	Max.Time (hrs.)	Min.Value (m/s)	Min.Time (hrs.)	Average (m/s)	Difference (m/s)
P-CAND-6062	0.0015	21:00	0.0005	1:00:00	0.001	0.001
P-CAND-6055	0.0056	20:00	0.0017	1:00:00	0.0033	0.004
P-CAND-6056	0.0152	20:00	0.0047	1:00:00	0.0093	0.0105
P-CAND-6057	0.0111	20:00	0.0034	1:00:00	0.0068	0.0077
P-CAND-6058	0.0251	20:00	0.0078	1:00:00	0.0154	0.0173
P-CAND-6059	0.0143	20:00	0.0044	1:00:00	0.0088	0.0098
P-CAND-6060	0.0032	20:00	0.001	25:00:00	0.002	0.0022
P-CAND-6061	0.0067	20:00	0.0021	1:00:00	0.0041	0.0046

Table C-4: Watermain Velocity under Future Maximum Day Demand Conditions

ID	Max.Value (m/s)	Max.Time (hrs.)	Min.Value (m/s)	Min.Time (hrs.)	Average (m/s)	Difference (m/s)
P-CAND-6062	0.0029	21:00	0.0009	1:00:00	0.0018	0.002
P-CAND-6055	0.0092	20:00	0.0027	1:00:00	0.0055	0.0064
P-CAND-6056	0.0268	20:00	0.0083	1:00:00	0.0165	0.0185
P-CAND-6057	0.0193	20:00	0.006	1:00:00	0.0118	0.0134
P-CAND-6058	0.0446	20:00	0.0138	1:00:00	0.0275	0.0307
P-CAND-6059	0.0255	20:00	0.0079	1:00:00	0.0157	0.0176
P-CAND-6060	0.0057	20:00	0.0017	1:00:00	0.0035	0.0039
P-CAND-6061	0.012	20:00	0.0037	1:00:00	0.0074	0.0083

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Project name:
Chickadee Lane Rounding Out Area B Subdivision

Project ref:
60662276

From:
Benny Wan, P.Eng.

Date:
December 8, 2021

To:
Diarmuid Hogan, P.Eng.
Candevcon Limited
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CC:
Brian Black

Technical Memorandum

Subject: Chickadee Lane Rounding Out Area B Subdivision – Response to Peel Region's Comments File No. 21T-20001C

The purpose of this memorandum is to provide the required information to address the Region's comments (File No. 21T-20001C) regarding the water analysis completed as part of the Functional Servicing Report (FSR) that was prepared by Candevcon Limited. AECOM was retained by Candevcon Limited in 2020 to perform water hydraulic analysis for confirming the water serviceability to the proposed Chickadee Lane Subdivision. The hydraulic analysis report was included in the FSR and submitted to the Region for approval of the proposed subdivision.

The Region provided the comments regarding the water hydraulic analysis and the following summarizes the Region's main comments about the water analysis.

1. Projected population for the proposed subdivision included in the hydraulic analysis report was higher due to the Region's recommended population density for typical townhomes was 3.2 PPU as opposed to 4.0 PPU; which was used in the hydraulic analysis,
2. Hydrant flow test results included in the FSR was not consistent with those provided by the fire flow analysis results in the hydraulic analysis report,
3. Hydraulic implications / improvements for the new 300mm diameter watermain on King Street was unclear in the hydraulic analysis report, and
4. Hydraulic implications to the overall Zone 6 system were not included in the hydraulic analysis report.

The following provides the additional information / responses to address the above noted Region's comments. The responses presented herein will serve as an addendum to the FSR / hydraulic analysis report.

1. The hydraulic analysis report was updated to reflect the projected population for the subdivision based on 3.2 PPU. The hydraulic analysis results indicated that the changes to the system hydraulics (pressures, velocity, flows) were minimal.
2. Hydrant flow test result was sceptical
    a. According to the hydrant test result (included in Appendix A of this memo), the measured static pressure was 60psi. Since the hydrant elevation was confirmed to be at around 260m above sea level, the hydraulic grade line (HGL) at this hydrant was calculated to be 302.19m[1]. Such HGL ishydraulically impractical since the top water level of the existing elevated storages in Bolton is at approximately 297m, and the existing North Bolton Booster Station located at Humber Lea Road was OFF during the field test. The measured

[1] 60psi = 42.19m of water level; HGL = Pressure + Elevation (42.19m + 260m = 302.19m)

static pressures in the system could not be higher than the existing storage level, otherwise, overflow of the existing elevated storage would occur.

b. Measured fire flow was 1297 gpm (81.83L/s) at 44psi and estimated fire flow at 20psi was approximately 2300 gpm (145.1L/s) at 20psi

    i. The hydraulic model used for this study was considered accurate:

        1. According to the Region's current pressure logging station results at Cedargrove Road (6081584), the recorded pressures were around 46psi as noted in the Region's comments

        2. The current hydraulic model indicated that the simulated pressures at this location were between 41.7psi to 46.5psi; which the modelling results were considered accurate and conservative. (See simulated pressure profiles in Appendix B).

    ii. According to the current hydraulic model, the minimum static pressure at King St. West and De Rose Avenue was 48psi (HGL = 293.3m)

        1. Based on Hazen Williams Equation[2] and the following parameters, the estimated available fire flow should be 390L/s

            a. HGL at tested hydrant = 260m + 20psi (14.06m) = 274.06m

            b. Distant between King St. West and De Rose Avenue intersection to the tested hydrant (13921 Chickadee Lane) = 240m

            c. Existing watermain size on Chickadee Lane = 300mm

            d. C-factor for existing 300mm watermain on Chickadee Lane = 130 (for PVC)

            e. Anticipated headloss in existing 300mm watermain with HGL of 274.06m at tested hydrant = 19.24m

            f. Theoretical flow at tested hydrant @ 20psi = 390L/s

    iii. The flow calculation based on Hazen William Equations did not account for the headlosses in the existing watermains between the source of supplies (existing elevated storages or Tullamore Pumping Station) but the hydraulic model did include this consideration. Therefore, the simulated fire flows presented in the model was lower than 390L/s. The key point was that the measured flows presented in the hydrant flow test report was considered impractical and did not represent the current system hydraulics.

        1. The possible causes of the impractical hydrant flow test results could be associated to the following:

            a. Measurements / equipment issues

            b. Partially closed valve(s) at the upstream of the tested hydrant

3. The hydraulic implications for the secondary 300mm watermain connection on Glasgow Road are summarized in the Table below. Detailed hydraulic modelling results are presented in Appendix C. As noted in the table below, the secondary watermain connection would improve the available fire flow to the proposed subdivision and the improvement in system pressures under normal operating conditions was considered minimal.

Hydraulic Characteristics	Without Secondary Watermain	With Secondary Watermain
Minimum Pressure under 2021 MDD condition	48.5 psi	48.5 psi
Lowest allowable fire flow @ 20psi under 2021 MDD condition	259.2 L/s	277.0 L/s
Minimum Pressure under 2041 MDD condition	48.2 psi	48.2 psi
Lowest allowable fire flow @ 20psi under 2041 MDD condition	223.06 L/s	237.9 L/s

2
$$H = \frac{10.583 * L * Q^{1.85}}{C^{1.85} * d^{4.87}}$$ (for metric units)

or

$$H = \frac{4.72 * L * Q^{1.85}}{C^{1.85} * d^{4.87}}$$ (for imperial units)

4. The hydraulic implications for the overall Zone 6 (Bolton) under pre and post development conditions are summarized below.
    a. Overall Zone 6 (Bolton) minimum system pressures for pre and post development conditions under 2021 MDD conditions were nearly identical. The hydraulic analysis results shown that the additional demands related to the proposed development did not cause any major impacts to the existing system pressures that drop below the Region's committed level of service (40psi and below). Please refer the system analysis results in Appendix D, Figures D.1 and D.2 for details
    b. Overall Zone 6 (Bolton) minimum system pressures for pre and post development conditions under 2041 MDD conditions were nearly identical. The hydraulic analysis results shown that the additional demands related to the proposed development did not cause any major impacts to the existing system pressures that drop below the Region's committed level of service (40psi and below). Please refer the system analysis results in Appendix D, Figures D.3 and D.4 for details
    c. To further confirm the hydraulic changes that were associated to the proposed development, the modelling results for local system pressures at the Region's Cedargrove pressure logging station were reviewed. According to the hydraulic analysis results:
        i. Minimum changes to the pressures at this location was identified in 2021 MDD scenario. Please refer Appendix D, Figure D.5 for details
        ii. Minimum changes to the pressures at this location was identified in 2041 MDD scenario. Please refer Appendix D, Figure D.6 for details

We trust the contents presented herein were sufficient to address the Region's comments. Should you have any questions, please feel free to contact the undersigned below.

Sincerely,

Benny Wan, P.Eng.
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Appendix A: Hydrant Flow Test Results

