74 Berkeley Street, Toronto, ON M5A 2W7

Chickadee Lane Rounding Out Area B Comprehensive Environmental Impact Study and Management Plan

Part A: Existing Conditions and Characterization

Part B: Impact Assessment

Part C: Detailed Analysis and Implementation

Environmental Impact Study (EIS)

Palmer Project #
170163

Prepared For
Zancor Homes (Bolton) Inc.

August 23, 2021

74 Berkeley Street, Toronto, ON M5A 2W7

August 23, 2021

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

Dear Mr. Filippo:

Re: **Comprehensive Environmental Impact Study and Management Plan (CEISMP) Part A, Part B and Part C Report, and Environmental Impact Study (EIS) for Chickadee Lane Rounding Out Area B, Bolton, Ontario**
Project #: **170163**

Palmer is pleased to submit this Comprehensive Environmental Impact Study and Management Plan (CEISMP) Part A, B and C Report, and Environmental Impact Study (EIS) for the Chickadee Lane Rounding Out Area B in Bolton, Ontario (the Site). This report has been updated from the version provided during the 1st Submission (dated December 29, 2020) to include the August 2021 Concept Plan. No substantive changes to the report findings or conclusions from the December 29, 2020 report are made in this updated report.

This combined report is intended to support the proposed urban boundary expansion of the Chickadee Lane Rounding Out Area B through the Local Official Plan Amendment (LOPA) process, as well as support a submission to the Town of Caledon for Draft Plan of Subdivision and Re-Zoning. The Regional Official Plan Amendment (ROPA) for the property was approved through the Local Planning Appeal Tribunal (LPAT) in Fall 2020.

The Chickadee Lane Site is approximately 10.04 hectares (ha) in area and is located outside of the current urban boundary. Lands northwest of the intersection of Chickadee Lane and Glasgow Road, as well as along the eastern property limits are located within the Greenbelt designated lands

The CEISMP reporting process to support the proposed urban boundary expansion is comprised of three (3) parts, all of which are included within this document:

- Part A Report: Existing Conditions and Gap Analysis;
- Part B Report: Impact Assessment; and,
- Part C Report: Detailed Analysis and Implementation.

The purpose of this report is to provide a complete and integrated assessment of the existing environmental conditions, potential effects from development, and the proposed mitigation and monitoring recommendations. The detail provided in this report is beyond what would typically be expected from a CEISMP Report, and it have been expanded to include a supporting effects assessment to support an EIS report submission.

The Draft Plan proposes to subdivide the Site into 37 blocks and create four new public streets. This includes 25 street townhouse blocks, with a total of 151 units, and one single detached home block. The Plan also proposes to maintain two of the existing rural residential lots and add a new single detached dwelling. In addition to these residential uses, the Draft Plan provides for a park block, a Stormwater Management Pond block, three Open Space/Natural Heritage System Blocks, two Restoration Area Blocks and a road widening along Glasgow Road.

Based on feedback from Peel Region, the Town of Caledon, and TRCA, the location and design of the Stormwater Management (SWM) Pond and its outfall location have been further studied and refined to address reviewer concerns. While the SWM Pond footprint is now larger than the previous version presented in the December 29, 2020 CEISMP and EIS Report, it is still located fully outside of the 30 m Greenbelt Minimum Vegetation Protection Zone (MVPZ), outside of the Long-Term Stable Slope Line and setback, and outlets further downstream at Alternative Location #2 (See Palmer Alternative Outfall Evaluation memo, dated March 23, 2021 provided in **Appendix M**) to avoid concerns about erosion in the steeply dipping ephemeral tributaries along the northern portion of the Site.

The CEISMP Report and EIS has shown that proposed development plan can be implemented while increasing the extent and diversity of the natural heritage system from that which exists pre-development. Restoration activities have been proposed for the lands within the 30 m Greenbelt MVPZ and areas of additional restoration have been proposed adjacent to the natural heritage system and required ecological setbacks. Through implementation of restoration measures for both the ecological setbacks and the additional compensation lands, net ecological gain shall be achieved by increasing the net area of natural heritage system and implementing related habitat enhancements.

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

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

Table of Contents

PART C: DETAILED ANALYSIS AND IMPLEMENTATION

List of Figures

List of Tables

List of Appendices

1. Introduction

Palmer has been retained by Brookvalley Project Management Inc. (Brookvalley) on behalf of Zancor Homes (Bolton) Inc. (Zancor) to prepare a Comprehensive Environmental Impact Study and Management Plan (CEISMP) Report and Environmental Impact Study (EIS) for the property referred to as the Chickadee Lane Rounding Out Area B lands in Bolton, Ontario (the Site) (**Figure 1**). This study supplies the necessary background information in support of a settlement area expansion for the Chickadee Lane Rounding Out Area B lands through the Local Official Plan Amendment (LOPA) process, as well as support a submission to the Town of Caledon for Draft Plan of Subdivision and Re-Zoning. This study has been prepared in accordance with the Bolton Residential Expansion Study Terms of Reference (TRCA, April 2012).

The CEISMP reporting process is comprised of three (3) parts, all of which are included within this document:

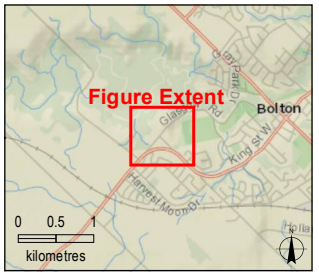
- Part A Report: Existing Conditions and Gap Analysis;
- Part B Report: Impact Assessment; and,
- Part C Report: Detailed Analysis and Implementation.

The Draft Plan proposes to subdivide the Site into 37 blocks and create four new public streets. This includes 25 street townhouse blocks, with a total of 151 units, and one single detached home block. The Plan also proposes to maintain two of the existing rural residential lots and add a new single detached dwelling. In addition to these residential uses, the Draft Plan provides for one park block, a Stormwater Management Pond block, three Open Space/Natural Heritage System Blocks, two Restoration Area Blocks and a road widening along Glasgow Road.

1.1 Planning Context

On May 16, 2020, the new Growth Plan for the Greater Golden Horseshoe, 2020 came into effect. The update to the Growth Plan extended the planning horizon to 2031 and increased intensification and Greenfield density targets for the municipalities within the Greater Golden Horseshoe. The updated Growth Plan also brought forth new policies pertaining to Settlement Area boundary expansions and to the MCR process, now only allowing upper or single tier municipalities to initiate the MCR process.

The Chickadee Lane Rounding Out Area B lands are part of the Bolton Residential Expansion Lands (BRES) Regional Official Plan Amendment (ROPA 30). These lands comprise approximately 10.04 hectares (ha) and are located outside of the current urban boundary. Lands northwest of the intersection of Chickadee Lane and Glasgow Road, as well as along the eastern property limits are outside of the urban boundary and within the Greenbelt designated lands (**Figure 1**). In December 2016, the Regional Municipality of Peel passed bylaw 67-2016 to adopt Regional Official Plan Amendment (ROPA) 30 under section 17 of the *Planning Act*. This approval was intended to support the planned growth of Peel Region and Caledon to 2031. Initially the Chickadee Lane Rounding Out Area B lands were not included under the ROPA 30 area of expansion; however, in November 2020, the ROPA for the Chickadee Lane Site was approved through the Local Planning Appeal Tribunal (LPAT) in Fall 2020. This CEISMP Report is intended to support the planned Chickadee Lane Settlement Area boundary expansion.



Legend

- Study Area (10.08 ha)
- Limit of Greenbelt Protected Countryside

0 25 50 75 100
metres

N

DRAWN: B. Elder
CHECKED: D. Janas
PROJECT: 1701603
DATE: Dec 23, 2020

Scale 1:4000
UTM Zone 17N
NAD 1983

Data Sources: Imagery ©2017 Google (southern portion). Overview basemap credits at page bottom.

Prepared by:

Palmer™

CLIENT: Brook Valley Homes
PROJECT: Chickadee Lane Ecology

Site Location

FIGURE 1

Document Path: G:\Shared drives\Projects 2017\17016 - Brook Valley Homes\1701603 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\170163_Figure1_Site_Eco.mxd

1.2 Report Goals and Objectives

This CEISMP Part A report was prepared to build upon the approved Phase 3 Preliminary Natural Heritage System study undertaken by Dougan & Associates (2014) for the BRES Area. The Dougan report is included in **Appendix A** for reference.

In 2017, Palmer initiated this study focusing on the Chickadee Lane Rounding Out Area B lands, to update and build upon the work completed by Dougan & Associates up until 2014. The Palmer study includes an initial characterization of the existing environmental conditions, an assessment of data gaps to be addressed in Part B, and most importantly, includes additional technical analysis and status updates to the Dougan & Associates 2014 report leading to detailed definition of the natural heritage constraints to development and opportunities for a Natural Heritage System (NHS) within the Chickadee Lane study area.

The Palmer Part A report also provides updated results, where applicable, from the various technical disciplines related to the natural environment including: terrestrial ecology, fisheries, hydrogeology, hydrology, surface water quality, geotechnical and geomorphology. The scope and extent of the updated results for each discipline reflects changes to agency approval requirements that occurred after 2014 and technical updates based on new information.

Ultimately, the findings of this report will form the basis for completion of a CEISMP Part B and Part C reports. These subsequent reports will bring together the existing natural environmental conditions and development constraints with the proposed development framework, to design a functional and sustainable system.

2. Environmental Policy

The Chickadee Lane Rounding Out Area B lands are part of the Bolton Residential Expansion Lands (BRES) Regional Official Plan Amendment (ROPA 30) and include lands which are currently outside of the urban boundary and within Greenbelt Plan lands designated as Protected Countryside. Within the Greenbelt lands, there are areas on the west portion of the Site designated as part of the Natural Heritage System, associated with significant woodland and a series of small watercourse features. Based on work completed by Dougan & Associates, a significant woodland is also located adjacent to the Site to the east, which is also within the Protected Countryside designation. The Site is located within the Humber River Watershed, under the jurisdiction of the Toronto and Region Conservation Authority (TRCA).

2.1.1 Greenbelt Plan

The Site contains lands designated as part of the Greenbelt (**Map A**). Under the Greenbelt Plan, lands through the western and eastern corners of the property are designated as part of the Natural Heritage System of the Protected Countryside. Proposed development must demonstrate that there will be no negative impacts to key natural heritage features and key hydrologic features or their function as well as no negative impact on biodiversity or connectivity of the Natural Heritage System.

Under the policies of the Greenbelt Plan, within the plan area a minimum vegetation protection zone (MVPZ) is to be established to protect key natural heritage features and key hydrological features. For

significant woodlands, fish habitat, and permanent and intermittent streams, the minimum vegetation protection zone shall be a minimum of 30 m measured from the outside boundary of the key natural heritage feature. Section 4.2.3 of the Greenbelt Plan provides policies for stormwater management infrastructure in the Protected Countryside.

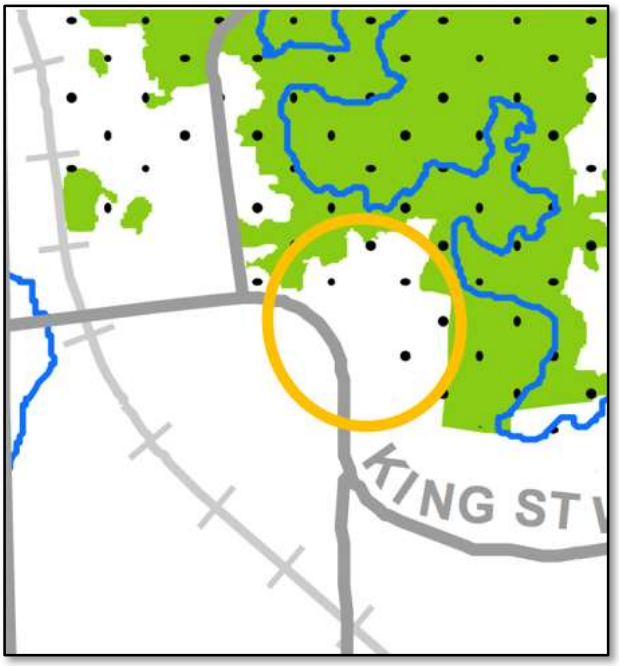
Map A. Detailed Mapping of the Greenbelt Plan [Greenbelt shown in green]

2.1.2 Region of Peel Official Plan

The natural heritage features in the Region of Peel are protected by its Greenlands System. Schedule A of the Region of Peel's Official Plan (OP) identifies the northwestern portion of the Site within areas designated as Core Areas of the Regional Greenlands System (**Map B**).

The OP states that *Core Areas "represent provincially and regionally significant features and areas and are considered a sub-set of what would be significant under Section 2.1 of the PPS"*.

The Greenlands System in the Region of Peel consists of Core Areas, Natural Areas and Corridors, and Potential Natural Areas and Corridors. The System is intended to support the Region's vision for the protection of the environment. The Region of Peel provides direction to area municipalities to develop criteria and thresholds for woodlands identified as Natural Areas and Corridors and Potential Natural Areas and Corridors in accordance with criteria provided by the Region.



Map B: Region of Peel Official Plan Schedule A [Core Areas of the Greenland System shown in green]

2.1.3 Town of Caledon Official Plan

Schedule C of the Town of Caledon Official Plan identifies designated Environmental Policy Area (EPA) through the western section and adjacent to the southeastern corner of the Site (**Map C**). These EPAs are within designated Protected Countryside under the Greenbelt Plan. On **Map C**, the EPA area is represented in olive green, Jack Garratt Soccer Park (Open Space Policy Area) as mid-green, while other lands within the Greenbelt area are represented by green polka dots.

Environmental Policy Area includes all Natural Core Areas and Natural Corridors. As stated in OP Section 5.7.3.1.1, new development is prohibited within areas designated EPA on the OP Land Use Schedules, with the exception of the specified permitted uses. Areas within the Greenbelt Protected Countryside designation, are subject to provisions of the Greenbelt Plan outlined in Sections 7.13.4.5 in the OP.