AQUAZITION

5-200 Connie Cres. Concord ON L4K 1M1 Phone 416-883-9777 Fax 905-303-6977

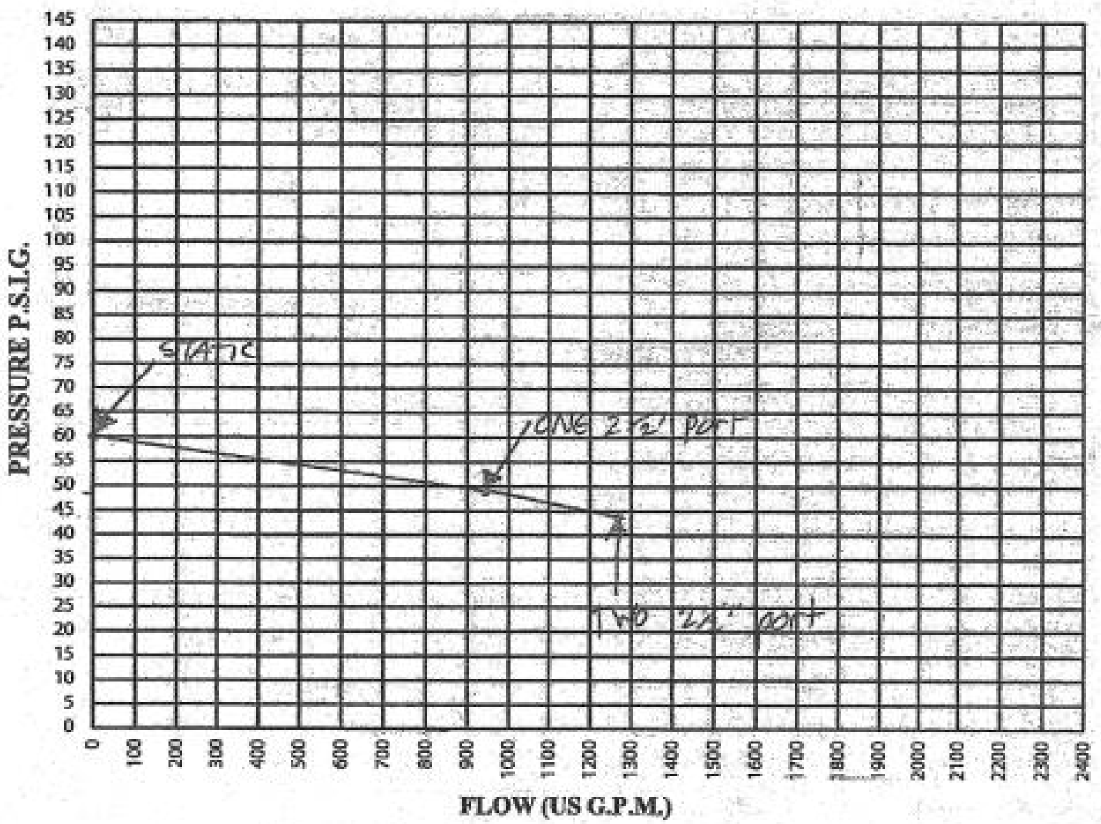
FLOW TEST REPORT

LOCATION OF RESIDUAL HYDRANT 13921 CHICKADEE LANE

LOCATION OF FLOW HYDRANT 13977 CHICKADEE LANE

TIME OF TEST 1:00 WATERMAIN SIZE 300 mm STATIC PRESSURE 60 psi

NUMBER OF OUTLETS	PITOT PRESSURE	FLOW (US G.P.M.)	RESIDUAL PRESSURE
One 2 ½" hydrant port	32 psi	947	48 psi
Two 2 ½" hydrant port	15 psi	1297	44 psi

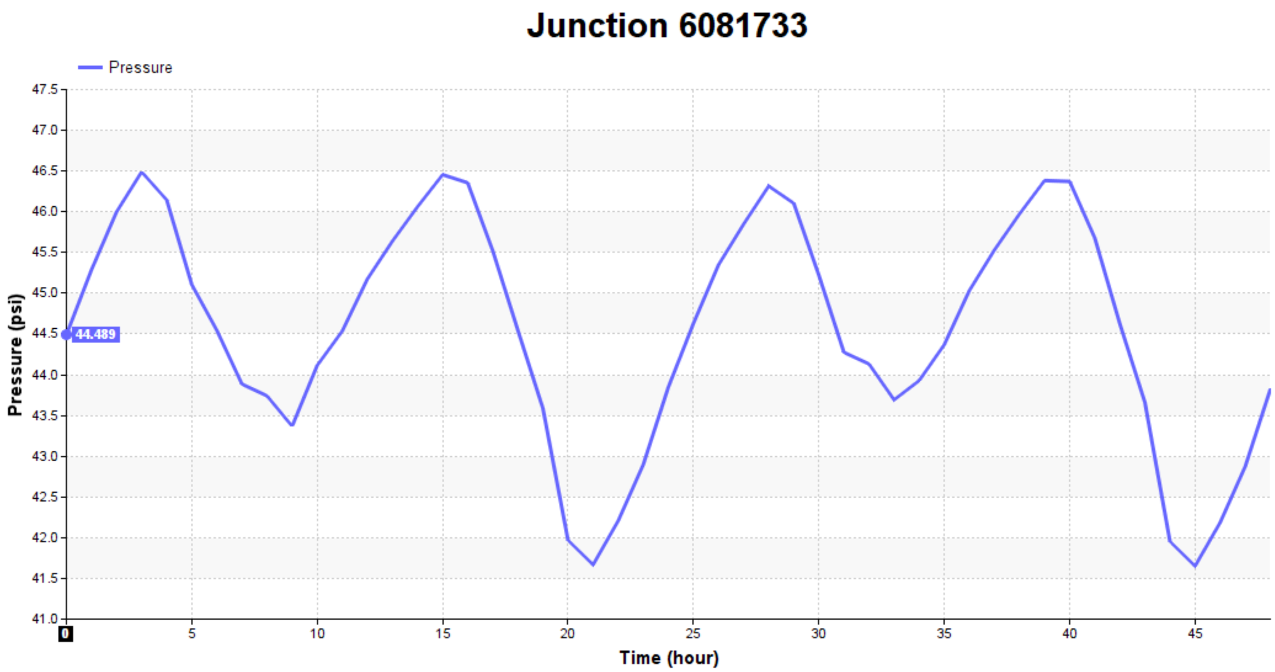


PROJECT LOCATION CHICKADEE Lane & Glasgow Rd DATE 04/09/18

COMPANY NAME BROOKVALLEY Project Management AQUAZITION EMPLOYEE Nick Gurie[illegible]

(PRINT NAME) (PRINT NAME)

Appendix B: Simulated Pressures at Cedargrove Pressure Logging Station



Appendix C: Hydraulic Analysis Results

Table C.1: Fire Flow Analysis Results for 2021MDD without Secondary Watermain

ID	Static Demand (L/s)	Static Pressure (psi)	Static Head (m)	Available Flow at Hydrant (L/s)	Available Flow Pressure (psi)
J-CAND-3	0.4442	48.4762	295.3000	259.2101	20.0017
J-CAND-9	0.4442	48.7606	295.3001	264.9778	20.0018
J-CAND-13	0.2625	49.3011	295.3004	271.0104	20.0017
J-CAND-11	0.1817	48.6189	295.3004	271.1467	20.0018
1601911	0.2571	49.6139	295.3004	284.8078	20.0018
J-CAND-5	0.6461	49.3296	295.3004	286.3692	20.0018
J-CAND-7	0.2827	49.0456	295.3006	289.4389	20.0018
J-CAND-1	0.3231	54.6885	295.3000	298.7981	20.0017

Table C.2: Fire Flow Analysis Results for 2021MDD with Secondary Watermain

ID	Static Demand (L/s)	Static Pressure (psi)	Static Head (m)	Available Flow at Hydrant (L/s)	Available Flow Pressure (psi)
J-CAND-3	0.4442	48.4723	295.2973	277.0132	20.0018
J-CAND-9	0.4442	48.7568	295.2974	283.0869	20.0018
J-CAND-11	0.1817	48.6147	295.2975	298.3157	20.0018
1601911	0.2571	49.6098	295.2975	313.3071	20.0018
J-CAND-13	0.2625	49.2964	295.2970	314.2135	20.0018
J-CAND-5	0.6461	49.3256	295.2976	315.2661	20.0018
J-CAND-1	0.3231	54.6846	295.2972	315.4106	20.0017
J-CAND-7	0.2827	49.0420	295.2980	316.7799	20.0018

Table C.3: Fire Flow Analysis Results for 2041MDD without Secondary Watermain

ID	Static Demand (L/s)	Static Pressure (psi)	Static Head (m)	Available Flow at Hydrant (L/s)	Available Flow Pressure (psi)
J-CAND-3	0.4442	48.3414	295.2052	223.0590	20.0018
J-CAND-9	0.4442	48.6259	295.2053	228.4596	20.0018
J-CAND-13	0.2625	49.1664	295.2055	232.0794	20.0018
J-CAND-11	0.1817	48.4841	295.2056	233.6658	20.0018
1601911	0.2571	49.4791	295.2055	246.3776	20.0018
J-CAND-5	0.6461	49.1949	295.2056	248.3508	20.0018
J-CAND-7	0.2827	48.9109	295.2058	251.2915	20.0018
J-CAND-1	0.3231	54.5537	295.2052	253.5158	20.0018

Table C.4: Fire Flow Analysis Results for 2041MDD with Secondary Watermain

ID	Static Demand (L/s)	Static Pressure (psi)	Static Head (m)	Available Flow at Hydrant (L/s)	Available Flow Pressure (psi)
J-CAND-3	0.4442	48.3311	295.1979	237.8919	20.0018
J-CAND-9	0.4442	48.6158	295.1982	243.0688	20.0018
J-CAND-11	0.1817	48.4729	295.1977	256.2883	20.0018
J-CAND-1	0.3231	54.5433	295.1978	266.5356	20.0018
1601911	0.2571	49.4683	295.1979	271.1304	20.0018
J-CAND-13	0.2625	49.1530	295.1961	271.7619	20.0018
J-CAND-5	0.6461	49.1843	295.1982	273.7969	20.0018
J-CAND-7	0.2827	48.9011	295.1989	276.3519	20.0018

Appendix D: Hydraulic Implications for Zone 6 (Bolton) under Pre and Post Development Conditions

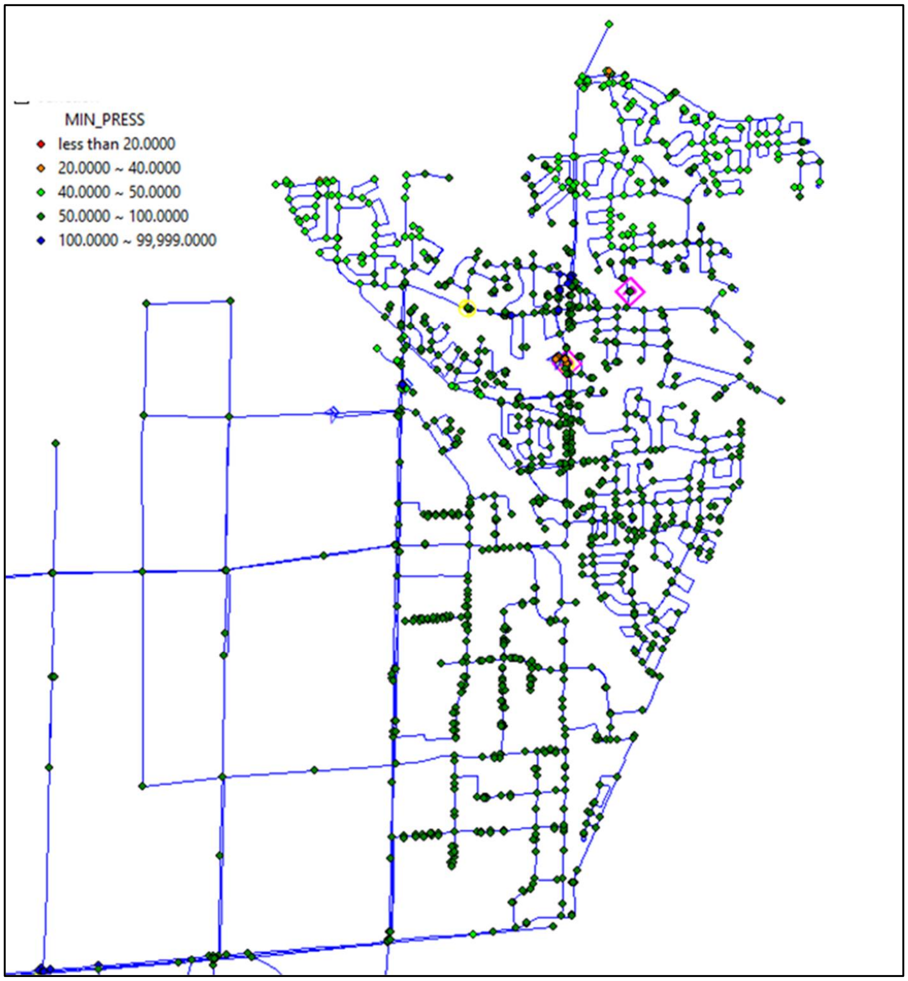


Figure D.1: Zone 6 (Bolton) Minimum System Pressure under 2021 MDD Pre Development Conditions

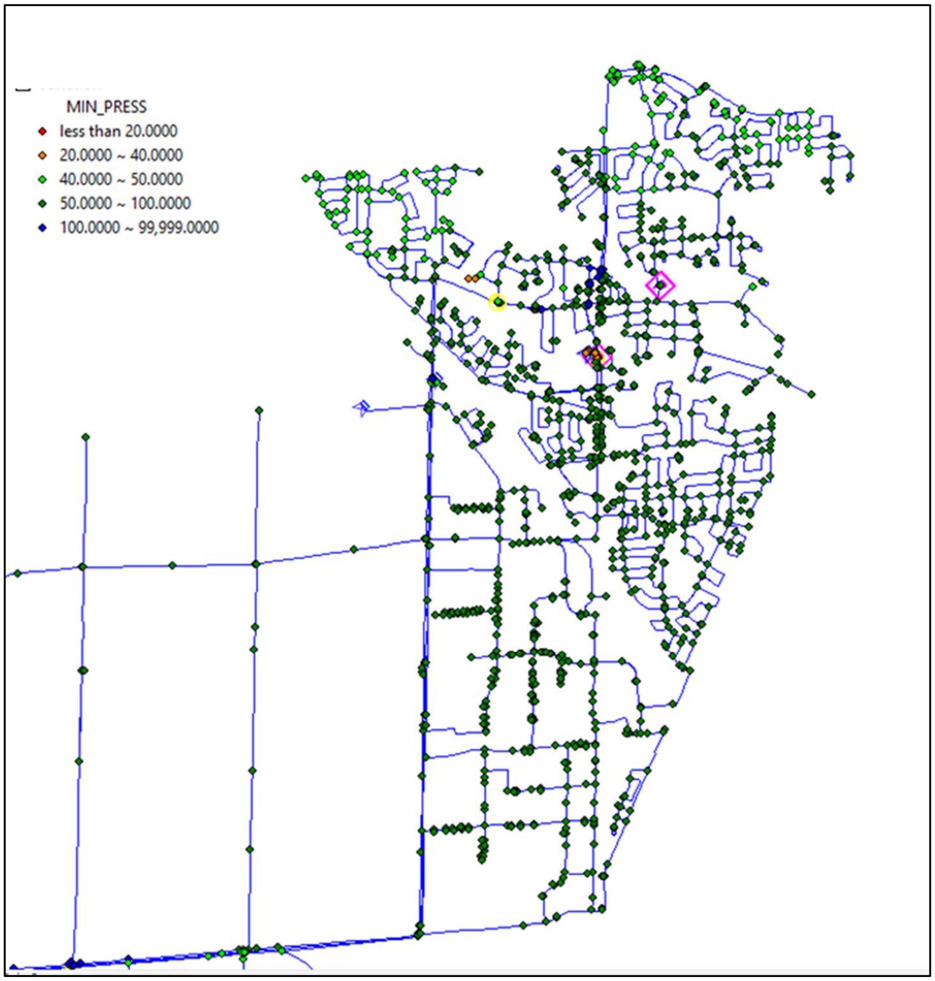


Figure D.2: Zone 6 (Bolton) Minimum System Pressure under 2021 MDD Post Development Conditions

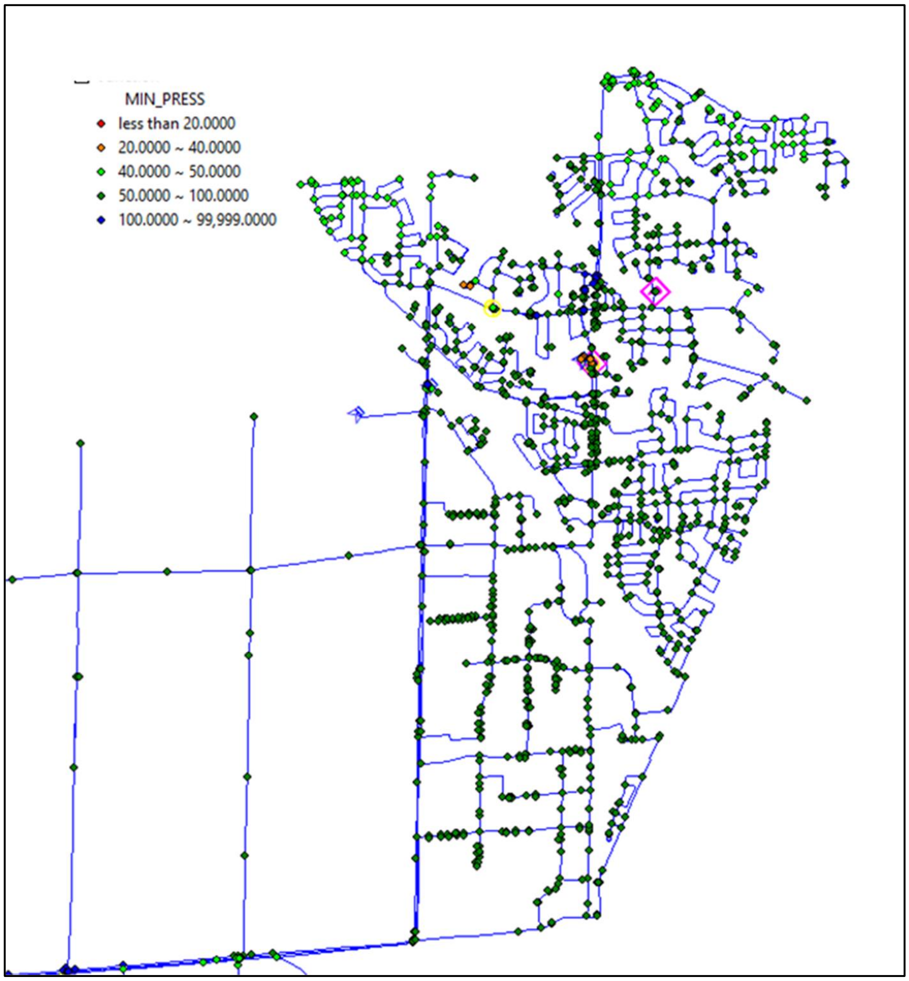


Figure D.3: Zone 6 (Bolton) Minimum System Pressure under 2041 MDD Pre Development Conditions

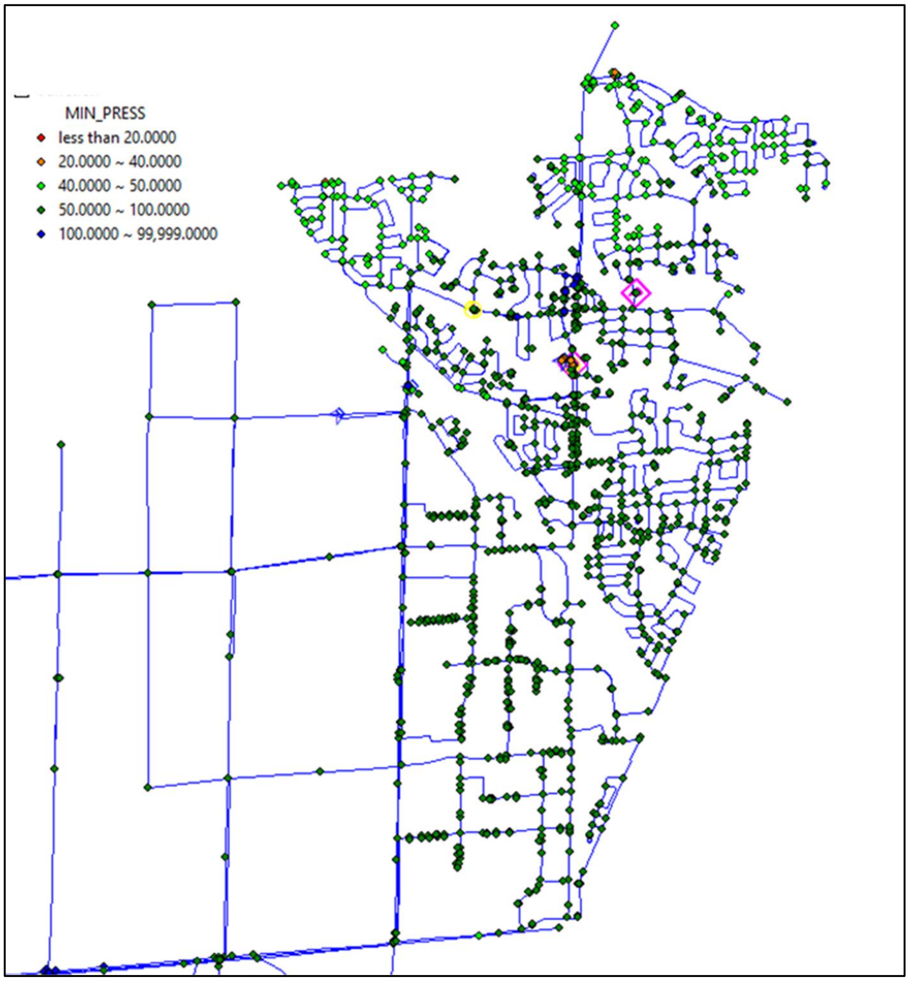


Figure D.3: Zone 6 (Bolton) Minimum System Pressure under 2041 MDD Post Development Conditions