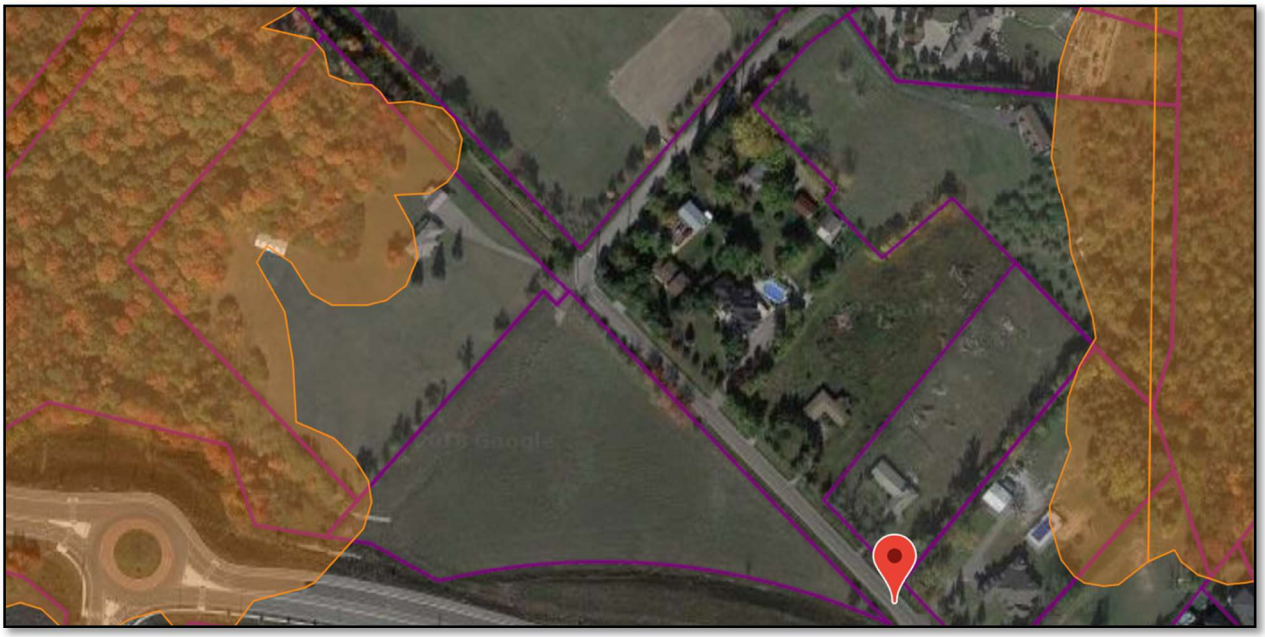
Map C: Caledon Official Plan Schedule C [Environmental Policy Area shown in solid olive green]

2.1.4 TRCA Ont. Reg. 166/06 and the Living City Policies and Regulations

Relevant TRCA regulations and policies for the Site include the following:

- Ontario Regulation 166/06 - *Development, Interference with Wetlands and Alterations to Shorelines and Watercourses*. Through this regulation, TRCA regulates activities in natural and hazardous areas (e.g., areas in and near rivers, streams, floodplains, wetlands, and slopes and shorelines).
- *The Living City Policies* (TRCA 2014) and associated *Planning and Development Procedural Manual* (TRCA January 2008a). These documents present TRCA's planning and permit review practices and technical guidelines. Relevant policies will be discussed in applicable sections of this report.

Regulated Area lands exist within the limits of the Site, at the northwestern and southeastern corners, in association with a series of small watercourse features (**Map D**). The hydrological and ecological functions and importance of lands within the Regulated Areas will have to be identified and development within these areas will be subject to approvals and permitting from the TRCA.



Map D. TRCA Regulated Areas (orange)

PART A – EXISTING ENVIRONMENTAL CONDITIONS AND GAP ANALYSIS

3. Existing Environmental Conditions

3.1 Aquatic Ecosystems

3.1.1 Background Conditions

The inventory of aquatic features by Dougan & Associates was completed to record the presence of water, instream habitat and flow conditions during the typically dry season of August 2013. The information collected was used to determine management recommendations for the watercourses in the Rounding Out Areas for incorporation into the preliminary Natural Heritage System (NHS). On October 15, 2013, Dougan & Associates electrofished all locations that held water on August 23, 2013, as well as other select locations using a Halltech Model HT 2000 backpack electrofisher. Dougan & Associates completed aquatic habitat assessments within the Rounding Out Areas, including the Chickadee Lane study area, in early December 2013.

Headwater Drainage Feature Assessments conducted as part of the Dougan & Associates Environmental Impact Study (June 2014), were completed in November for the larger BRES Expansion Area and are noted in the 2014 report as preliminary and requiring review and further field work at a later date.

Since the preparation of Phase 3 Preliminary Natural Heritage System study by Dougan & Associates (2014) (**Appendix A**), the Chickadee Lane Rounding Out Area has been expanded. **Section 3.1.2** below identifies field work completed in 2018 by Palmer to confirm and augment existing aquatic feature and habitat information and to address areas not covered by previous surveys and reporting.

3.1.1.1 Fish and Fish Habitat

To update and supplement the existing background information, Palmer obtained fisheries data from the TRCA online data portal on March 7, 2018. TRCA fish monitoring station HU029WM is located on the Humber River upstream of the Chickadee Lane Study Area. Fish species data from the station is summarized below from monitoring ranging from 2001 to 2016 (**Table 1)**.

Table 1. TRCA Fish Monitoring Station HU029WM Results 2001 - 2016

Scientific Name	Common Name	G-Rank	S-Rank	COSEWIC	SARO
Rhinichthys atratulus	Blacknose Dace	G5	S5	-	-
Salmo trutta	Brown Trout	G5	SNA	-	-
Semotilus atromaculatus	Creek Chub	G5	S5	-	-

Scientific Name	Common Name	G-Rank	S-Rank	COSEWIC	SARO
Etheostoma flabellare	Fantail Darter	G5	S5	-	-
Notemigonus crysoleucas	Golden Shiner	G5	S5	-	-
Etheostoma nigrum	Johnny Darter	G5	S5	-	-
Catostomus commersonii	White Sucker	G5	S5	-	-
Luxilus cornutus	Common Shiner	G5	S5	-	-
Ichthyomyzon sp.	Northern Lamprey sp.			-	-
Rhinichthys cataractae	Longnose Dace	G5	S5	-	-
Hypentelium nigricans	Northern Hog Sucker	G5	S4	-	-
Lepomis gibbosus	Pumpkinseed	G5	S5	-	-
Etheostoma caeruleum	Rainbow Darter	G5	S4	-	-
Noturus flavus	Stonecat	G5	S4	-	-
Lepomis cyanellus	Green Sunfish	G5	S4	NAR	NAR
Notropis rubellus	Rosyface Shiner	G5	S4	NAR	NAR
Lethenteron appendix	American Brook Lamprey	G4	S3		
Pimephales notatus	Bluntnose Minnow	G5	S5	NAR	NAR
Catostomidae sp.	Sucker sp.			-	-
Pimephales promelas	Fathead Minnow	G5	S5	-	-
Percina caprodes	Logperch	G5	S5	-	-

Legend

SARO – Species at Risk in Ontario (MNRF 2018)

S-Rank – Provincial Rank (MNRF 2018)

G-Rank – Global Rank (NatureServe 2018)

COSEWIC – Committee for the Status on Endangered Wildlife in Canada (COSEWIC 2018)

NAR – Not at Risk

3.1.2 Palmer 2018 Field Investigations

To build upon the existing conditions data from Dougan & Associates, in August 2018 Palmer undertook a field program to characterize aquatic features and functions that included a Headwater Drainage Feature (HDF) Assessment and aquatic habitat characterization.

3.1.2.1 Headwater Drainage Feature Assessment

Review of TRCA mapping revealed a potential HDF in the northern portion of the Site. As this feature was previously undocumented, a HDF Assessment was conducted on August 16, 2018. The survey was completed in accordance with the *Evaluation, Classification and Management of Headwater Drainage Features Guideline* (TRCA, 2014). The following parameters were recorded for upstream and downstream during the assessment:

- Feature type;
- Riparian conditions;
- Flow conditions;
- Feature vegetation;
- Feature bankfull widths and depths;
- Sediment deposition/Transport;
- Flow measures;
- Longitudinal gradient;
- Site features; and
- Channel connectivity.

The HDF on the Site is located south of Glasgow Road and flows northeast in the ditch on the southern side of the road (**Photo 1, Figure 2**). The upstream and downstream sections of this feature are defined by the point where the feature becomes the Glasgow Road ditch. The upstream end of the feature is defined by cultural meadow with obligate species and the downstream end is a manicured lawn contained by a ditch and culverts for driveways along Glasgow Road. The upstream and downstream flow was dry during the assessment. There was no evidence of sediment transport or deposition observed. For the upstream feature, the feature and bankfull widths are approximately 4.8 m. For the downstream feature, the feature and bankfull widths are 3.1 m. The riparian vegetation upstream consists of meadow, and manicured lawns are found downstream. This feature is not entrenched into the floodplain and there is no channel connectivity present. The culvert observed downstream is buried under a driveway and conveys flows in the ditch adjacent to the road. The HDF is screened below in accordance with the TRCA protocol (**Table 2**). Based on the desktop screening, field assessment and application of the TRCA protocol, there is no management required for this HDF.

Table 2. TRCA HDF Summary of Functional Classification and Management

Drainage Feature	Step 1		Step 2	Step 3	Step 4	Management Recommendation
	Hydrology	Modifiers	Riparian	Fish Habitat	Terrestrial Habitat	
HDF	Limited Function	No	Contributing	N/A	Limited functions	No Management Required

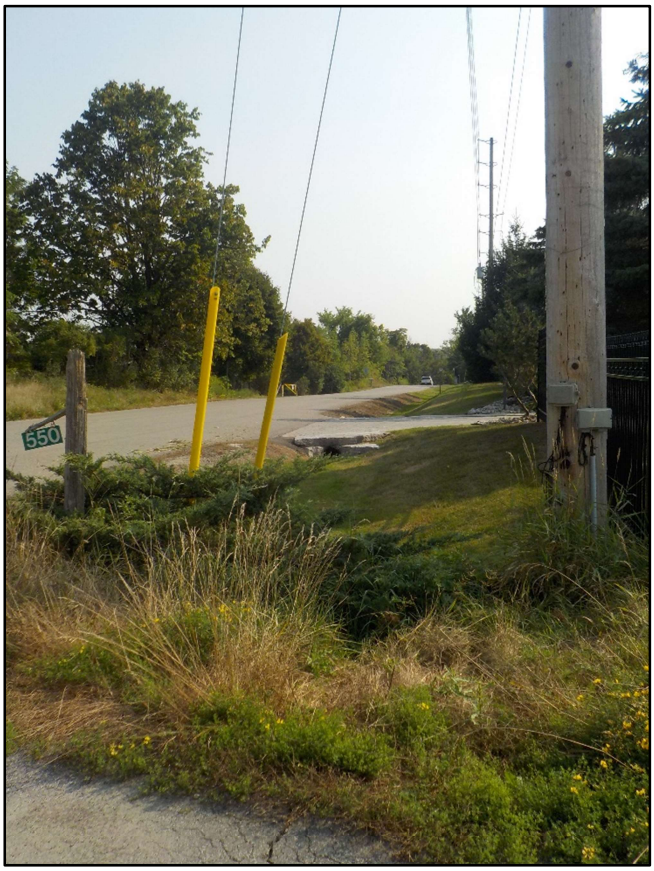


Photo 1. Downstream view of HDF along Glasgow Road

3.1.2.2 Aquatic Habitat Characterization

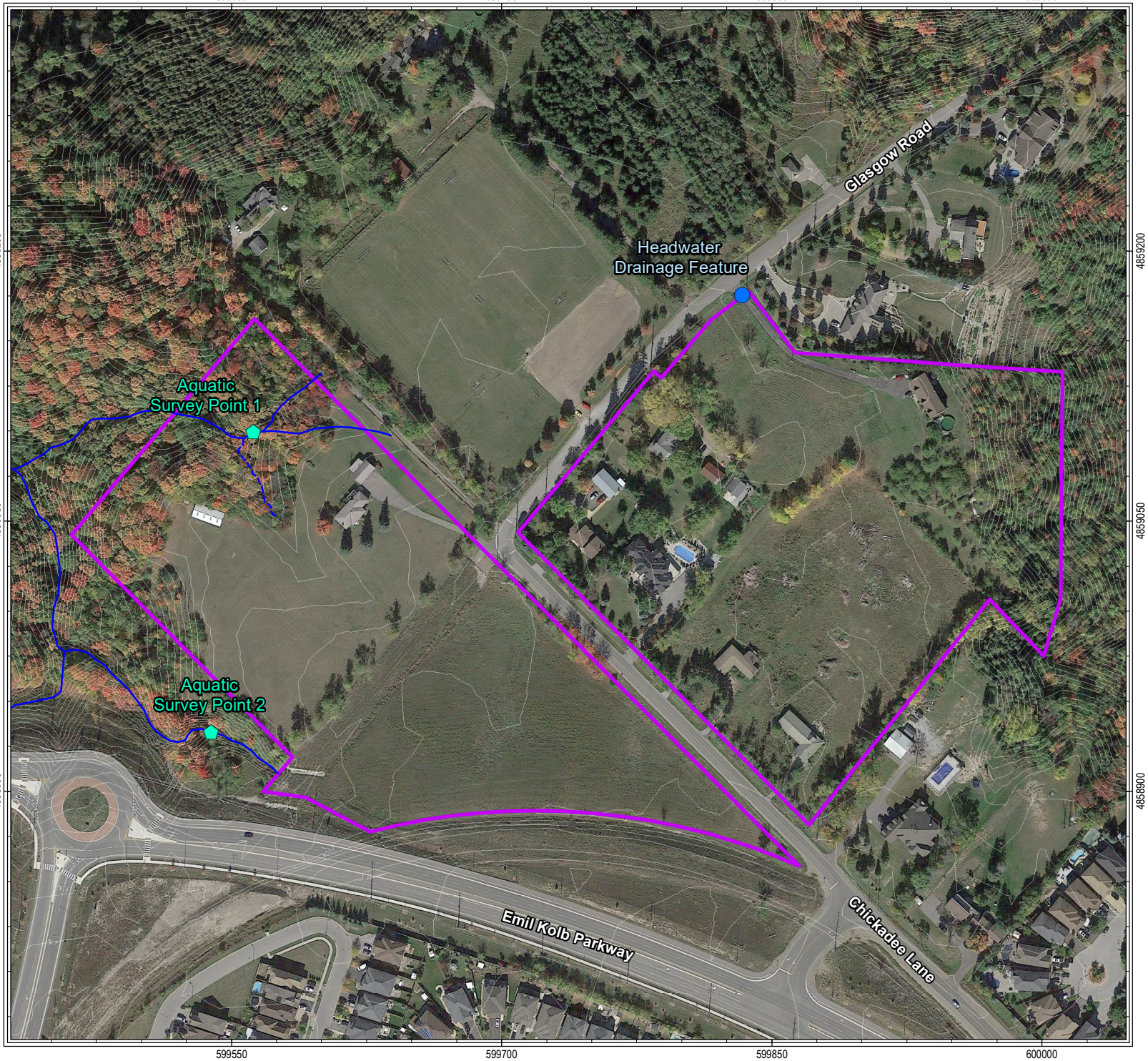
Aquatic assessments were conducted on the Chickadee Lane Study Area to document habitat quality of the surface water features. The survey was conducted on August 16, 2018 at two tributaries of the Humber River on and adjacent to the Chickadee Lane Site (**Figure 2**), recording the following parameters:

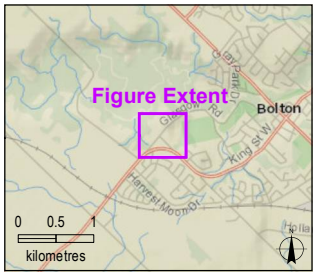
- Identification of in-stream barriers to fish passage;
- Channel morphology measurements (water depth, pool depth, stream width, bankfull width, stream order, habitat structure, pools and riffles);
- Bank undercuts and instream cover;
- Point source impacts (e.g., outfalls, sources of pollution) and surrounding land uses;
- Baseflow, flow regime characteristics (e.g., flashy urban system);
- Water quality;
- Substrate type;
- Critical habitats (spawning, nursery or rearing grounds);
- Riparian cover and shading;
- Groundwater discharge and upwellings;
- Other measurements that indicate the quality of the habitat such as entrenchment, erosion, degradation; and
- Rehabilitation and enhancement opportunities.