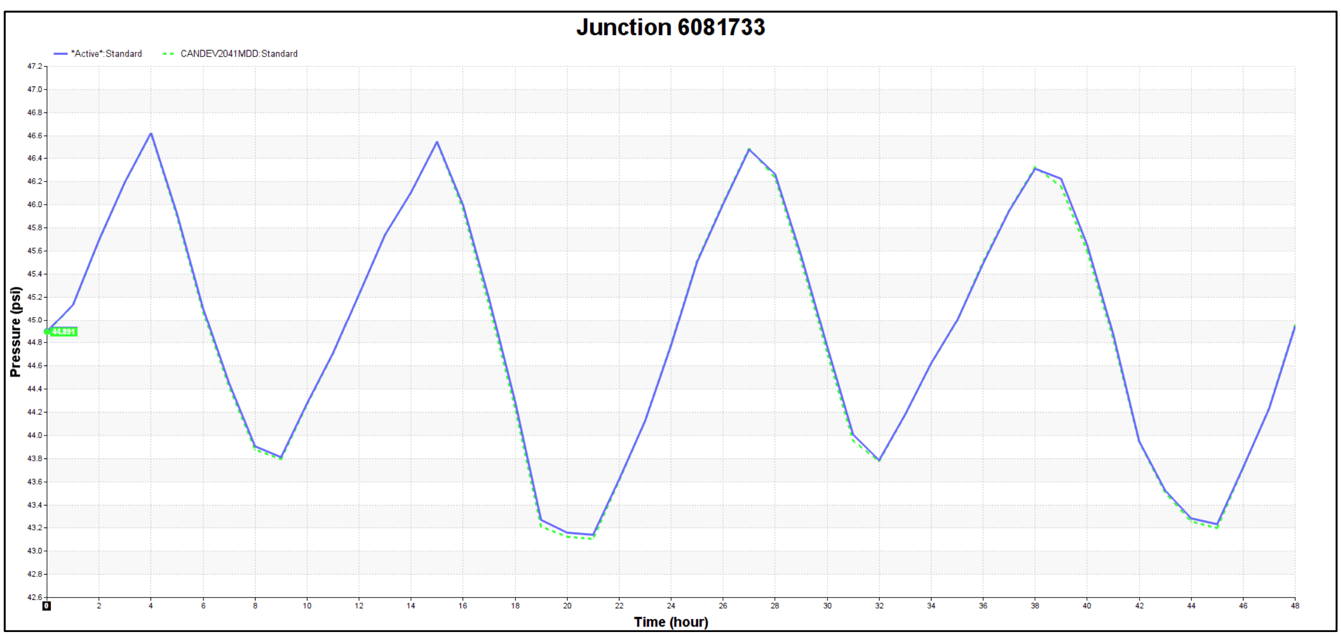


Figure D.5: System Pressure Comparisons for 2021MDD at Cedargrove Pressure Logging Station

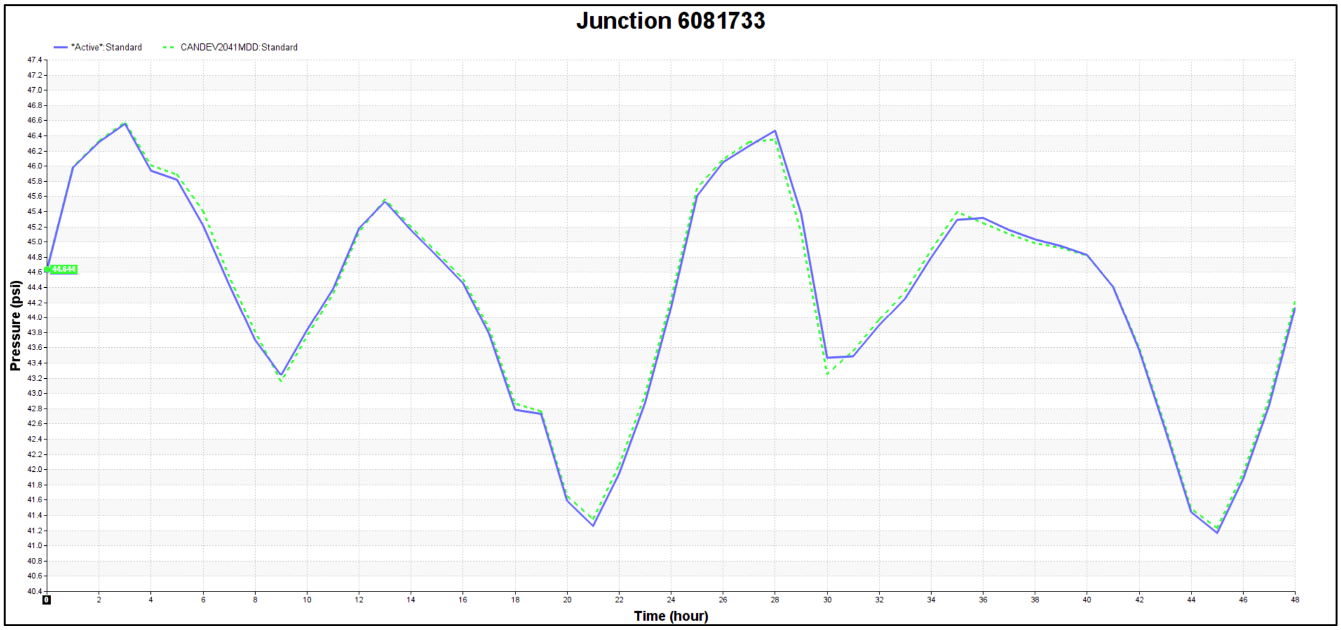


Figure D.6: System Pressure Comparisons for 2041MDD at Cedargrove Pressure Logging Station

Diarmuid Horgan

From: Wan, Benny <Benny.Wan@aecom.com>
Sent: February-03-22 2:16 PM
To: Frank Filippo
Cc: Diarmuid Horgan
Subject: RE: Chickadee Lane Subdivision - suggested hydrant flow testlocations

Hi Frank,

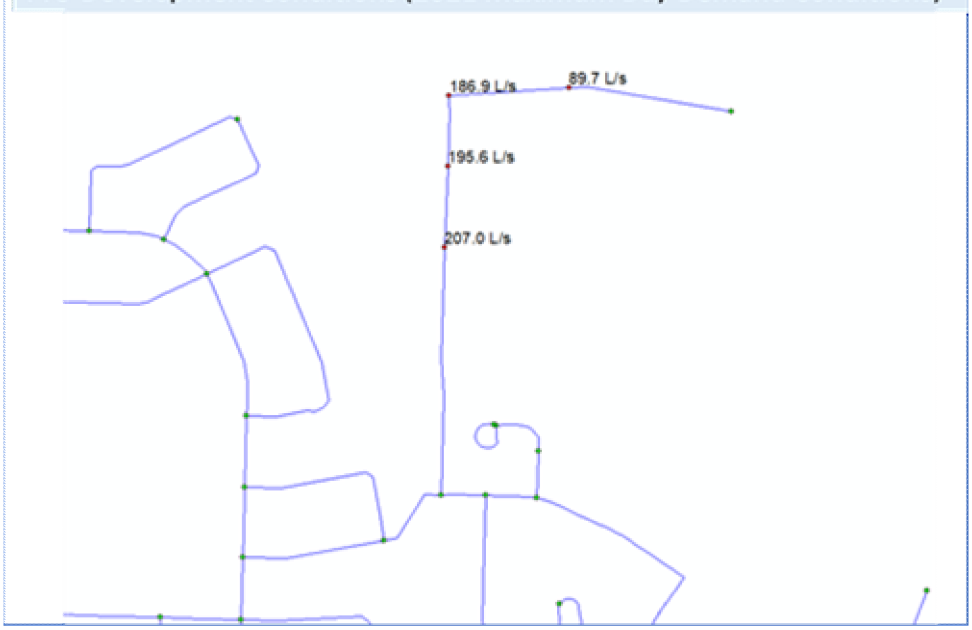
I reviewed the hydrant test results and validated the modelling results with these test results. The following table shows the model vs. field test results comparison for the 300mm watermain on Chickadee Lane.

	Field Test Results	Model Results
Static Pressure	45 psi	48 psi
Residual Pressure @ 1899gpm (120L/s)	37 psi	37 psi

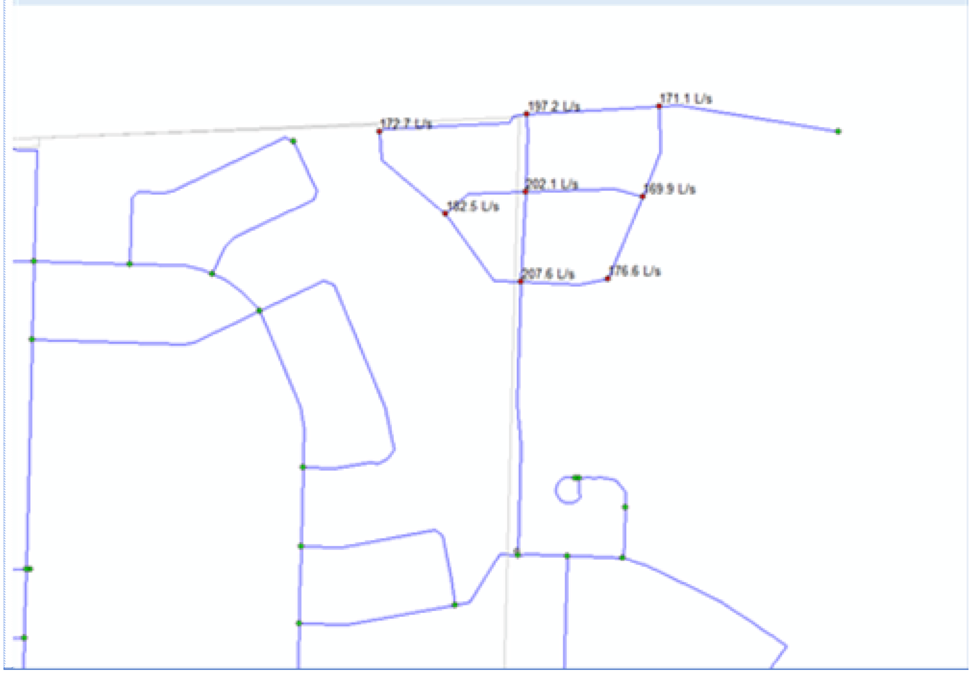
As seen in the able above, the modelling result was identical to those obtained from the field during the fire flow conditions. As a result, the modelling results are considered to be accurate.

Based on the fire flow analysis conducted in the Region's hydraulic model, the maximum available fire flows @20psi in the existing system and in the proposed subdivision are presented in the figures below. According to the fire flow analysis results presented in the figures below, the 300mm watermain connection on King Street would significantly improve the available fire flow for the proposed subdivision as well as improving the overall system resiliency as discussed in our original modelling analysis report. As a result, we recommend this 300mm watermain to be implemented for the proposed Chickadee Lane Subdivision.