Aquatic Survey Point 1

This feature is an ephemeral tributary of the Humber River located in a forested area at the northwest portion of the Site. This intermittent stream was dry during the time of the assessment and exhibits a sinuous pattern throughout the forest floor. There is a potential fish barrier at the upper reach consisting of a culvert and it has been casually hardened with stones, brick and broken tiles. There is a culvert that exits above the location of the assessment (**Photo 2**). Two merging channels were observed at this location. The channel widths range from 2.2 to 3 m in the primary channel. The average width in the secondary channel is 1.3 m. The substrate on the banks and channel consist of fines and cobbles. The left and right bank shape are vertical and the riparian vegetation is mature deciduous forest. The instream cover consists of abundant large woody debris and canopy cover (**Photo 3**). The habitat quality for fish ranges from poor to none, due to the lack of permanent water that restricts spawning, rearing and overwintering opportunities. Groundwater/ surface water assessment completed at this location (MP1 on **Figure 5**) show a strong downwards hydraulic gradient indicating that this channel loses water to the water table and is not supported by groundwater discharge. Monitoring data is presented on **Table 6**.

Photo 2 and 3. Aquatic Survey Point 1





Legend

- Headwater Drainage Feature
- Aquatic Survey Point
- Watercourse
- Secondary Channel
- Contour (1 m)
- Study

0 25 50 75
metres

N

DRAWN: B. Elder
CHECKED: R. Augustine — Scale 1:3000
PROJECT: 1701603 — UTM Zone 17N
DATE: Dec 23, 2020 — 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

Existing Aquatic Conditions

FIGURE 2

Document Path: G:\Shared drives\Projects 2017\17016 - Brook Valley Homes\1701603 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\2020\1701603_Figure2_Aquatic Conditions.mxd

Aquatic Survey Point 2

This section of the Humber River is located in a forested area southwest of the Site. This intermittent stream was dry in some areas at the time of assessment and exhibits an irregular wandering to sinuous pattern throughout the forest floor (**Photo 4**). There were no fish barriers observed during the assessment. The average width in the channel is 5.2 m. The wetted width ranges from 15 to 30 cm. The bankfull depth ranges from 0.5 to 5 cm. The substrate on the banks and channel is dominated by clay with scattered boulders. The left and right bank shape are vertical and the riparian vegetation consists of a young forest with shrubs and deciduous trees. The instream cover consists of trace amounts of woody debris, vascular plants, overhanging vegetation and boulders. There was garbage and debris observed in the channel during the aquatic assessment. The habitat quality for fish ranges from poor to none, due to the lack of permanent water that restricts spawning, rearing and overwintering opportunities.

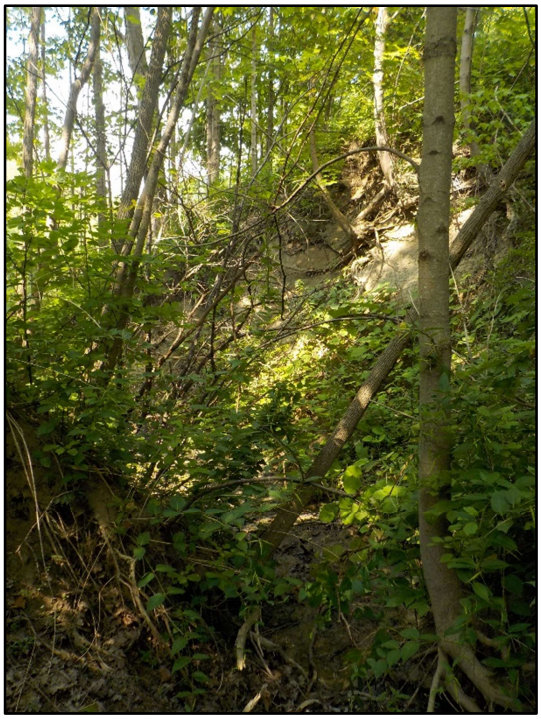


Photo 4. Aquatic Survey Point 2

3.2 Terrestrial and Wetland Ecosystems

3.2.1 Background Conditions

In November and December 2013, Dougan & Associates collected Ecological Land Classification (ELC) data for the Rounding Out Areas, including the Chickadee Land Study Area. All properties with potential significant natural heritage features were visited. Additionally, adjacent lands to 120 m beyond the boundaries of the study area were assessed.

Additional visits were made by Dougan & Associates to screen for seasonal indicators of Significant Wildlife Habitat in October and November 2013, with particular attention paid to open country Species at Risk (SAR) birds, for which potential suitable habitats are presumed to exist on may sites within the overall BRES study area, including Barn Swallow, Bobolink and Eastern Meadowlark. Other key wildlife habitat, including Significant Wildlife Habitat and habitats for other potentially occurring SAR, such as Chimney Swift and Monarch were also assessed. The Dougan & Associates report identifies the need for further field investigations in subsequent phases of study to support the identification/confirmation of SWH within the Site. To support this, Dougan & Associates conducted preliminary roadside breeding bird surveys in early July 2013.

Field-collected data was used by Dougan & Associates to develop a preliminary NHS for the Chickadee Lane Rounding Out Area (**Appendix A**). The NHS includes the identification of Significant Woodlands through the eastern and western sections of the Site. The NHS identifies an enhancement/restoration area based on ELC communities (e.g. successional habitats or cultural woodlands) within the southeastern corner of the current Chickadee Lane Study Area. No wetland communities were identified within or adjacent to the Chickadee Lane Site.

As previously noted, since the preparation of Phase 3 Preliminary Natural Heritage System study by Dougan & Associates (2014), the Chickadee Lane Rounding Out Area has been expanded. Data collected as part of the 2014 reporting has been reviewed and incorporated as applicable. Section 3.2.2 below identifies field work completed in 2018 by Palmer to confirm and augment existing terrestrial feature and habitat information and to address areas not covered by previous surveys and reporting.

3.2.2 Palmer 2018 Field Investigations

To characterize terrestrial natural heritage features and functions and to determine the potential limits of development, Palmer undertook a field program in June and August 2018 that included breeding bird surveys, ELC, assessment of significant natural heritage features, a preliminary assessment of significant wildlife habitat and Species at Risk habitat, and a staking of the vegetation dripline.

3.2.2.1 Breeding Birds

Breeding bird surveys were conducted at the Site to document the bird communities in the following habitats: wooded upland, meadow and residential anthropogenic areas. Two surveys were completed seven or more days apart within the regional breeding season following Ontario Breeding Bird Atlas Protocols (Bird Studies Canada 2001). The two surveys were carried out on June 1 and June 26, 2018

between 06:45 and 09:00 to coincide with the dawn chorus. Weather conditions during the surveys were 25-60% overcast, with light breezes, no precipitation and temperatures of 15°C and 19°C, respectively.

A total of 21 bird species were documented on the property, including one Species of Conservation Concern. Specifically, an Eastern Wood Pewee (*Contopus virens*) was heard singing in the forested area in the western corner of the Site on both site visits. This indicates that this species was on an established territory and probably breeding on the Site. The species is listed as Special Concern both provincially and federally. Most of the birds recorded on the property are considered common (**Appendix B**). The most common species found on the Site included birds characteristic of open areas, such as Red-winged Blackbird (*Agelaius phoeniceus),* American Goldfinch (*Spinus tristis*) and Song Sparrow (*Melospiza melodia*).

Area-sensitive species require large areas of continuous habitat for breeding and foraging. The specific habitat requirements vary by species. One area-sensitive species was observed within the Site: White-breasted Nuthatch (*Sitta carolinensis*). This species was recorded on two visits, both on the edge of the forest community through the western corner of the Site and near the houses, just south of Glasgow Road. The White-breasted Nuthatch uses natural cavities in trees with a diameter at breast height (DBH) greater than 30 cm and requires at least 10 ha of continuous forest. Based on the locations of the observations and the habitat preferences of this species, it is inferred that the woodland west of the Site is considered its established territory. While considered an area-sensitive species, White-breasted Nuthatch is not an indicator of Woodland Area-sensitive Bird Breeding Habitat SWH, for which the indicator species typically require greater than 30 ha.

3.2.2.2 Vegetation Communities

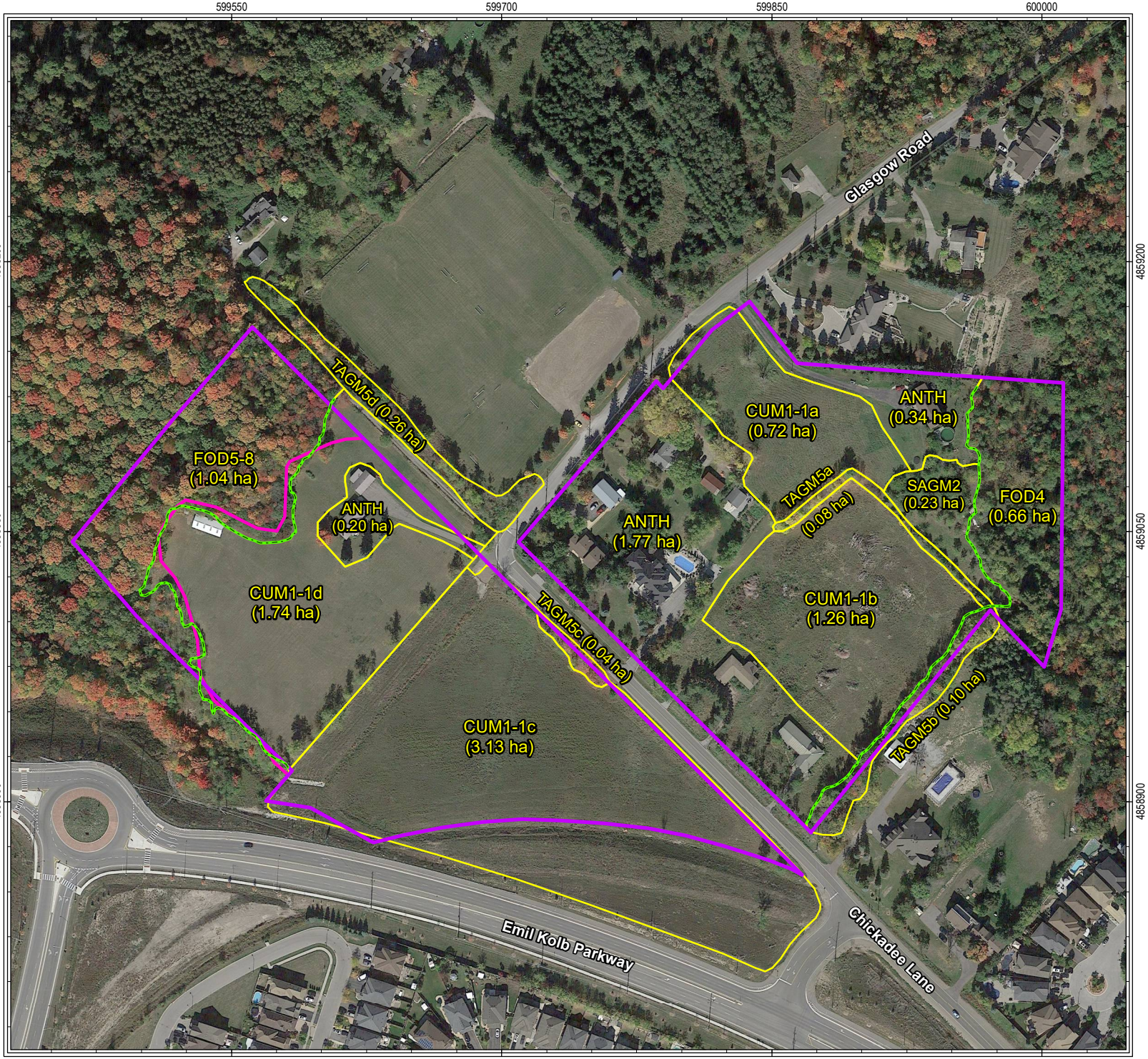
A field survey was conducted on August 16, 2018 to document the vegetation communities, natural features, and general site conditions on the Chickadee Lane properties, and to confirm and update the Natural Heritage System developed by Dougan & Associates (2014). Vegetation communities were mapped and described according to the Ecological Land Classification (ELC) system for southern Ontario (Lee et al., 1998) and 2008 update tables. Existing environmental conditions are shown on **Figure 3** with a summary of communities provided below. Representative photos of vegetation communities are also provided (**Photos 5 to 13**). A plant species list is provided in **Appendix C**.

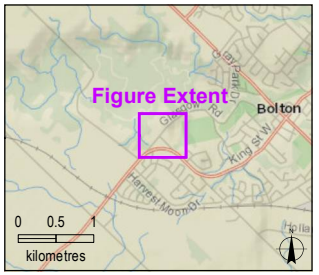
Most of the Site is tablelands characterized by cultural meadow (Dry-Moist Old Field Meadow (CUM1-1)) and there are forested valleys located along the eastern and western Site boundaries. An orchard is located on a former rural residential property at the east corner of the Site. In the anthropogenic portion of the Site, it is understood that the homes have been demolished subsequent to fieldwork; however, fencerows remain that outline many of the former individual properties.

Cultural (CU)

Dry – Moist Old Field Meadow (CUM1-1a)

This cultural meadow has a canopy consisting of scattered Manitoba Maple (*Acer negundo*), providing 0 to 10% cover at a height of 10 to 25 m (**Photo 5**). There is no subcanopy or understorey present in this community. The ground layer is dominated by non-native Smooth Brome (*Bromus inermis*). This area is





Legend

- Palmer Staked Dripline (August 16 2018)
- Long Term Stable Slope Line (LTSSL)
- ELC Community
- Study Area (10.08 ha)

Vegetation Communities

Cultural (CU)
Dry – Moist Old Field Meadow (CUM1-1)

Forest (FO)
Dry- Fresh Deciduous Forest (FOD4)
Dry – Fresh Sugar Maple – White Ash Deciduous Forest (FOD5-8)

Shrub Agriculture (SAG)
Orchard (SAGM2)

Treed Agricultural (TAG)
Fencerow (TAGM5)

Anthropogenic (ANTH)

0 25 50 75
metres

N

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

Scale 1:3000
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

Existing Terrestrial Conditions

FIGURE 3

Document Path: G:\Shared drives\Projects 2017\17016 - Brook Valley Homes\1701603 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\20201701603_Figure3_Existing Terrestrial Conditions.mxd

relatively level and somewhat low lying (containing the HDF) and forms the front yard of a former rural residence.

Dry – Moist Old Field Meadow (CUM1-1b)

This cultural meadow is dominated by Bentgrass (*Agrostis* sp.) with Canada Goldenrod (*Solidago canadensis*), Queen Anne's Lace (*Daucus carota*) and other common cultural meadow species (**Photo 7**). There is a random distribution of White Poplar (*Populus alba*) and Manitoba Maple throughout the meadow. There is a large pile of dead trees located in the centre of the community.