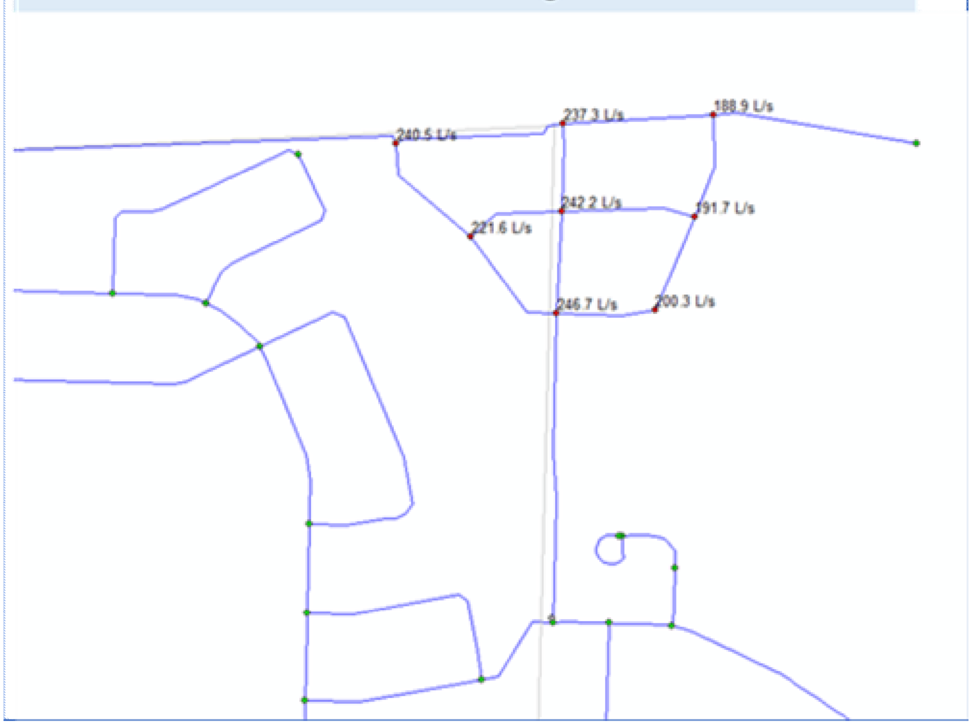
Pre-Development Conditions (2021 Maximum Day Demand Conditions)



Post-Development Conditions (2021 Maximum Day Demand Conditions)
Without 300mm connection on King Street



Post-Development Conditions (2021 Maximum Day Demand Conditions)
With 300mm connection on King Street



Benny Wan, P.Eng., M.Sc.

AECOM
105 Commerce Valley Dr. W.


KEY PLAN
N.T.S.
SITE
LEGEND:
LIMIT OF SUBDIVISION
EXISTING CONTOUR LINE
PROPOSED STORM SEWER
PROPOSED SANITARY SEWER
PROPOSED GROUND ELEVATION
PROPOSED STORM SEWER OBVERT ELEVATION
PROPOSED SANITARY SEWER INVERT ELEVATION
OVERLAND FLOW
LONG TERM STABLE SLOPE LINE
TRCA GENERIC REGULATION LINE
TRCA TOP OF BANK & NATURAL FEATURES STAKED LINE
WATERCOURSE BUFFER (30m)
WATERCOURSE
DE ROSE AVENUE
TOMEL COURT
BOWES COURT
CHICKADEE LANE
GLASGOW ROAD
STREET 'A'
STREET 'B'
STREET 'C'
STREET 'D'
EMIL KOLB PARKWAY
(REGIONAL ROAD 150)
LISMER CRESCENT
FRANK JOHNSTON ROAD
LAWREN HARRIS CRESCENT
CEDARGROVE ROAD
HUMBERSHED CRESCENT
BLOCK 31 OPEN SPACE
LOT 3 EXISTING RESIDENTIAL
BLOCK 33 RESTORATION AREA
BLOCK 32 OPEN SPACE
BLOCK 36 ROAD WIDENING
BLOCK 34 RESTORATION AREA
BLOCK 30 2.5m NOISE BUFFER
STORMWATER MANAGEMENT POND
NOTE
FOR STORMWATER MANAGEMENT POND DETAILS SEE DRAWING SWM-1
REVISIONS
3 REVISED AS PER DRAFT PLAN DATED APRIL 06, 2022 28.04.22 D.K.H.
2 REVISED AS PER DRAFT PLAN DATED AUGUST 20, 2021 27.08.21 D.K.H.
1 REVISED AS PER DRAFT PLAN DATED 28 DEC., 2020. 29.12.20 D.K.H.
NO. DESCRIPTION DATE BY
CANDEVCON LIMITED
CONSULTING ENGINEERS AND PLANNERS
9358 GOREWAY DRIVE BRAMPTON, ONTARIO L6P 0M7
TEL. (905) 794-0600 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 SERVICING PLAN
DRAWN BY: E.M.
PROJECT No. W17003
CHECKED BY: D.K.H.
DRAWING No. PS-1
SCALE: 1:1000
DATE: FEB., 19th 2019

LEGEND:

- LIMIT OF SUBDIVISION
- EXISTING CONTOUR LINE
- PROPOSED GROUND ELEVATION
- 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 APRIL 06, 2022	28.04.22	D.K.H.

REVISIONS

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TOWN OF CALEDON

**ZANCOR HOMES (BOLTON) LTD.
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AND
550, 600 AND 615 GLASGOW ROAD
PART OF LOT 10, CONCESSION 5 & 6
TOWN OF CALEDON
REGIONAL MUNICIPALITY OF PEEL

SHEET TITLE:

PRELIMINARY GRADING PLAN

DRAWN BY: E.M.	PROJECT No. W17003
CHECKED BY: D.K.H.	DRAWING No.
SCALE: 1:1000	PG-1
DATE: FEB., 19th 2019	

SETUP 1:1000m 30x42

NOTE
FOR STORMWATER MANAGEMENT POND DETAILS SEE DRAWING SWM-1

NO.	DESCRIPTION	DATE	BY
3	REVISED AS PER DRAFT PLAN DATED APRIL 06, 2022	28.04.22	D.K.H.
2	REVISED AS PER DRAFT PLAN DATED AUGUST 20, 2021	27.08.21	D.K.H.
1	REVISED AS PER DRAFT PLAN DATED 28 DEC., 2020.	29.12.20	D.K.H.

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TOWN OF CALEDON

CHICKADEE LANE 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

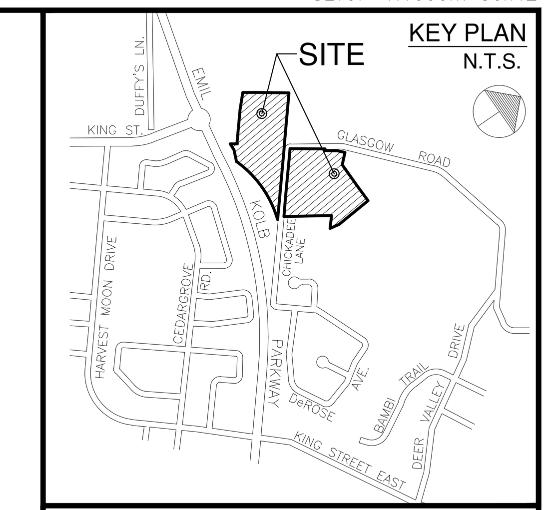
SHEET TITLE:
SANITARY DRAINAGE AREA PLAN

DRAWN BY: E.M.	PROJECT No. W17003
CHECKED BY: D.K.H.	DRAWING No.
SCALE: 1:1000	SA-1
DATE: FEB., 19th 2019	3

SETUP 1:1000m 30x42

NOTE
FOR STORMWATER
MANAGEMENT POND
DETAILS SEE DRAWING
SWM-1

KEY PLAN
N.T.S.



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

NO.	DESCRIPTION	DATE	BY
3	REVISED AS PER DRAFT PLAN DATED APRIL 06, 2022	28.04.22.	D.K.H.
2	REVISED AS PER DRAFT PLAN DATED AUGUST 20, 2021	27.08.21.	D.K.H.
1	REVISED AS PER DRAFT PLAN DATED 28 DEC., 2020.	29.12.20.	D.K.H.

REVISIONS

CANDEVCON LIMITED
CONSULTING ENGINEERS AND PLANNERS
9358 GOREWAY DRIVE BRAMPTON, ONTARIO L6P 0M7
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TOWN OF CALEDON

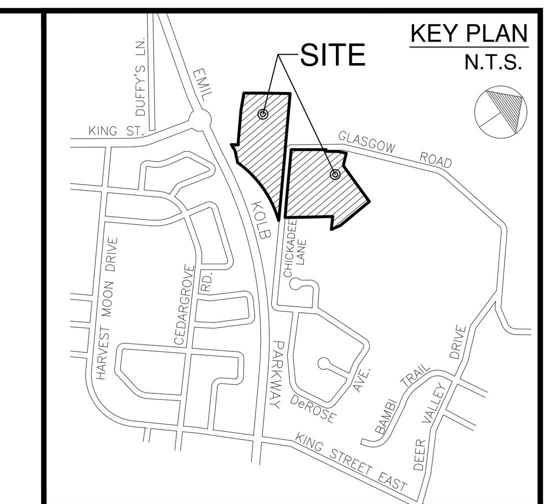
CHICKADEE LANE ROUNDING OUT AREA "B"

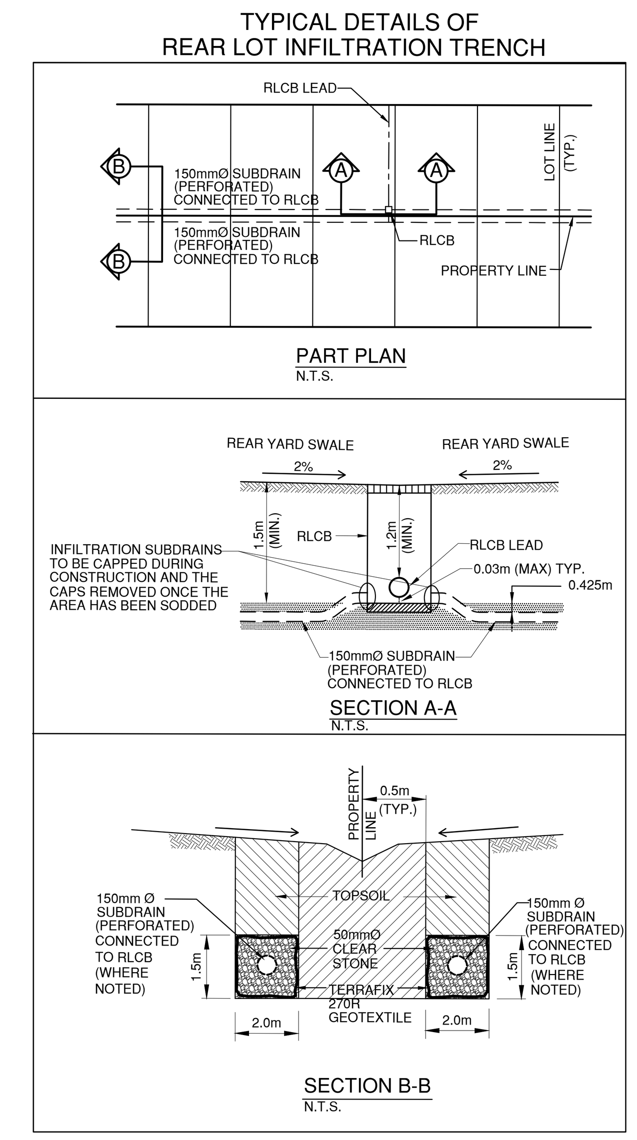
13935, 13951 & 13999 CHICKADEE LANE, 0 KING STREET
AND
550, 600 AND 615 GLASGOW ROAD
PART OF LOT 10, CONCESSION 5 & 6
TOWN OF CALEDON
REGIONAL MUNICIPALITY OF PEEL