Dry – Moist Old Field Meadow (CUM1-1c)

This large cultural meadow is dominated by Bentgrass and Canada Goldenrod with Creeping Thistle (*Cirsium arvense*), Queen Anne's Lace and other typical cultural meadow species (**Photo 8**). There is a patch of Broad-leaved Cattail (*Typha latifolia*) along Chickadee Lane. This area is very level and it is suspected that the area was graded at some point for agriculture or in relation to the construction of Emil Klob Parkway.

Dry – Moist Old Field Meadow (CUM1-1d)

This large cultural meadow is the yard of a former rural residence, and is dominated by Kentucky Bluegrass (*Poa pratensis*), Canada Goldenrod, Queen Anne's Lace and Smooth Wild Strawberry (*Fragaria virginiana*) (**Photo 9**). There are nine to ten large Silver Maples (*Acer saccharinum*) located along the southern property line of the former rural home. There are also three large White Spruce (*Picea glauca*), one Sugar Maple (*Acer saccharum*), and several landscape shrubs surrounding the home. The terrain of this area is somewhat rolling, with a gradual grade towards the forest found in the northwest corner of the Site.

Forest (FO)

Dry – Fresh Sugar Maple – White Ash Deciduous Forest (FOD5-8)

This forest community has a canopy cover dominated by Sugar Maple with Green Ash (*Fraxinus pennsylvanica*) and Ironwood (*Ostrya virginiana*), providing 25 to 60% cover at a height >25 m (**Photo 10**). The subcanopy is composed of scattered Sugar Maple, Green Ash and Ironwood, providing 0 to 10% cover at a height of 2 to 10 m. The understorey is composed of scattered Chokecherry (*Prunus virginiana*), providing 0 to 10% cover at a height of 1 to 2 m. The ground layer is dominated by Small Enchanter's Nightshade (*Circaea alpina*), providing 10 to 25% cover at a height less than 0.2 m. This forest commences at the end of the tablelands of the Site and is found on steeper slopes associated with drainage features (Section 5.3.2.2). The forest dripline (**Figure 3**) is relatively analogous with the Top of Slope of this forested valley feature.

Dry – Fresh Deciduous Forest (FOD4)

This forest community has a canopy dominated by American Basswood (*Tilia americana*), providing 0 to 10% cover at a height greater than 25 m (**Photo 6**). The subcanopy is also dominated by American Basswood with Green Ash (*Fraxinus pennsylvanica*), providing 25 to 60% cover at a height of 2 to 10 m. The understorey is composed of non-native European Buckthorn (*Rhamnus cathartica*), providing 10 to 25% cover at a height of 1 to 2 m. The ground layer is composed of European Buckthorn and Canada Goldenrod (*Solidago canadensis*), providing 10 to 25% cover at a height of 0.5 to 1 m. The topography of

this feature is also relatively steep, with the dripline here also analogous to the Top of Slope within the Site.

Shrub Agriculture (SAG)

Orchard (SAGM2)

This orchard contains a variety of Apple (*Malus* sp.), Mulberry (*Morus* sp.), Pear (*Pyrus* sp.) and Cherry (*Prunus* sp.) trees (**Photo 11**). The ground cover is dominated by Common Teasel (*Dipsacus fullonum*) and Quackgrass (*Elymus repens*), relatively similar to the CUM1-1a area found immediately to the west. The orchard is separated from the FOD4 forest to the east by a break in canopy prior to the Top of Slope and the change in species composition from the FOD4 slope, which is dominated by American Basswood.

Treed Agricultural (TAG)

Fencerow (TAGM5a)

This fencerow is located at the northeast corner of the property adjacent to a cultural meadow (CUM1-1a). The canopy is composed of mainly Green Ash with Freeman's Maple (*Acer freemanii*), Eastern White Pine (*Pinus strobus*), Apple, Red Oak (*Quercus rubra*), and Norway Spruce (*Picea abies*) (**Photo 12**). The understorey is composed of Cranberry Viburnum (*Viburnum opulus*) and Tartarian Honeysuckle (*Lonicera tatarica*).

Fencerow (TAGM5b)

This fencerow located is located along the eastern property boundary. The canopy is composed of Black Walnut (*Juglans nigra*) with Eastern Cottonwood (*Populus deltoides*), White Spruce, American Elm (*Ulmus americana*), American Basswood and Silver Maple. The understorey is occupied by Manitoba Maple, American Basswood and American Elm with some Silver Maple and White Spruce.

Fencerow (TAGM5c)

This small fencerow is located along Chickadee Lane. The canopy is composed of four Sugar Maple and one Green Ash in the canopy. The understorey is composed of European Buckthorn, Black Walnut and American Basswood.

Fencerow (TAGM5d)

This fencerow is located along the northeastern boundary of the former rural residence and is adjacent to the Jack Garratt Soccer Park. The canopy is composed of Ash (*Fraxinus* sp.) and Manitoba Maple (**Photo 13**). There is a large White Willow (*Salix alba*) at the northern end of the fencerow.

Photo 5. Dry – Moist Old Field Meadow (CUM1-1a)

Photo 6. Dry- Fresh Deciduous Forest (FOD4)

Photo 7. Dry – Moist Old Field Meadow (CUM1-1b)

Photo 8. Dry – Moist Old Field Meadow (CUM1-1c)

Photo 9. Dry – Moist Old Field Meadow (CUM1-1d)

Photo 10. Dry – Fresh Sugar Maple – White Ash Deciduous Forest (FOD5-8)

Photo 11. Orchard (SAGM2)

Photo 12. Fencerow (TAGM5a)

Photo 13. Fencerow (TAGM5d)

3.2.2.3 Species at Risk

Consultation with MNRF was undertaken with respect to Species at Risk (SAR) within the broader Bolton Residential Expansion Study Area. A request for natural heritage features and element occurrences for the Chickadee Land Study Area was submitted to the MNRF as part of the preparation of this Part A Report. *It is noted that as of 2019, responsibility for SAR has transferred to the Ministry of Environment, Conservation and Parks (MECP), but as correspondence regarding SAR for this report was completed with the MNRF before the name change, MNRF rather than MECP will be used in this report.*

No SAR specific surveys were conducted as part of the Dougan & Associates 2014 study for the Chickadee Lane Rounding Out Area. Dougan & Associates identified the need for field studies to confirm the status of SAR within the study area, during subsequent phases of study.

For the purposes of this report, SAR include species listed as Endangered, Threatened or Special Concern under Ontario's *Endangered Species Act* (ESA). The protection provisions for species and their habitat within the ESA apply only to those species listed as Endangered or Threatened on the SARO list. Special Concern species may be afforded protection through policy instruments respecting significant wildlife habitat as defined by the Province or other relevant authority, or other protections contained in OP policies.

Palmer sent a data request to the Aurora District MNRF and received a letter response including records of Species at Risk for the Chickadee Land Study Area on July 5, 2018. The following Species at Risk were recorded as occurring on or adjacent to the Site:

- Butternut (*Juglans cinerea*) (Endangered)
- Barn Swallow (*Hirundo rustica*) (Threatened)
- Bobolink (*Dolichonyx oryzivorus*) (Threatened)
- Eastern Meadowlark (*Sturnella magna*) (Threatened)
- Eastern Wood-Pewee (*Contopus virens*) (Special Concern)
- Snapping Turtle (*Chelydra serpentina*) (Special Concern)
- Wood Thrush (*Hylocichla mustelina*) (Special Concern)

The following species have the potential to occur in the vicinity of the Site according to the MNRF:

- Eastern small-footed myotis (*Myotis leibii*) (Endangered)
- Little brown myotis (*Myotis lucifugus*) (Endangered)
- Northern myotis (*Myotis septentrionalis*) (Endangered)
- Tri-coloured bat (*Perimyotis subflavus)* (Endangered)

Based on a query of the Natural Heritage Information Centre (NHIC), there are records of Butternut and Snapping Turtle in vicinity of the Site.

Table 3. Habitat Screening for MNRF and NHIC SAR Records

Species	Habitat Requirement Overview	Habitat Suitability
Butternut (tree)	Butternut grows best on rich, moist, well-drained loams often found on stream bank sites but may be found on well-drained gravelly sites, especially those of limestone origin.	Potential
Eastern Wood Pewee	The Eastern Wood-pewee is mostly associated with the mid-canopy layer of forest clearings and edges of deciduous and mixed forests. It is most abundant in forest stands of intermediate age and in mature stands with little understory vegetation.	Present (within Significant Woodland)
Barn Swallow	Prefers farmland; lake/river shorelines; wooded clearings; urban populated areas; rocky cliffs; and wetlands. They nest inside or outside buildings; under bridges and in road culverts; on rock faces and in caves etc.	Absent
Wood Thrush	The Wood Thrush is found in moist, deciduous hardwood or mixed stands, often previously disturbed (e.g., small-scale logging and ice storm damage), with a dense deciduous undergrowth and with tall trees for singing perches.	Potential
Snapping Turtle	Snapping turtles spend most of their lives in water. They prefer shallow waters so they can hide under the soft mud and leaf litter, with only their	Absent

Species	Habitat Requirement Overview	Habitat Suitability
	noses exposed to the surface to breathe.	
Eastern Meadowlark	Generally, prefers grassy pastures, meadows and hay fields. Nests are always on the ground and usually hidden in or under grass clumps.	Potential
Bobolink	Generally, prefers open grasslands and hay fields. In migration and in winter uses freshwater marshes and grasslands	Present
Eastern Small-footed Myotis (bat)	Eastern Small-footed Myotis will roost in a variety of habitats, including in or under rocks, in rock outcrops, in buildings, under bridges or in caves, mines or hollow trees.	Potential
Little Brown Myotis (bat)	Little Brown Myotis often select attics, abandoned buildings and barns for summer colonies where they can raise their young.	Potential
Northern Myotis (bat)	Northern Myotis bats are associated with a range of forests, choosing to roost under loose bark and in the cavities of trees (SARO website). They may also roost in anthropogenic structures.	Potential
Tri-coloured Bat	Tri-colored Bat is found in a variety of forested habitats during the summer. It forms day roosts and maternity colonies in older forest and occasionally in barns or other structures. It forages over water and along streams in forests.	Potential

The results from the Palmer breeding bird survey in June 2018 determined that there is one confirmed Special Concern species, Eastern Wood Pewee, present on the Site observed in the Dry – Fresh Sugar Maple – White Ash Deciduous Forest (FOD5-8) community. While the 2018 field program did not include SAR specific field investigations, candidate habitat was recorded during field surveys within the Study Area. As the cultural meadows on Site have not been maintained in sometime, there is a limited potential for use by grassland bird species, including Bobolink and Eastern Meadowlark; however, it is considered of low quality due to size and adjacent anthropogenic uses. Potential SAR bat habitat was identified in the FOD5-8 woodland, due to the mature trees with potential cavities present. There were no Butternut trees observed during field surveys. It is understood that the abandoned homes on Site have been demolished since fieldwork took place, removing those as potential habitats for Barn Swallow.

Therefore, based on field surveys and the habitat screening provided in **Table 3**, the following SAR have suitable habitat present on the Site:

- Eastern Wood Pewee
- Bobolink

The following SAR have potential suitable habitat on the Site:

- Butternut
- Wood Thrush
- Eastern Meadowlark
- Eastern small-footed myotis
- Little brown myotis
- Northern myotis
- Tri-coloured bat

3.2.2.4 Valleylands

Valleylands, as defined by the Provincial Policy Statement (PPS), are natural areas that occur in a valley or depression in the land that have standing or flowing water for some period of the year (Ministry of Municipal Housing and Affairs, 2020). Important ecological functions are performed by valleyland features including the provision of diverse habitats due to microclimate variations and the connection of natural areas, providing important migration and dispersal corridors for terrestrial, aquatic and avian species.

Valleylands occur to the west and east of the Site. The west valleyland is associated with a tributary of the Humber River, while the east slope is a former oxbow of the Humber River, but now contains tablelands at the base; Edelweiss Park specifically. These “apparent” valleylands are distinguished by an identifiable Top of Slope, which were staked by the TRCA on February 23, 2016. The driplines for the forested corridors through these areas were plotted in the field during 2018 field investigations and are found to be roughly analogous to the staked Top of Slopes. An erosion hazard assessment and an assessment of the Long-Term Stable Slope Line (LTSSL) was completed for the west valleyland is associated with a tributary of the Humber River to determine the appropriate setback (see **Section 6.1.3** for details). For the east slope, as there is table land at the base and no erosion risk, a 10 m set back from the staked top of bank has been applied. Refer to Section 4.1 for further discussion and mapping of the staked Top of Slope and forest driplines in the context of constraint limits as part of the proposed NHS.

3.3 Natural Heritage Features

A Natural Heritage System (NHS) was proposed by Dougan & Associates (2014) for the Chickadee Lane Rounding Out Area (**Appendix A**). This NHS was used as a starting point for the ecological field program conducted in 2018 by Palmer and for assessments of feature significance as part of this report (Section 3.3.1).

Lands within the Site are predominately cultural meadow, with some existing residential homes. A large deciduous forest community extends into the western portion of the property, within the designated

Natural Heritage System of Greenbelt Protected Countryside. This community is classified, according to the TRCA, as a Dry – Fresh Sugar Maple – White Ash Deciduous Forest (FOD5-8), providing a dense canopy cover of greater than 60% (**Figure 3**). This forest community has been identified as a significant woodland and included as part of the NHS as determined by Dougan & Associates (2014).

Along the eastern limit of the Site is a Fresh – Moist White Elm Lowland Deciduous Forest (FOD7-1) and Cultural Thicket (CUT1-A2) as classified and mapped by the TRCA, which provided a dense canopy cover of greater than 60%. The CUT1-A2 area was reclassed by Palmer in 2018 as the FOD4 area, as it was found to be dominated by American Basswood of moderate height, though some degree of cultural influence is evident via the presence of invasive European Buckthorn. These forest communities have been identified as a significant woodland and included as part of the Natural Heritage System identified by Dougan & Associates (2014).

The NHS delineated by Dougan & Associates identified an area for restoration within the 30 m buffer setback of the NHS within the Greenbelt Plan Boundary. The CEISMP Part B Report will address this area and provide recommendations for restoration and enhancement opportunities for the Chickadee Lane Site.

3.3.1 Natural Heritage Feature Significance

Based on the guiding legislation and policies, significant natural heritage features within the Chickadee Lane Site are listed below. The natural heritage features and functions used to delineate the NHS are included in this section.

3.3.1.1 Significant Wildlife Habitat

Significant Wildlife Habitat (SWH) is considered a significant feature in Provincial, Regional, and Municipal (Town of Caledon) policies. The Region of Peel and Town of Caledon have significant wildlife habitat (SWH) policies in conformity with the PPS, although to date there is no Town, MNRF or TRCA data or mapping of SWH features within the Site. Significant Wildlife Habitat (SWH) is defined by the MNRF in the Significant Wildlife Habitat Technical Guide (OMNR 2000) and includes the following broad categories:

- seasonal concentration areas;
- rare vegetation communities or specialised habitats for wildlife;
- habitats of species of conservation concern, excluding the habitats of endangered and threatened species; and
- animal movement corridors.

Criteria for the identification of these features are provided in the *Significant Wildlife Habitat Criteria Schedules for Ecoregion 7E* (MNRF, 2015). These criteria were used to screen wildlife habitat within the Site for potentially significant wildlife habitat.

A preliminary assessment by Dougan & Associates in October and November 2013 did identify some candidate SWH areas. In general, SWH is usually aligned with specialized habitats such as wetlands, larger forested areas, extensive successional cover, or vegetated valleylands and, as such, each of these areas are included within the proposed NHS (Dougan & Associates, 2014).

Considering the Dougan & Associates NHS, the 2018 Palmer field assessment determined a moderate potential for specific SWH types within the Site boundary. The Site is predominately cultural meadow with some existing residential homes. Large and contiguous natural heritage features predominately occur adjacent to the Site, with the exception of the forested area that extends into the Site's western and eastern corners. **Table 4** presents potential SWH that has been identified for the Chickadee Lane Site.

Table 4. Potential Significant Wildlife Habitat

Potential/Candidate SWH	Location	Comment
Candidate SWH for Waterfowl Stopover and Staging Area (Terrestrial) (per Ecoregion 7E criteria) for ducks	In association with the Dry – Moist Old Field Meadow (CUM1-1)	This is unlikely, as the concentrations of waterfowl required to confirm the SWH type (100 or more individuals) would be a noted occurrence in the area.
Reptile Hibernaculum	In woody debris piles at Dry – Moist Old Field Meadow (CUM1-1b)	Review of historical GoogleEarth imagery shows that these piles were not present prior to 2016, and the development of hibernacula habitat in the subsequent years is unlikely, as time for the debris to settle and develop pockets below the frost line is improbable.
Raptor Wintering Area	In the Dry – Fresh Sugar Maple – White Ash Deciduous Forest (FOD5-8)	Turkey Vultures (*Cathartes aura*) were observed in flyovers of the nearby Dry – Moist Old Field Meadow (CUM1-1b). Due to the expected preservation and protection of the Significant Woodland, none of this habitat is likely to be affected.
Old Growth Forest	In Dry – Fresh Sugar Maple – White Ash Deciduous Forest (FOD5-8).	Only a small portion of the potential Old Growth Forest in this community is on the Site. Due to the expected preservation and protection of the Significant Woodland, none of this habitat is likely to be affected.
Bat Maternity Roost Habitat	May be present within the Dry – Fresh Sugar Maple – White Ash Deciduous Forest (FOD5-8).	As the Significant Woodland is expected to be preserved and protected, no loss of bat maternity roost habitat is expected, and no further studies are likely to be necessary.

The determination of whether significant wildlife habitat is present within the Chickadee Lane Rounding Out Area B lands may require more detailed study. Additional field data, focused on identifying/confirming SWH during subsequent phases of study (Part B) will confirm and refine this information, as required.

3.3.1.2 Species at Risk

The results from the Palmer breeding bird survey in June 2018 determined that there is one confirmed Special Concern species, Eastern Wood Pewee, present on the Site observed in the Dry – Fresh Sugar Maple – White Ash Deciduous Forest (FOD5-8) community. Potential SAR bat habitat was also identified in the FOD5-8, due to the mature trees with potential cavities present. There were no Butternut (*Juglans cinerea*) trees observed during field surveys.

Field investigations to be conducted as part of subsequent study phases (Part B) will further assess the potential presence of SAR within the Site based on the SAR records provided by MNRF and on the SAR habitat screening presented in Section 3.2.2.3. The need for SAR field investigations to be conducted as part of subsequent study phases (Part B) is discussed in Section 4.1.1 below.

3.3.1.3 Wetlands

No provincially significant wetlands (PSW), evaluated non-PSW, or unevaluated wetlands have been identified within the Chickadee Lane Rounding Out Area B lands or within adjacent lands (within 120 m of the Site boundary). No further study of wetlands is considered necessary for this project.

3.3.1.4 Significant Woodlands

Criteria for determining woodland significance are provided in the Region of Peel Official Plan and in the Natural Heritage Reference Manual (NHRM) (OMNR, 2010). The deciduous forest (FOD5-8) through the western portion of the Site qualifies as Core Woodland (as mapped in the Peel Official Plan, Schedule A) and is therefore considered significant. The woodlands to the east of the Site are designated as Environmental Policy Area within the Town of Caledon OP, and should also be treated as significant.

3.3.1.5 Significant Valleylands

The Region of Peel has significant valleyland policies in conformity with the PPS. Significant valleylands are represented in the vicinity of the Chickadee Lane Rounding Out Area B lands by ravines of the main branch and major tributaries of the Humber River. Valleylands have been included where appropriate within the proposed NHS. Where valley features are evident, the natural heritage and hazard features including woodland limits, Top of Slope, and the Long-Term Stable Slope Line (LTSSL) are used to determine appropriate setbacks/buffers relevant to applicable policies.

3.3.1.6 Fish and Fish Habitat

One headwater drainage feature was assessed following TRCA protocol as part of 2018 field investigations (**Figure 2**). Based on this assessment, no management is required for this HDF. The HDF was determined to not hold opportunities for fish habitat.

The aquatic features within and adjacent to the Site fall within the FOD5-8 woodland. The habitat quality of these features for fish ranges from poor to none, due to the lack of permanent water that restricts spawning, rearing and overwintering opportunities. These aquatic features are afforded protection within the significant woodland features and its setbacks and buffers.

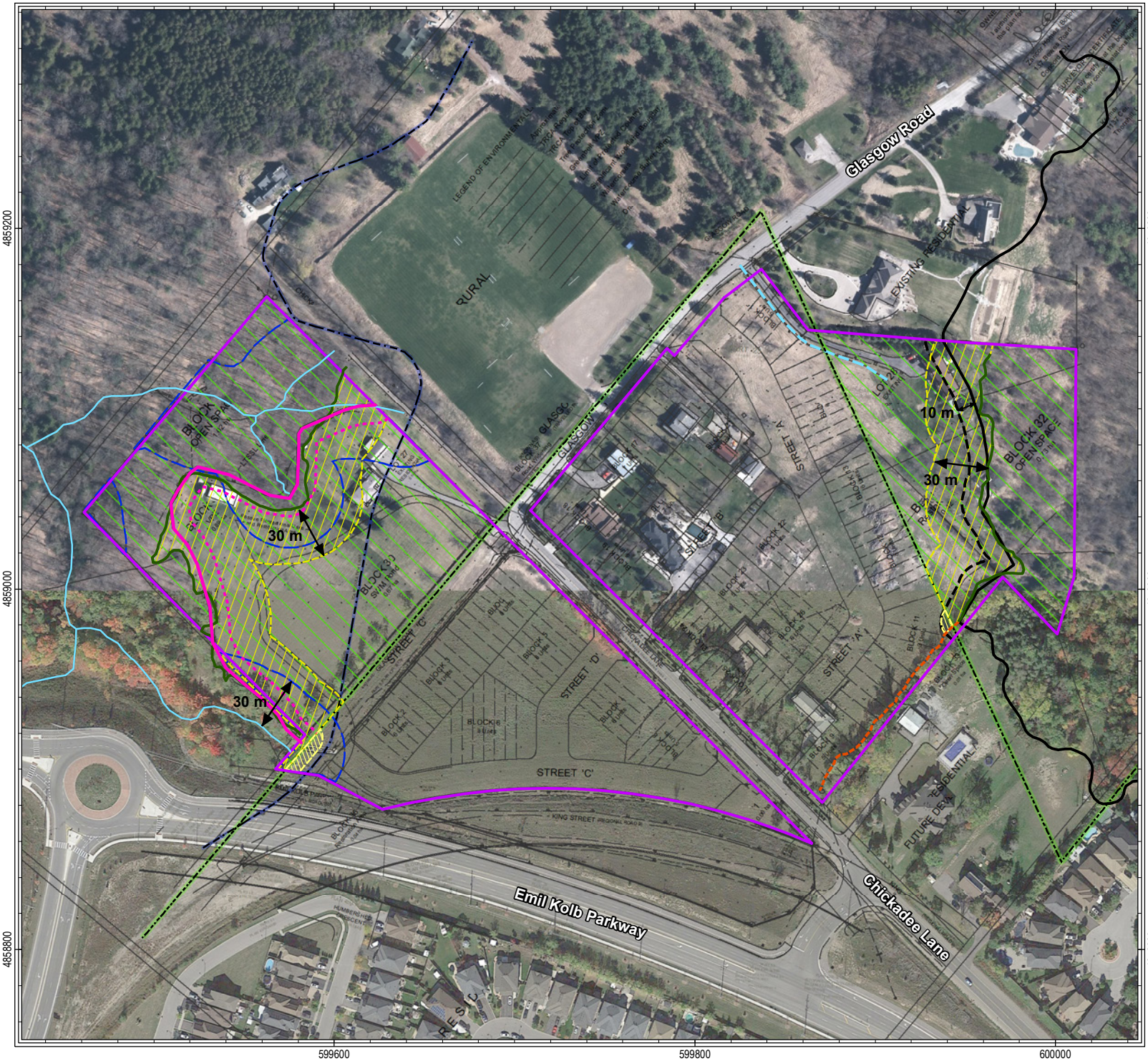
4. Natural Heritage System

Using the background information reviewed and consolidated as part of this Part A report, as well as recent 2018 field investigations, natural heritage planning policy and agency consultation, an updated natural heritage system has been developed for the Site (**Figure 4**). This figure depicts significant natural heritage features which require protection and setback widths informed by relevant policy and regulation. A refined assessment of natural heritage features and functions and the establishment of the development limits is addressed in greater detail in the Part B report (**Sections 8 and 9**) based on the results of this Part A study and the details of the proposed development at the Site (**Section 8**).

4.1 Environmental Constraint Analysis

Natural heritage constraints have been determined through field investigations, assessment of significance and agency consultation. The following are constraints that require avoidance or mitigation with respect to the proposed development:

- The western portion of the Site is designated as part of the NHS of the Greenbelt Plan Protected Countryside. Development and site alteration are prohibited within key natural heritage features (i.e. significant woodland), key hydrological features (i.e. permanent and intermittent streams), and their minimum vegetation protection zone (30 m).
- The eastern corner of the Site is designated as part of the NHS of the Greenbelt Plan Protected Countryside. Development and site alteration are prohibited within key natural heritage features (significant woodland) and its minimum vegetation protection zone (30 m)
- For the above features, areas outside the Greenbelt Plan area are subject to regional and municipal setbacks that relate to the PPS and TRCA policy, as per the Greenbelt Plan Technical Paper (OMNR, 2012).
- The LTSSL has been determined in the western portion of the Site associated with valleylands for a tributary of the Humber River and a 10 m erosion hazard limit established.
- The top of slope and natural features limit line was staked by the TRCA (February 2016) through the eastern portion of the property. A 10 m setback has been applied to the top of slope line to address setback from the hazard lands, and a 10 m vegetation protection zone has been established from the staked natural features limit as required under TRCA development policies.
- Within the fencerow extending from the eastern corner of the Site to the south, the trees are located on the adjacent property. Tree protection fencing should be erected during construction beyond the dripline as per Town of Caledon Landscape Standard No. 707.
- Though of limited potential, the watercourses in the forested western corner contains contributing fish habitat. It is anticipated that a 30 m setback may be recommended for these features by environmental approval and review agencies; however, these setbacks would be contained within the overall significant woodland setback, as demonstrated on **Figure 4**.
- Note that the combination of the 30 m minimum vegetation protection zone and the 10 m TRCA setback would define the limits of the natural features, and in combination with the LTSSL Erosion Hazard Limit would define the development limit, whichever is the greater of the three.
- A small drainage feature occurs through the northern corner of the Site, just south of Glasgow Road. According to the results from the 2018 Palmer survey and assessment following TRCA HDF guidelines (TRCA, 2014), this feature can be removed with no management recommendations required.



Legend

- Approximate TRCA Generic Regulation Line
- TRCA Top of Bank and Natural Features Staked Line (23/02/16)
- TRCA Policy Top of Bank and Natural Features Setback Line (10 m)
- Significant Woodland Boundary (Palmer staked dripline - August 2018)
- Drainage Feature
- Tree Protection Zone as per Standard No. 707
- Long Term Stable Slope Line (LTSSL)
- LTSSL Erosion Hazard Setback (10m)
- Watercourse
- Watercourse Buffer (30 m)
- Greenbelt VPZ (30m)
- TRCA Policy Top of Bank and Natural Features Setback Line (10m)
- Greenbelt Protected Countryside
- Study Area

0 25 50 75
metres

N

DRAWN: B. Elder
CHECKED: D. Janas
PROJECT: 1701603
DATE: Aug 16, 2021

Scale 1:3000
UTM Zone 17N
NAD 1983

Data Sources: Imagery ©2017 Google (southern portion). Overview basemap credits at page bottom.

Prepared by:

Palmer™

CLIENT: Brook Valley Homes
PROJECT: Chickadee Lane Ecology

Preliminary Constraints and Opportunities

FIGURE 4

Document Path: G:\Shared drives\Projects 2017\17016 - Brook Valley Homes\1701603 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\20211701603_Figure4_Constraints.mxd

4.1.1 Species at Risk

Based on the SAR records provided by the MNRF and on the SAR habitat screening presented in Section 3.2.2.3, the potential habitats on Site for certain SAR were considered either of marginal quality or would not be impacted by the proposed development due to adequate setbacks. Specifically:

1) There are several open meadow areas on the Site that may provide habitat for open country birds, including Eastern Meadowlark and Bobolink. As the quality of the habitat is somewhat variable and generally of low quality, the necessity for species-specific surveys was discussed with the MNRF.
2) There is potential for bat maternity roost habitats in the wooded portions of the Site. Should the proposed Site Plan consider encroachment into the 30 m vegetation protection zones of these features, the necessity for SAR bat surveys was discussed with the MNRF.

As part of the on-going consultation with the MNRF, the MNRF reviewed the proposed development plan and recommended avoidance and mitigation measures. The MNRF concluded, based on this review, that no additional SAR surveys are required and that they had no concerns with the proposed development plan (MNRF Correspondence, March 7, 2019 – **Appendix K**).

4.1.2 Significant Wildlife Habitat

Similar to potential SAR habitats, certain potential SWH types on-site was considered marginal and warranted discussion with the MNRF:

1) While the open meadow habitats are not considered to hold SWH types for the reasons described in Section 3.3.1.1, spring surveys may be required to confirm these assumptions. The need for confirmatory surveys to assess the potential for the meadows to hold sheet water for waterfowl use (Waterfowl Stopover and Staging Area (Terrestrial) SWH) and closer inspections of the woody debris piles (Reptile Hibernaculum) was discussed with MNRF.

As part of the on-going agency consultation, the MNRF reviewed the proposed development plan and recommended avoidance and mitigation measures. The MNRF concluded, based on this review, that no additional SWH surveys are required and that they had no concerns with the proposed development plan (MNRF Correspondence, March 7, 2019 – **Appendix K**).