SHEET TITLE:

PRELIMINARY STORM DRAINAGE AREA PLAN

DRAWN BY:	E.M.	PROJECT No.	W17003
CHECKED BY:	D.K.H.	DRAWING No.	ST-1 (3)
SCALE:	1:1000		
DATE:	FEB., 19th 2019		





LEGEND:

- LIMIT OF SUBDIVISION
- EXISTING CONTOUR LINE
- PROPOSED STORM SEWER
- PROPOSED INFILTRATION TRENCH
- 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

BH
(GROUND WATER ELEVATION)

BOREHOLES AS PER SOIL ENGINEERS LTD.
REPORT DATED JULY 2018
REFERENCE No. 1801-S032

NO.	DESCRIPTION	DATE	BY
3	REVISED AS PER DRAFT PLAN DATED APRIL 06, 2022.	28.04.22.	D.K.H.
2	REVISED AS PER DRAFT PLAN DATED AUGUST 20, 2021.	27.08.21.	D.K.H.
1	REVISED AS PER DRAFT PLAN DATED 28 DEC., 2020.	29.12.20.	D.K.H.

REVISIONS

CANDEVCON LIMITED
CONSULTING ENGINEERS AND PLANNERS
9358 GOREWAY DRIVE BRAMPTON, ONTARIO L6P 0M7
TEL. (905) 794-0600 FAX (905) 794-0611

TOWN OF CALEDON

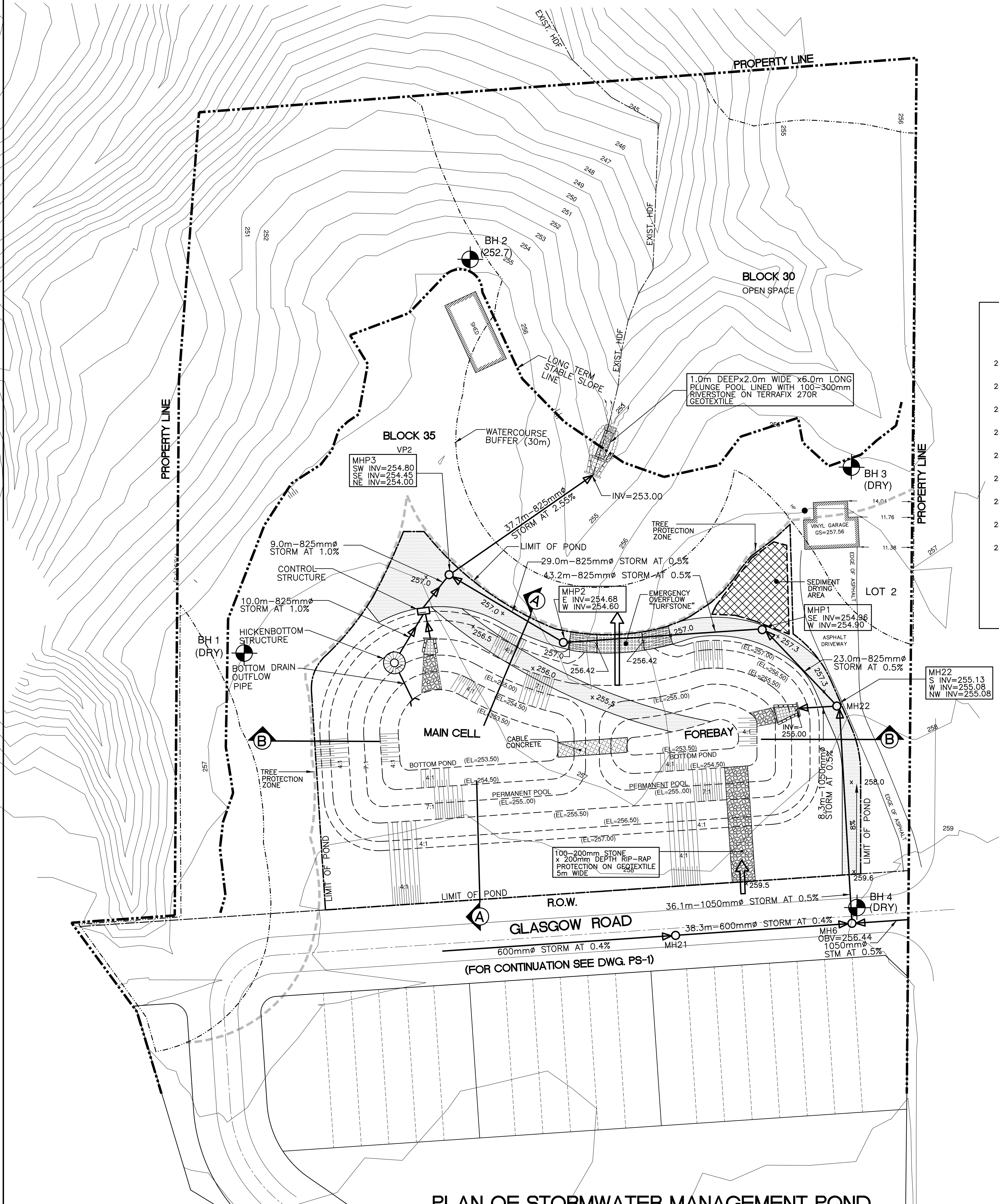
CHICKADEE LANE ROUNDING OUT AREA "B"

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

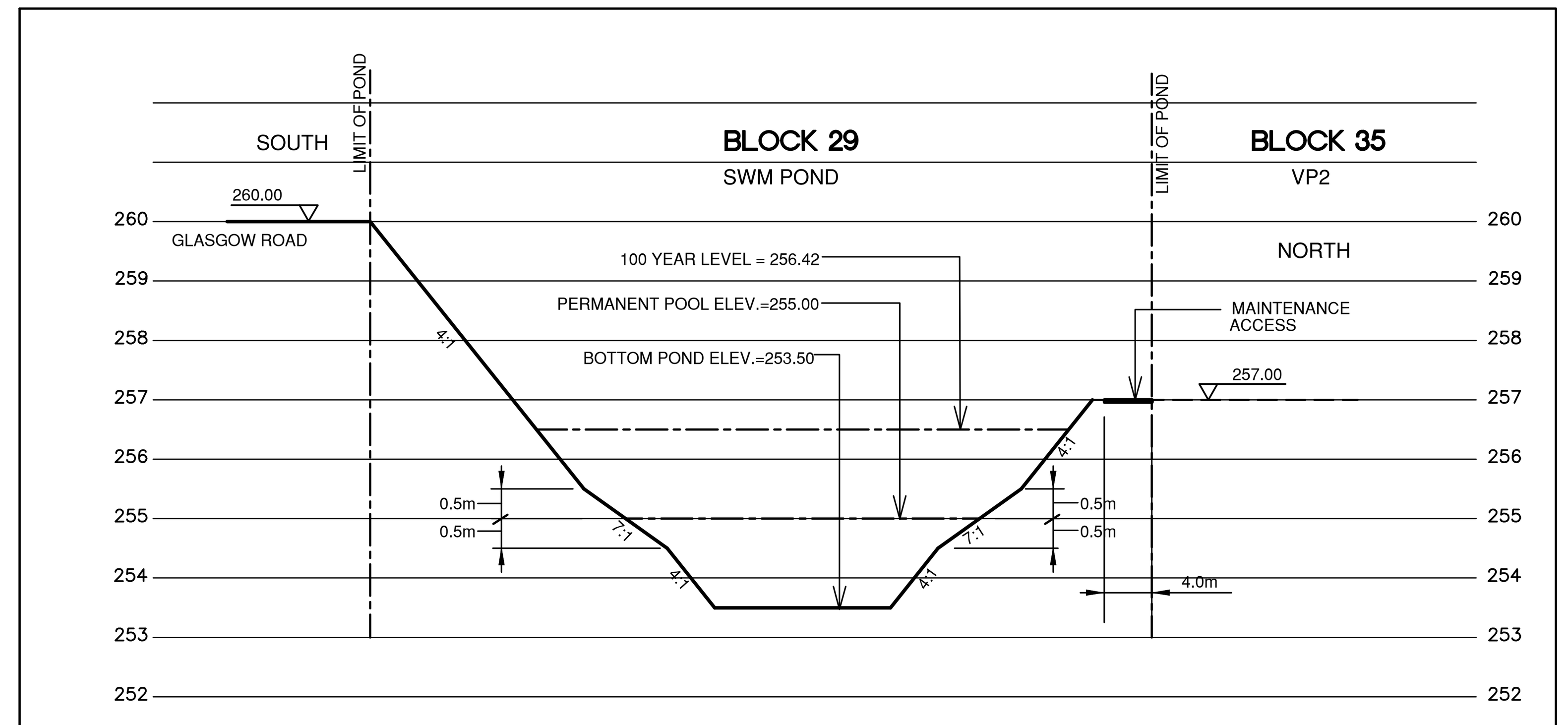
SHEET TITLE:

INFILTRATION PLAN

DRAWN BY: E.M.		PROJECT No. W17003	
CHECKED BY: D.K.H.		DRAWING No.	
SCALE: 1:1000		IT-1	3
DATE: FEB., 19th 2019			



PLAN OF STORMWATER MANAGEMENT POND
1:500



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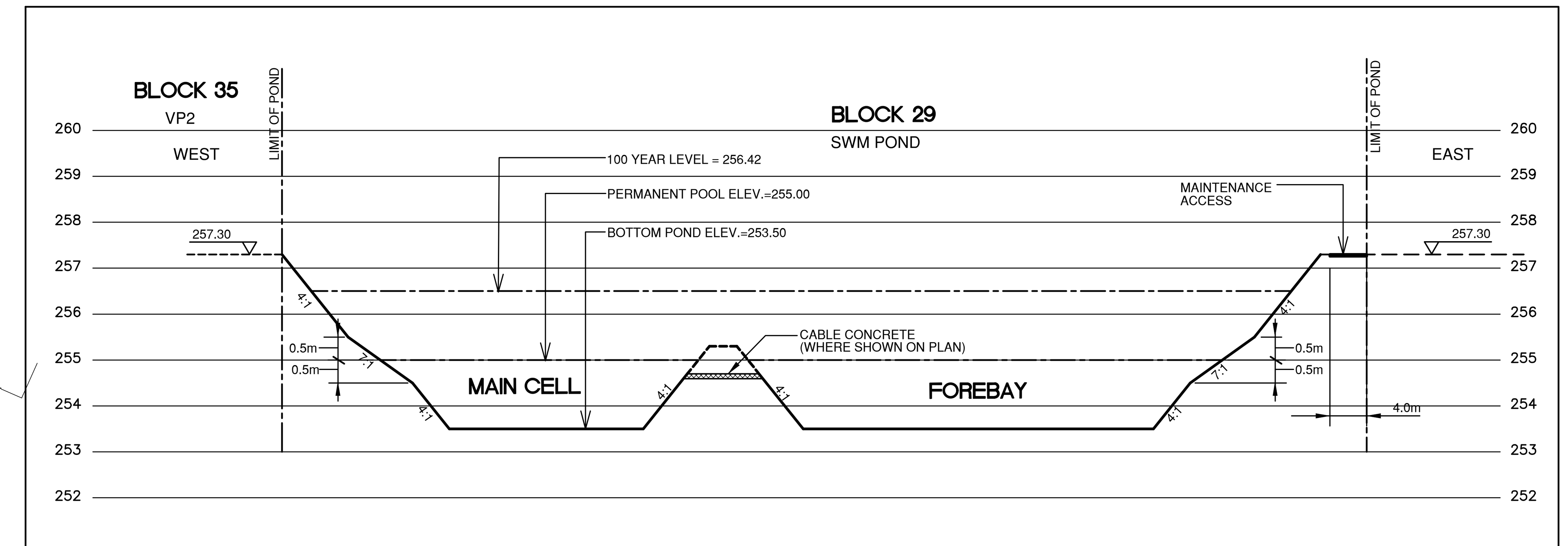

SECTION B-B
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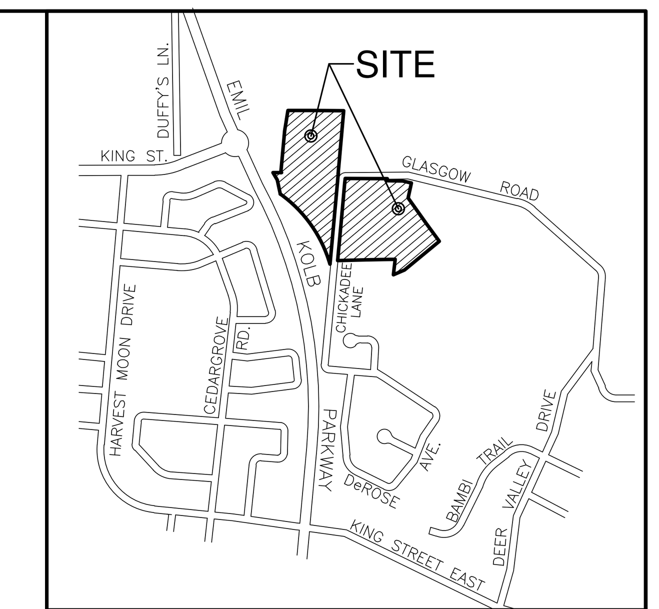


KEY PLAN
N.T.S.

BH
(GROUND WATER ELEVATION)
BOREHOLES AS PER SOIL ENGINEERS LTD. REPORT DATED JULY 2018 REFERENCE No. 1801-S032

NO.	DESCRIPTION	DATE	BY
2	POND LAYOUT REVISED	28.04.22	D.K.H.
1	REVISED AS PER TOWN OF CALEDON'S COMMENTS DATED MAY 13, 2021	27.08.21	D.K.H.

REVISIONS

CANDEVCON LIMITED
CONSULTING ENGINEERS AND PLANNERS
9358 GOREWAY DRIVE BRAMPTON, ONTARIO L6P 0M7
TEL. (905) 794-0600 FAX (905) 794-0611

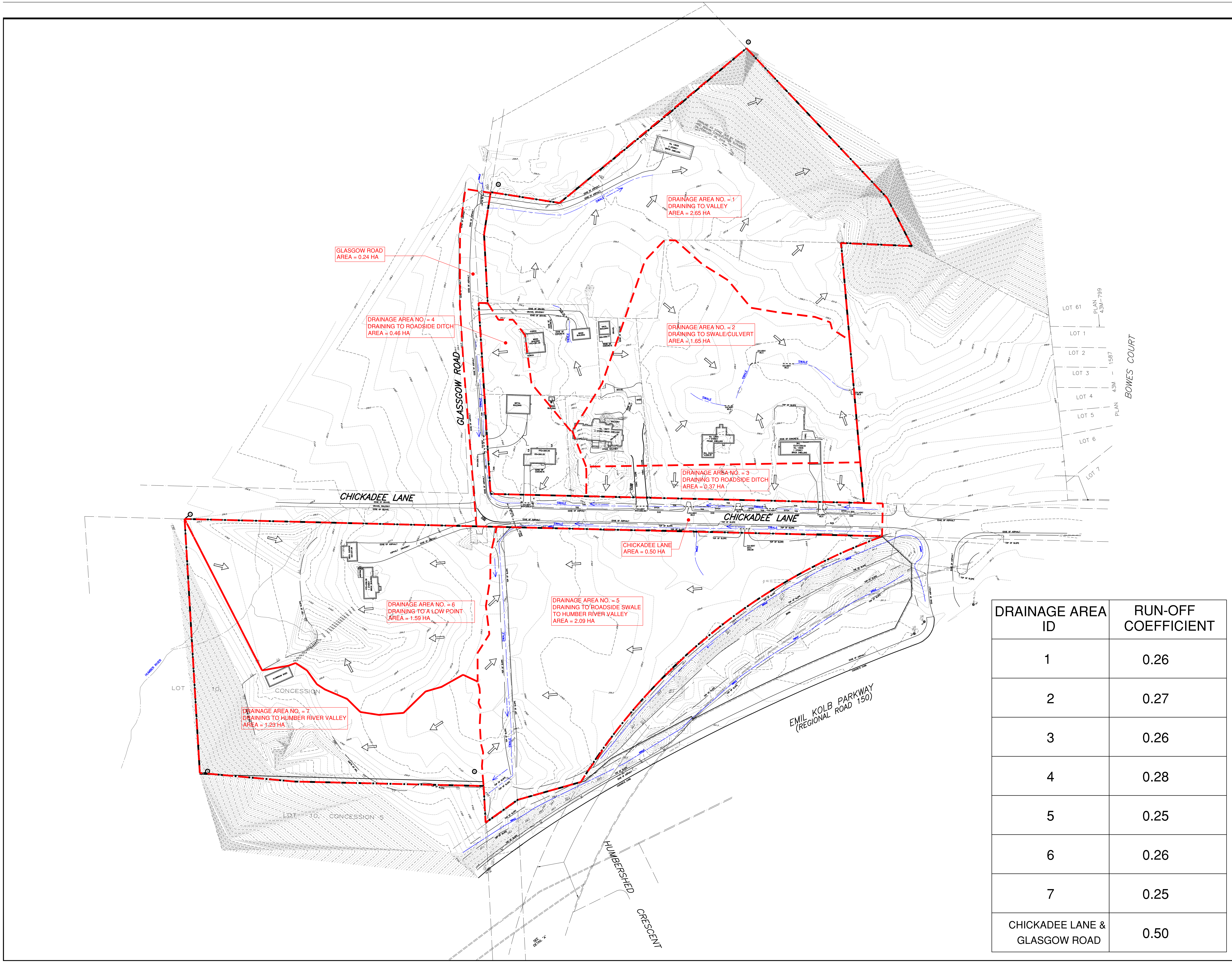
TOWN OF CALEDON

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
FILE No. 21T - 0001C
RZ - 2020 - 3 - 0004

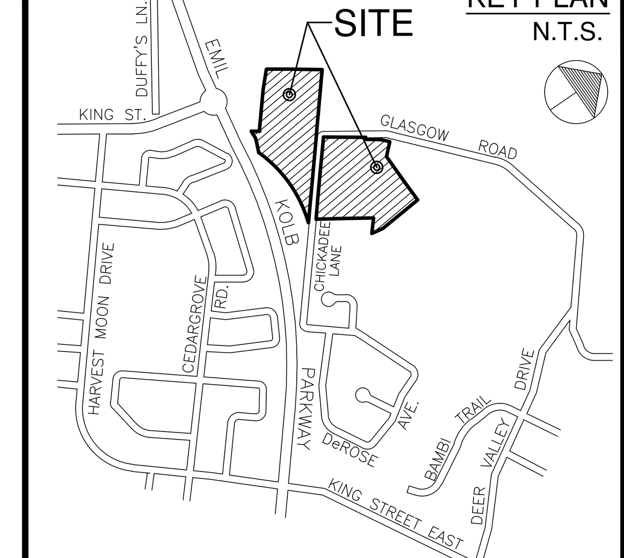
SHEET TITLE:
STORMWATER MANAGEMENT POND PLAN and SECTIONS

DRAWN BY:	D.R.	PROJECT No.	W17003
CHECKED BY:	D.K.H.	DRAWING No.	
SCALE:	AS NOTED		SWM-1 (2)
DATE:	DEC., 15th. 2020		



DRAINAGE AREA ID	RUN-OFF COEFFICIENT
1	0.26
2	0.27
3	0.26
4	0.28
5	0.25
6	0.26
7	0.25
CHICKADEE LANE & GLASGOW ROAD	0.50

KEY PLAN
N.T.S.



LEGEND:

- LIMIT OF SUBDIVISION
- EXISTING CONTOUR LINE
- DRAINAGE DIRECTION
- DRAINAGE BOUNDARY
- EXISTING SWALE

NO.	DESCRIPTION	DATE	BY
1	RUN-OFF COEFFICIENTS ADDED	27.08.21	D.K.H.