4.2 Development Opportunities

The remainder of the Site as shown on **Figure 4** is potentially unconstrained from a natural heritage perspective. The development constraint lines shown on **Figure 4** were used in the development of the proposed development plan to ensure consideration of natural heritage and hydrologic features.

5. Hydrogeology

The purpose of the hydrogeological investigation is to determine the existing hydrogeological conditions and identify the relationship between groundwater and the natural environmental features. For a more detailed discussion of the hydrogeological characteristics of the Site, methods, and data collected, refer to Palmer's 2020 report, "Hydrogeological Investigation – Chickadee Lane Rounding Out Area B".

5.1 Regional Existing Conditions

5.1.1 Physiography and Regional Geology

The Site is located within the South Slope physiographic region, which is situated south of the Oak Ridges Moraine and north of the Peel Plain (Chapman and Putman, 1984). The topography of the region is characterised as flat to moderately undulating and is marked with drumlins.

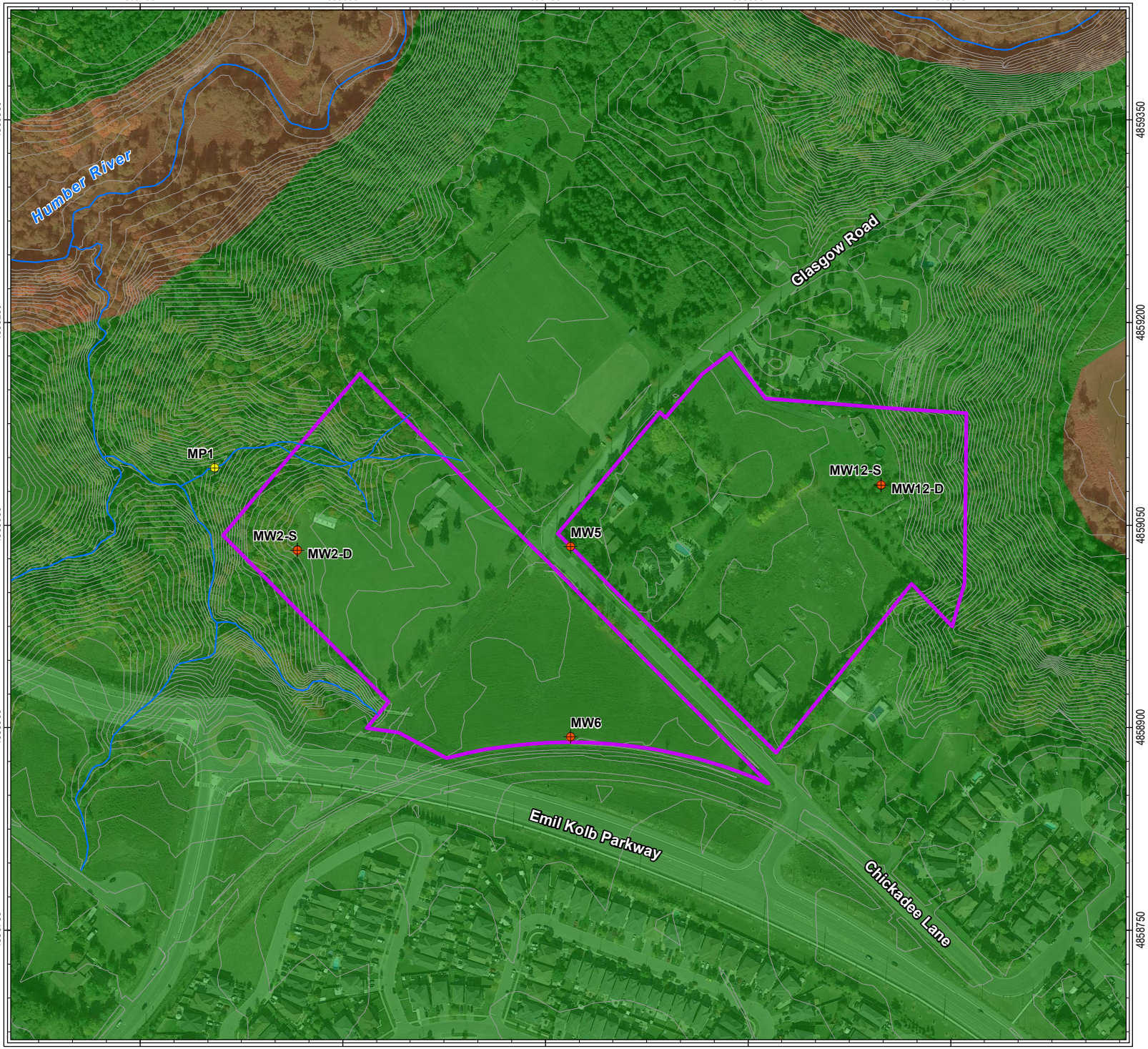
The surficial geology of the Site, as described by Ontario Geological Survey (OGS) mapping, is characterized as Halton Till. This unit is generally comprised of clayey to silt-textured sediments derived from glaciolacustrine deposits or shale (**Figure 5**). The Halton Till overlies the Newmarket Till, and where present, these tills are separated by the sandy deposits of the Oak Ridges Moraine aquifer. No ORM aquifer materials were encountered during borehole drilling at the Site (Palmer, 2020).

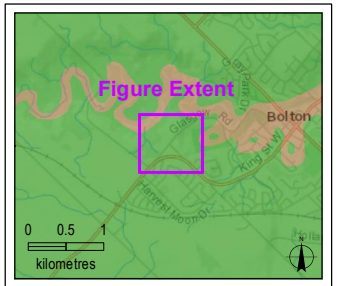
Paleozoic bedrock at the Site is characterized as shale and limestone of the Georgian Bay Formation. Though bedrock was not encountered during the most recent borehole drilling, which occurred to depths of between 6.1 meters below ground surface (mbgs) to 32.0 mbgs, the depth to bedrock in this area can be approximated using data available from the Ministry of the Environment, Conservation and Parks (MECP). Upon review of the water well database information, this formation is expected to be encountered at approximately 156 m below ground surface, or at approximately 100 meters above sea level (masl) at the Site location.

5.1.2 Hydrostratigraphy

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

The ***Halton Till*** and underlying ***Newmarket Till*** have similar hydrostratigraphic properties, and are therefore often grouped together. These units act as a significant regional aquitard due to low permeability which 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. The bulk hydraulic conductivity (K) of these units ranges from approximately $5x10^{-6}$ m/sec to $5x10^{-8}$ m/sec (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.





Legend

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

Surficial Geology

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

0 25 50 75 100
metres

N

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

Scale 1:4000
UTM Zone 17N
NAD 1983

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

Prepared by:

Palmer™

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

Surficial Geology

FIGURE 5

Document Path: G:\Shared drives\Projects 2017\17016 - Brook Valley Homes\1701603 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\20201701603_Figure5_Surficial Geology.mxd

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. No ORM deposits were encountered at the Site.

5.1.3 MECP Water Well Records

Based on a search of the MECP water well database, 35 water wells were identified within a 500 m radius of the Site. Of these wells, 11 are used for domestic water supply, two are for the public, three are municipal, four are for monitoring, one is a monitoring/test hole, four are not used, and 10 are unknown. The depth of wells ranged from 7.6 to 156.1 mbgs, with an average depth of 12.0 mbgs. The static water level depth ranged from -0.3 to 12.2 mbgs, with and average of 49.9 mbgs. The well yield ranged from 7.6 to 946.4 L/min, with a median yield of 20.8 L/min. As Bolton is serviced with municipal water supply, it is not expected that any of the wells identified as private supply wells are currently active. Prior to a Site Plan Application, Palmer will be completing a door-to-door water well survey within 500 m of the site to document the existing groundwater conditions of existing groundwater users in accordance with Peel Region requirements.

5.2 Local Existing Conditions

5.2.1 Site Geology

Borehole drilling for the Hydrogeological Investigation was conducted concurrently with the Geotechnical Investigation completed by Soil Engineers Ltd. (Soil Eng.). Borehole drilling was completed between February 23 to February 29, 2018, under the supervision of Soil Eng. Staff, and consisted of fourteen (14) boreholes drilled to depths ranging from 6.10 mbgs to 32.0 mbgs. Six of the 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). MW2-S/D and MW12-S/D were installed as nested wells, with S and D indicating a shallow or deep well, respectively. The location of each monitoring well is shown on **Figure 5** and well details are provided in **Table 5**. Borehole logs are presented in **Appendix D**. The remaining geotechnical borehole locations are shown in **Appendix G.**

A mini piezometer (MP1) was installed within the drainage feature present within the forest community in the northern portion of the Site (Aquatic Survey Point 1) to measure the magnitude and direction of the hydraulic gradient within the tributary. The location of the MP is shown on **Figure 5** and water level monitoring data are provided in **Table 6**.

The surficial geology of the Site was found to be generally consistent with regional OGS mapping (**Figure 5**). The overall lithology of the silty clay till unit is consistent with the Halton Till, as it contains trace gravel and occasional sand seams, cobbles and boulders, and the unit ranged in thickness from 16.4 m to 22.5 m. The sandy silt till of the Newmarket Till formation was encountered under the Halton Till, however the full thickness of the till was not observed during drilling. ORM aquifer materials were not encountered.

Table 5. Monitoring Well Installation Details and Groundwater Levels

MW ID	Approx. Surface Elevation (masl)	Stick Up (m)	Depth (mbgs)	Screened Interval (mbgs)	Screened Geology	Water Level (mbgs)							
						Mar 15, 2018	Mar 19, 2018	Apr 4, 2018	May 17, 2018	Jun 13, 2018	Jul 19, 2018	Aug 27, 2018	Oct 29, 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	6.09
MW2-D	256	0.73	19.80	18.30 – 19.80	Sandy Silt Till	11.94	11.88	11.98	11.35	11.81	12.72	13.70	14.72
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	1.50	1.41
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	3.29
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	6.01
MW12-D	256	0.80	30.20	30.50 – 32.00	Sandy Silt Till	23.29	29.12	21.85	14.30	22.31	25.33	25.93	26.46

Table 6. Mini Piezometer Installation Details, Water Levels, and Hydraulic Gradients

MP ID	Surface Elevation (masl)	Stick Up (m)	Depth to Screen (m)	Water Level (mbgs)	Apr 4, 2018	May 17, 2018	Jun 13, 2018	Jul 19, 2018	Aug 27, 2018	Oct 29, 2018
MP1	243	1.00	0.85	In	0.50	0.11	0.00	0.03	0.02	0.21
				Out	-0.09	-0.06	Dry	Dry	Dry	Dry
				Hydraulic Gradient	-0.69	-0.20	-	-	-	-

** A negative water level indicates water level was measured above ground surface.*
** A negative hydraulic gradient indicates groundwater recharge conditions.*

5.2.2 Groundwater Levels

Groundwater levels were measured on March 15th and 19th, April 4th, May 17th, June 13th, July 19th, August 27th, and October 29th, 2018 (**Table 5**). The shallow groundwater levels 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 level ranged from 11.35 mbgs (MW2-D on May 17, 2018) to 29.12 mbgs (MW12-D on March 19, 2018). Dataloggers were installed in MW-2S and MW5 to capture seasonal changes (**Figure 6**).

The shallow water levels measured in some wells indicate the presence of perched groundwater conditions. These conditions are common in areas with poor drainage, such as where the Halton Till aquitard is at surface, as there is slow downward percolation rates and an increased response of shallow soils to surface water inputs. The actual level of the long-term *water table* is interpreted to range from approximately 4.5 m to 8 mbgs across the Site, indicated by a shift in soil colour from brown (oxidized) to grey (wet, low oxygen) in the borehole log records for MW2, MW6, BH7, and MW12-S/D (**Appendix D**). As a result of this deeper water table, the site is well suited for the use of infiltration-based LID, albeit limited by the low permeability of the till soils.

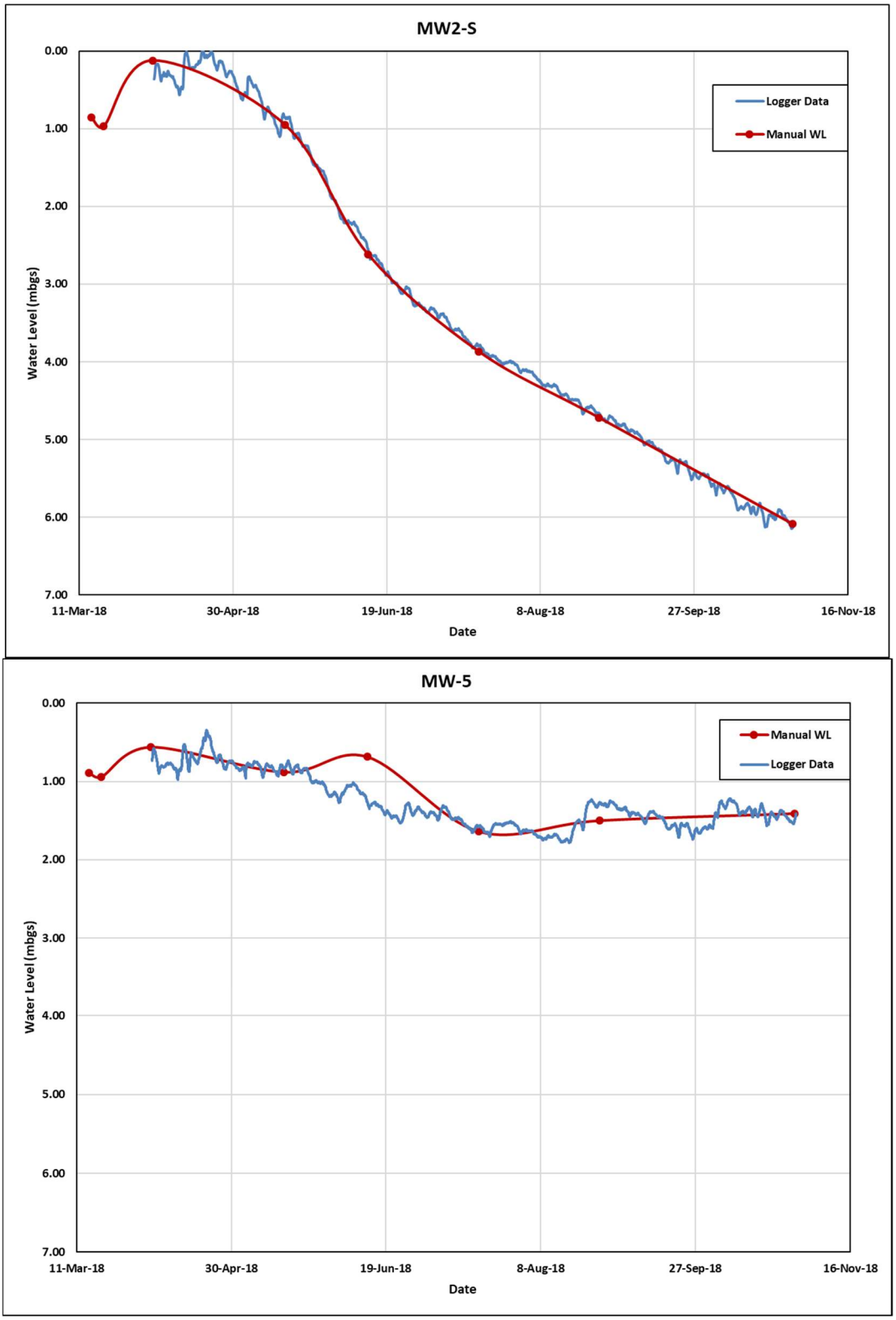


Figure 6. Recorded Groundwater Levels in MW-5 and MW-2S

5.2.3 Groundwater Flow

Groundwater flow within the Site generally follows topography, and is generally controlled by the presence of the Humber River valley and by a north-south groundwater divide located through the center of the Site (**Figure 7**). Groundwater on the east side of the divide is directed to the northeast, and groundwater on the west side of the divide is directed northwest. A mean horizontal groundwater gradient of 0.02 m/m was observed towards both the northwest (MW2) and northeast (MW12) of the Site area.

A strong downwards vertical hydraulic gradient was observed in the nested monitoring wells on the east (MW2 = -0.91 m/m) and west (MW12 = -1.15 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 both well locations. The vertical hydraulic gradient is approximately 1.5 orders of magnitude greater than the horizontal hydraulic conductivity indicating that the dominant groundwater flow direction is downwards.

5.2.4 Hydraulic Conductivity and Percolation

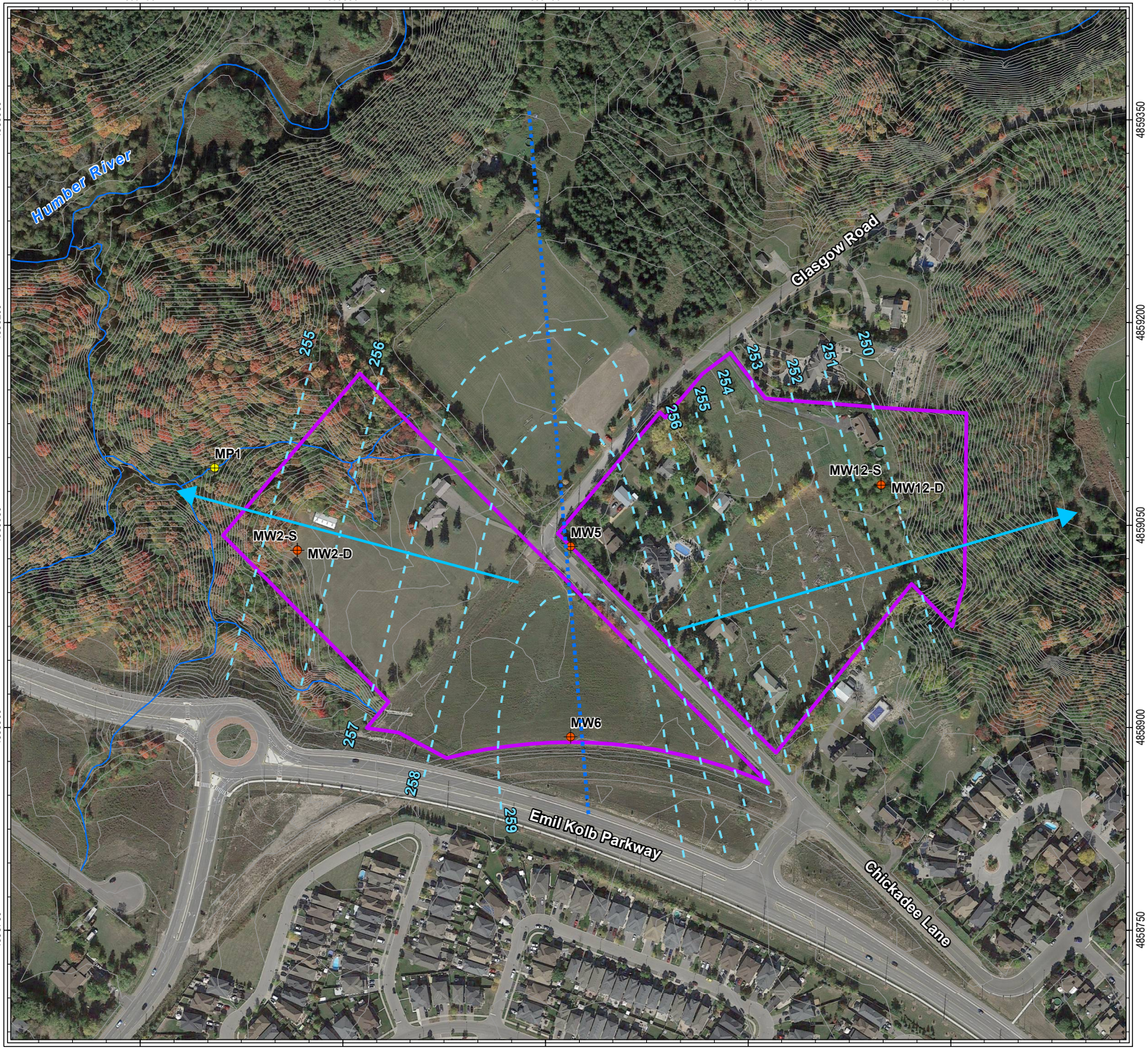
On March 19 and April 4, 2018, Palmer personnel conducted single well response tests (i.e., slug tests) at each of the monitoring well locations to determine the hydraulic conductivity (K) of the surrounding soils. Both rising head (RH) and falling head (FH) tests were conducted.

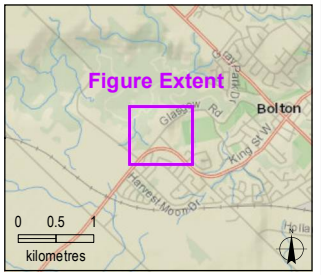
Hydraulic conductivity (K) values were calculated using the displacement-time data and were analysed using the Hvorslev (1951) method for confined aquifers, modelled using Aqtesolv™ software (**Appendix E**). Calculated K values ranged from $3.5x10^{-6}$ m/sec to $4.4x10^{-8}$ m/sec, with a site-wide geometric mean K of $6.1x10^{-7}$ m/sec. These values are within the expected range for the Halton Till Aquitard, which ranges from $5x10^{-6}$ m/sec to $5x10^{-8}$ m/sec (CAMC-YPDT, 2006). The observed differences in K values 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/sec), while MW5 is within a silt and clay unit, thus resulting in a lower observed K value (~10^{-8} m/sec).

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

5.2.5 Groundwater / Surface Water Interactions

Groundwater and surface water levels were measured in the Humber River tributary using a mini-piezometer (MP1) (**Table 6**). The MP was installed in a section of the tributary within the forest community northwest of the Site. Based on the results of monitoring at this MP, this tributary has a mean downward vertical hydraulic gradient of -0.45, indicating that the feature is predominately runoff supported, and is possibly ephemeral. Surface water flow was present within the feature on April 4th and May 17th, 2018, and was dry on the others.





Legend

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

0 25 50 75 100
metres

N

DRAWN: C. Veres
CHECKED: R. Rolick
PROJECT: 1701603
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

Groundwater Flow

FIGURE 7

Document Path: G:\Shared drives\Projects 2017\17016 - Brook Valley Homes\1701603 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\20201701603_Figure7_Groundwater Flow.mxd

5.2.6 Groundwater Chemistry

Groundwater chemistry samples were collected from MW6 on March 15, 2018 and analyzed for a suite of water quality parameters such as turbidity, total suspended solids (TSS), pH, nutrients and metals. The Certificate of Analysis is provided in **Appendix F**. Results were compared against Ontario Provincial Water Quality Objectives (PWQO) and indicate that the sample exceeds PWQO criteria for total aluminum (Al) and total iron (Fe), most likely as a result of high TSS in the collected sample

5.2.7 Water Balance

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 conditions such as the average annual evapotranspiration (ET). Long-term climate data (30-year duration, 1981 to 2010) were obtained from the meteorological station approx. 7.6 km from to the study area, Albion Field Centre (43°55' N, 79°50' W).

The Site was divided according to the pre-development land use components: forested cover and agricultural/rural residential. 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. Soil moisture storage values of 250 mm and 400 mm were used to represent the agricultural/rural residential and forested areas, respectively, overlying silty clay till.

The calculated mean annual water surplus was then partitioned using infiltration factors dependent on three properties: soil type (**Figure 5**), topography and slope (**Figure 8**), and land use (**Figure 9**) (MOEE, 1995). Geographic Information System (GIS) mapping was used to divide each layer into discrete sections and assign respective infiltration factors. The total average annual infiltration was then determined by multiplying the appropriate water surplus value by the sum of the three individual factors.

According to “Bolton Residential Expansion Study: Phase 3 Technical Memo – Development of a Preliminary Natural System” completed by Douglan and Associates in 2014 and Palmer’s ecological study, no wetlands or other natural features are found on or adjacent to the Site that rely on groundwater or surface water from the Site. Therefore, a feature-based water balance assessment is not required and a site-wide water balance will be used to maintain the groundwater function of the Site.

Pre-Development Water Balance Results

Based on 30-year climate normals, total precipitation at the Site is approximately 821 mm/yr. This precipitation will either infiltrate through the unsaturated zone soils or be removed through evapotranspiration (ET). Actual ET (AET) is calculated based on potential evapotranspiration (PET) and soil-moisture storage withdrawal. Based on the Thornthwaite and Mather (1957) model, calculated AET for the Agricultural/Rural Residential and Forested land use areas is 528 mm/yr and 537 mm/yr, respectively. 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 and the TRCA on-line water balance tool value of 520 mm/yr.

Monthly PET is defined as water loss through evaporation or transpiration from a homogeneous vegetated area that does not lack water (Thornthwaite, 1948; Mather, 1978). Calculated PET for the total Site area is 590 mm/yr (approximately 72% of total precipitation), while the soil moisture deficit is between 53 mm/yr (Forested) and 62 mm yr^{-1} (Agricultural/Rural Residential).

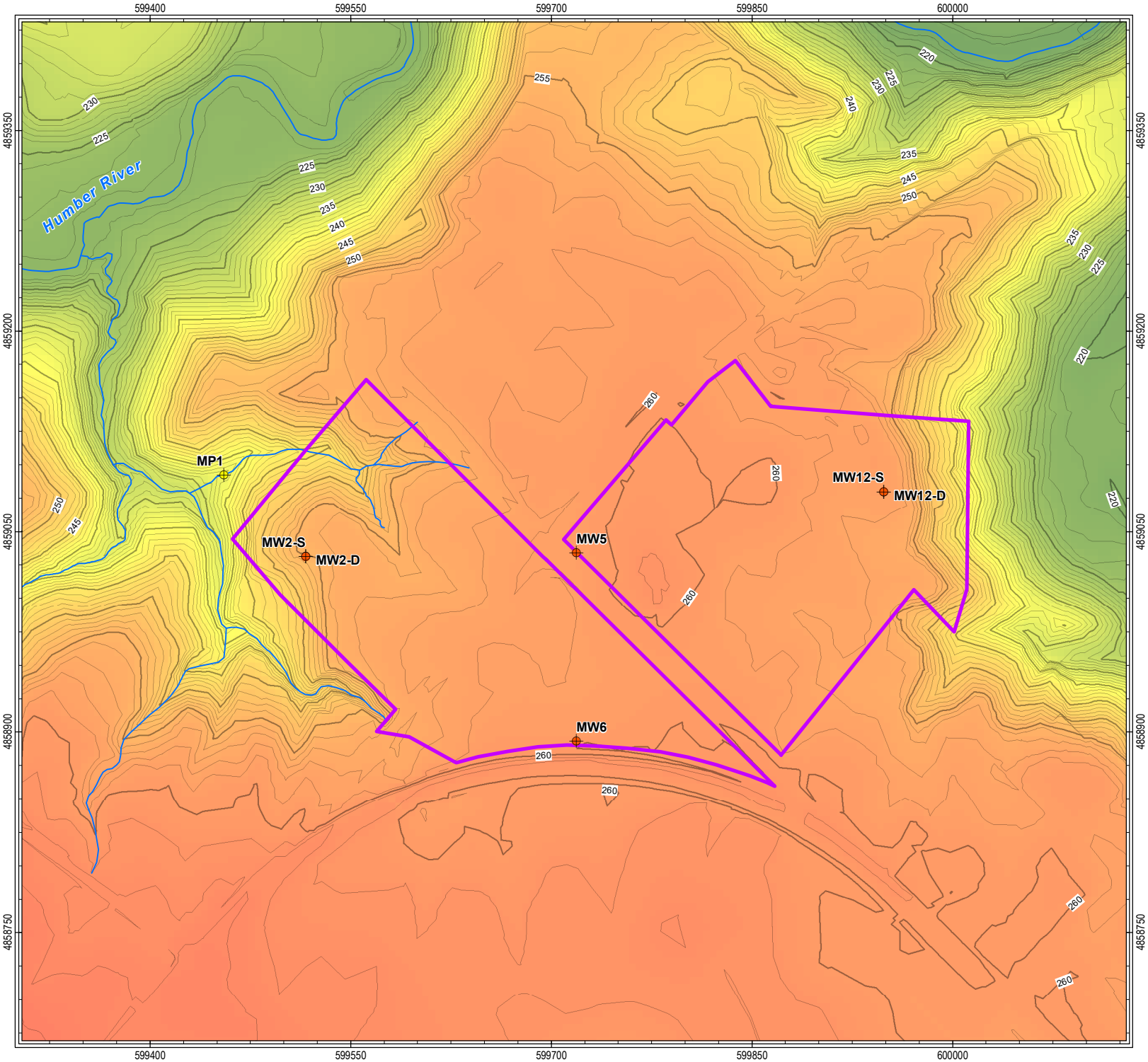
Estimated water surplus within the Site ranges from approximately 285 mm/yr (Forested; 35% of total precipitation) to 294 mm/yr (Agricultural; 36% of total precipitation) and is divided into two components: infiltration and runoff. Using the method outlined in the MOE SWM manual and MOEE (1995), approximately 67% (219 mm/yr) of the surplus runs off, while the remaining 33% (91 mm/yr) infiltrates. Over the entire Site area (100,800 m^2), this translates to approximately 9,186 m^3/yr of infiltration, and approximately 22,113 m^3/yr of runoff (**Figures 10 & 11**). 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.

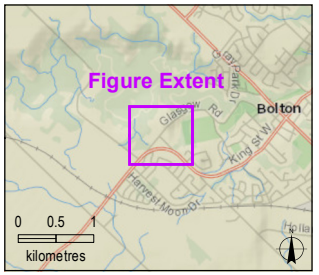
Post-Development Water Balance Results

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

The post-development water balance is described in detail in **Section 8.3**. Based on proposed Draft Plan of Subdivision provided by Humphries Planning Group (HPG, 2021; **Appendix H**), without mitigation, the post-development runoff is expected to increase to 46,542 mm/yr and the post-development infiltration is expected to decrease to 4,257 mm/yr. This represents a 110% increase in runoff and 53% reduction in infiltration. The relatively high change in infiltration is due to the area of proposed medium density land-uses, relative to the existing conditions.