REVISIONS

CANDEVCON LIMITED
CONSULTING ENGINEERS AND PLANNERS
9358 GOREWAY DRIVE BRAMPTON, ONTARIO L6P 0M7
TEL (905) 794-0600 FAX (905) 794-0611

TOWN OF CALEDON

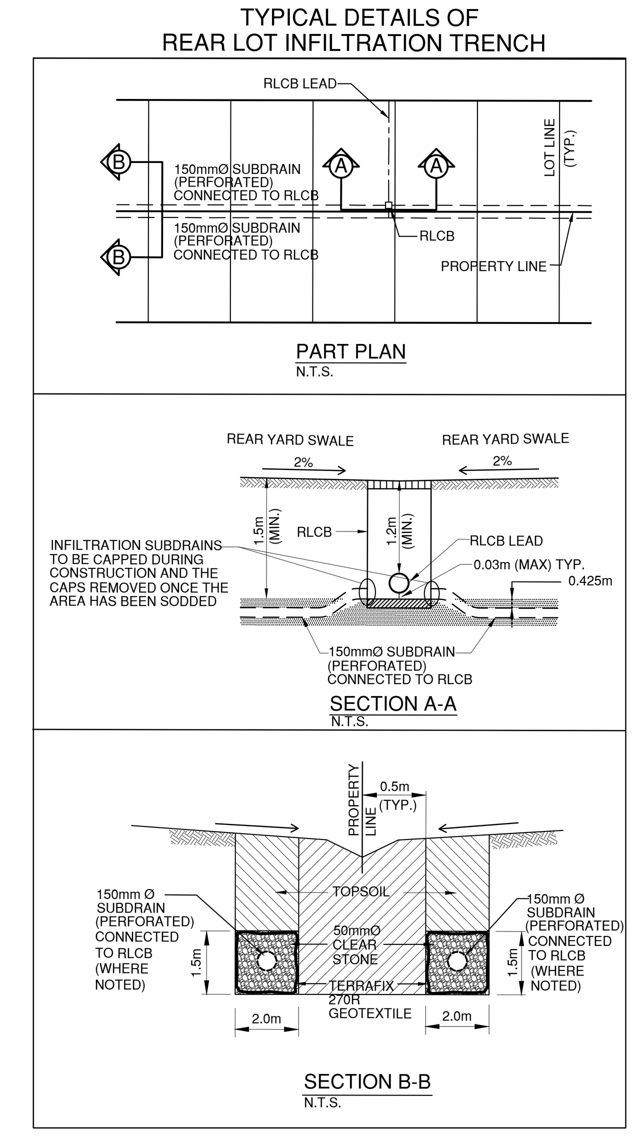
CHICKADEE LANE ROUNDING OUT AREA "B"

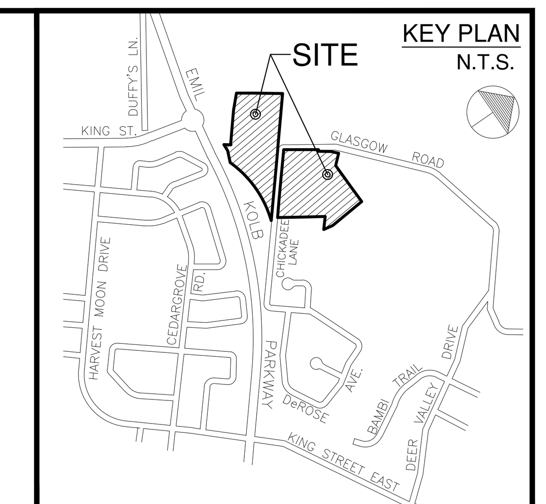
13935, 13951 & 13999 CHICKADEE LANE, 0 KING STREET
AND
550, 600 AND 615 GLASGOW ROAD
PART OF LOT 10, CONCESSION 5 & 6
TOWN OF CALEDON
REGIONAL MUNICIPALITY OF PEEL

SHEET TITLE:

PRE-DEVELOPMENT STORM DRAINAGE PLAN

DRAWN BY: S.S.	PROJECT No. W17003
CHECKED BY: D.K.H.	DRAWING No.
SCALE: 1:1000	PD-1
DATE: MARCH, 9th. 2021	





LEGEND:

- LIMIT OF SUBDIVISION
- EXISTING CONTOUR LINE
- PROPOSED STORM SEWER
- PROPOSED INFILTRATION TRENCH
- 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

BH (GROUND WATER ELEVATION)

BOREHOLES AS PER SOIL ENGINEERS LTD.
REPORT DATED JULY 2018
REFERENCE No. 1801-S032

NO.	DESCRIPTION	DATE	BY
3	REVISED AS PER DRAFT PLAN DATED APRIL 06, 2022.	28.04.22.	D.K.H.
2	REVISED AS PER DRAFT PLAN DATED AUGUST 20, 2021.	27.08.21.	D.K.H.
1	REVISED AS PER DRAFT PLAN DATED 28 DEC., 2020.	29.12.20.	D.K.H.

REVISIONS

CANDEVCON LIMITED
CONSULTING ENGINEERS AND PLANNERS
9358 GOREWAY DRIVE
TEL. (905) 794-0600
BRAMPTON, ONTARIO L6P 0M7
FAX (905) 794-0611

TOWN OF CALEDON

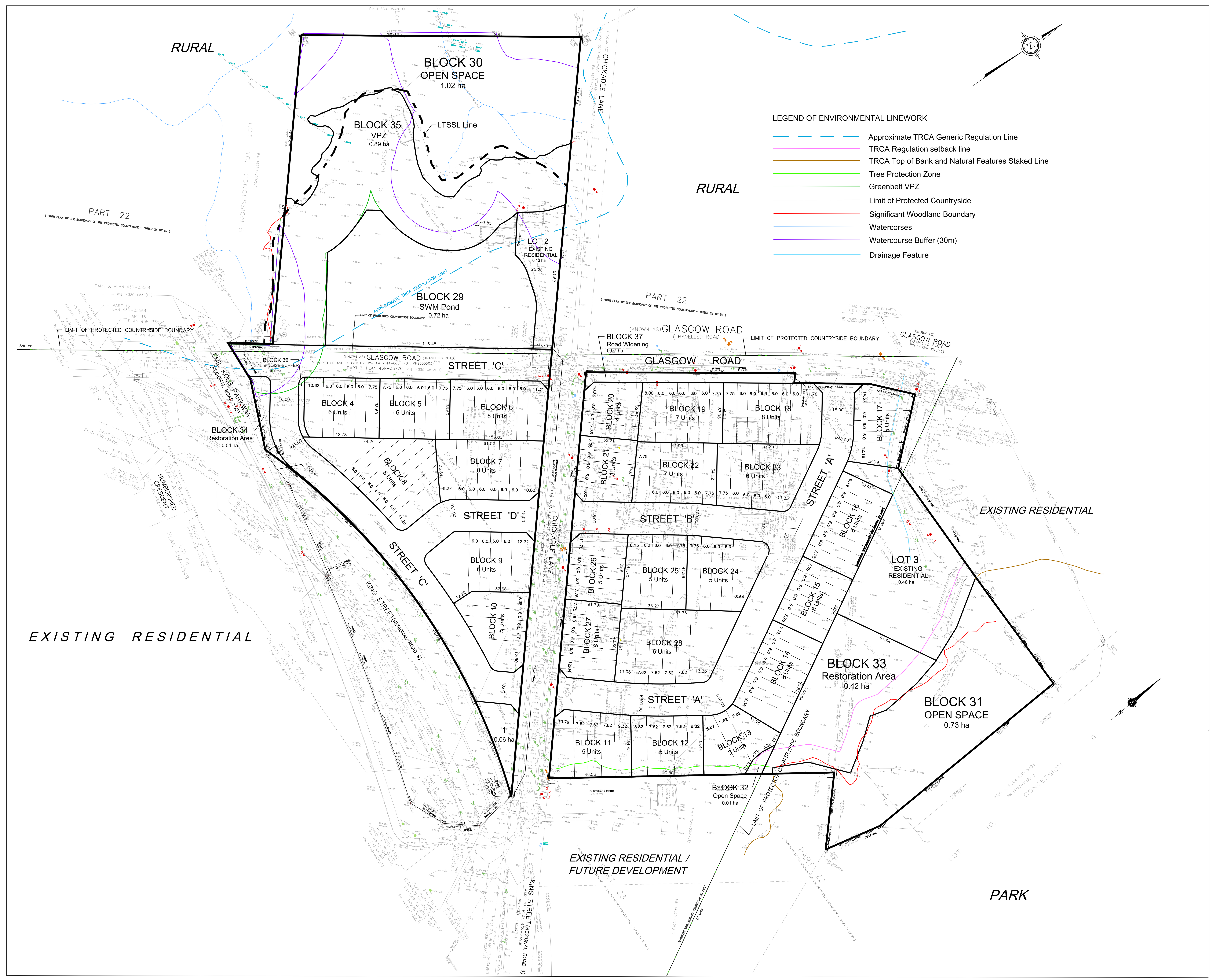
CHICKADEE LANE ROUNDING OUT AREA "B"

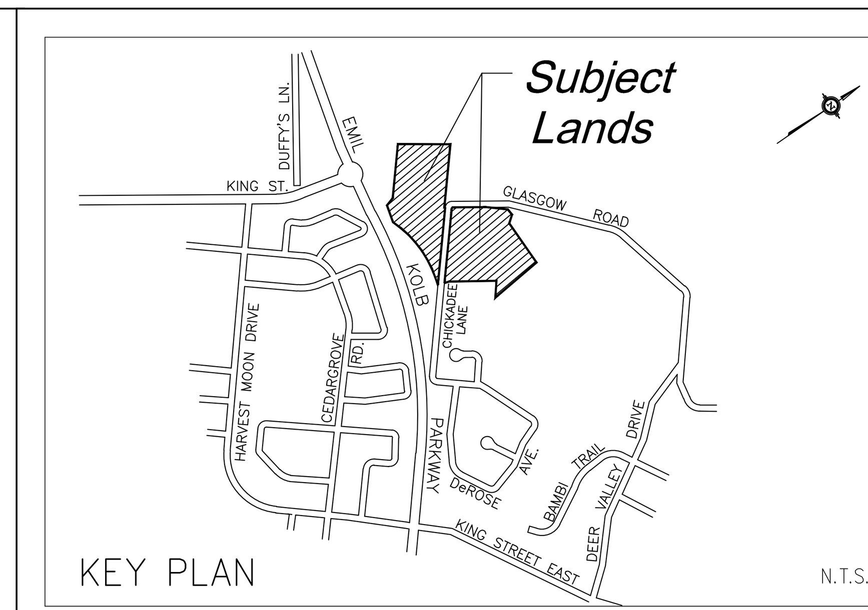
13935, 13951 & 13999 CHICKADEE LANE, 0 KING STREET
AND
550, 600 AND 615 GLASGOW ROAD
PART OF LOT 10, CONCESSION 5 & 6
TOWN OF CALEDON
REGIONAL MUNICIPALITY OF PEEL

SHEET TITLE:

INFILTRATION DRAINAGE PLAN

DRAWN BY:	E.M.	PROJECT No.	W17003
CHECKED BY:	D.K.H.	DRAWING No.	IT-1A
SCALE:	1:1000		
DATE:	FEB., 19th 2019		





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	1–3	3	0.64 ha
Street Townhouses	4–28		3.95 ha
6.0m Units		132	
7.62m Units		19	
Storm Water Management Pond	29		0.72 ha
Open Space	30–32		1.75 ha
Restoration Area	33–34		0.46 ha
VPZ	35		0.89 ha
2.5m Noise Buffer	36		0.01 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.

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File Number:	
Date Drawn:	2 MAR 2019
Drawn By:	BT
Checked By:	R.H.
Date Revised:	6 APR 2022
CAD File No. :	

Drawing Number: A1