Proposed methods to balance infiltration volumes post-development include a series of rear-yard infiltration trench LID at locations shown in **Appendix J**. A completed pre-to-post development water balance and the implications of the proposed LID mitigation measures are described in **Section 8.3**.





Legend

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

Elevation

High : 265

Low : 215

0 25 50 75 100
metres

N

DRAWN: B. Elder
CHECKED: R. Rolick
PROJECT: 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:

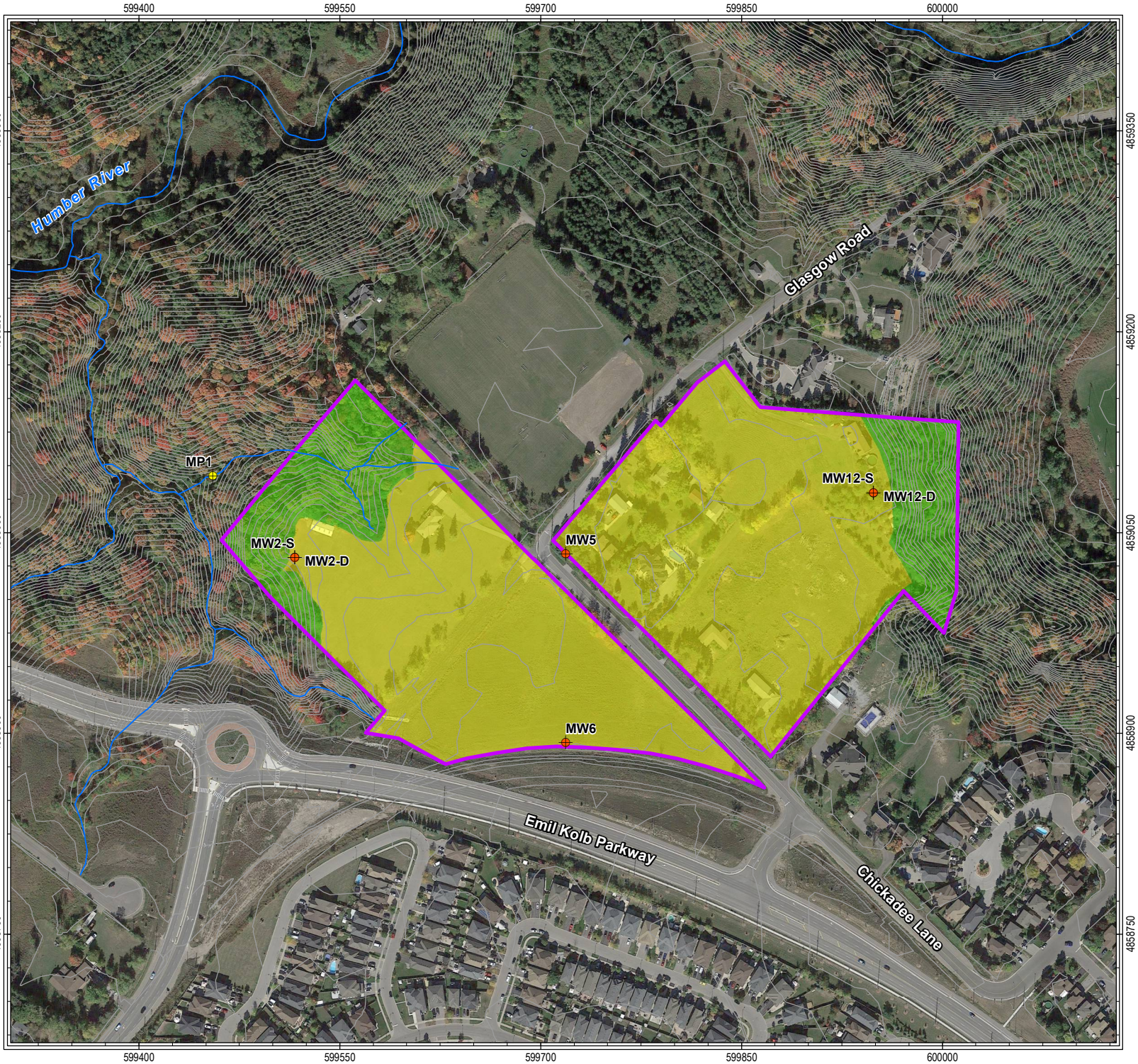
Palmer™

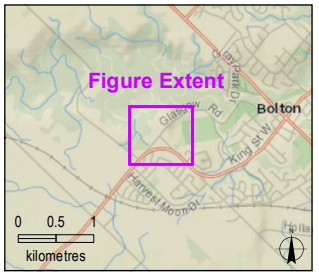
CLIENT: Brook Valley Homes
PROJECT: Chickadee Lane Ecology and Hydrogeology

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





Legend

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

Land Cover

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

0 25 50 75 100
metres

N

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

Scale 1:4000
UTM Zone 17N
NAD 1983

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

Prepared by:

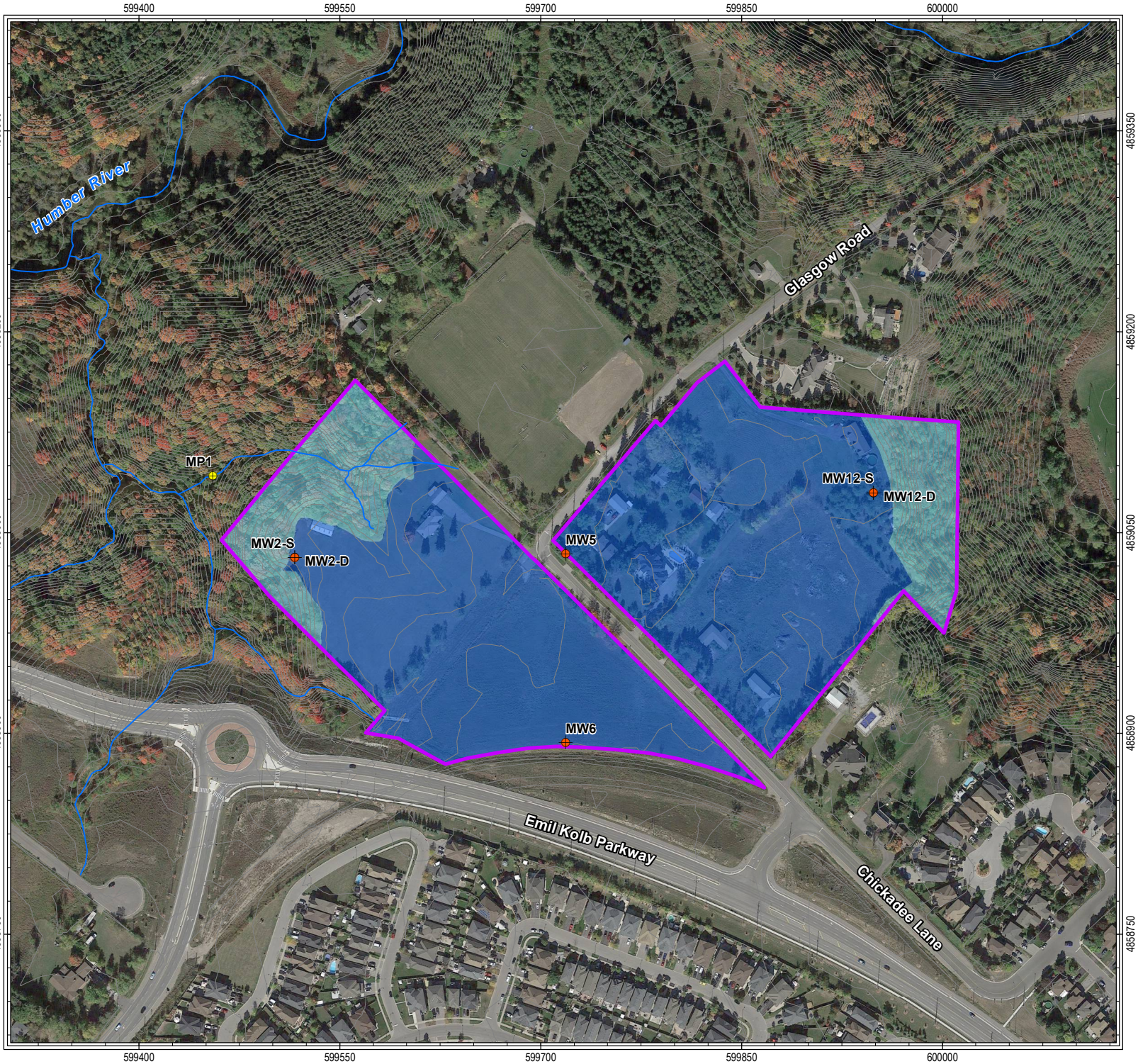
Palmer™

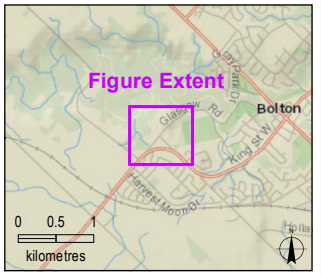
CLIENT: Brook Valley Homes
PROJECT: Chickadee Lane Ecology and Hydrogeology

Pre-development Landuse

FIGURE 9

Document Path: G:\Shared drives\Projects 2017\17016 - Brook Valley Homes\1701603 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\20201701603_Figure9_Landuse.mxd





Legend

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

Infiltration by Land Cover Type

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

0 25 50 75 100
metres

N

DRAWN: B. Elder
CHECKED: R. Rolick
PROJECT: 1701603
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:

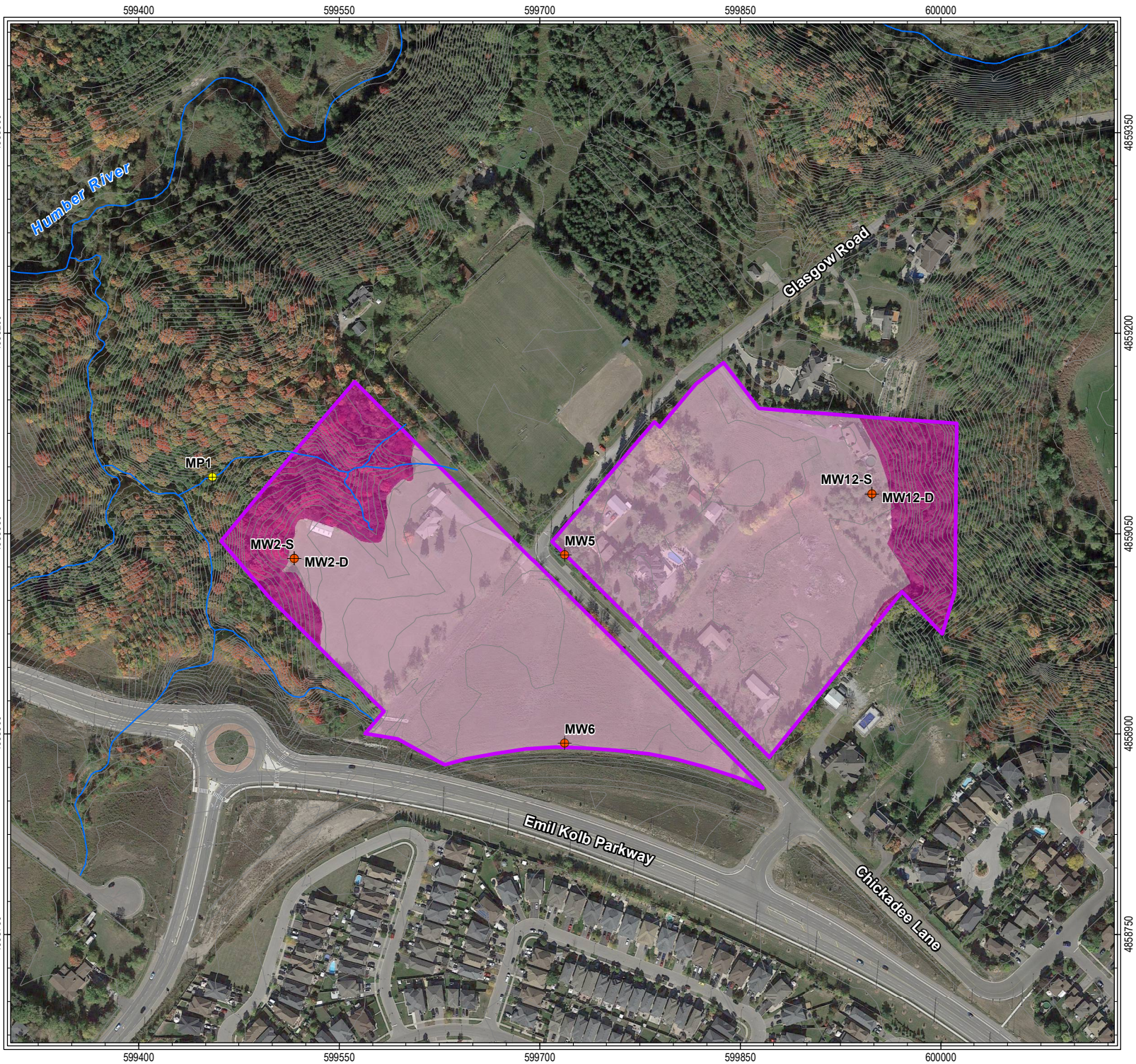
Palmer™

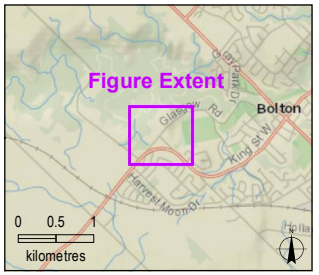
CLIENT: Brook Valley Homes
PROJECT: Chickadee Lane Ecology and Hydrogeology

Pre-development Infiltration

FIGURE 10

Document Path: G:\Shared drives\Projects 2017\17016 - Brook Valley Homes\1701603 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\20201701603_Figure10_Infiltration.mxd





Legend

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

Runoff by Land Cover Type

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

0 25 50 75 100
metres

N

DRAWN: B. Elder
CHECKED: R. Rolick
PROJECT: 1701603
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 Runoff

FIGURE 11

Document Path: G:\Shared drives\Projects 2017\17016 - Brook Valley Homes\1701603 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\20201701603_Figure11_Runoff.mxd

5.2.8 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 Palmer did not identify any groundwater supported natural features (i.e., groundwater supported wetlands and watercourses) on or within 120 m 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 and Newmarket Till aquitard units (approximately 40 m thick). The low permeability of the till (geometric mean K = 6.1×10^{-7} m/s) greatly limits groundwater recharge and potential contaminant migration.

5.2.9 Construction Dewatering

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

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

The groundwater table is expected range between approximately 4.5 m to 8 mbgs across the Site, indicated by a shift in soil colour from brown (oxidized) to grey (wet, low oxygen) in the borehole log records the Site (**Appendix D**). The shallower water levels measured in MW5 and MW6 are interpreted to represent a perched, poorly drained condition related to local infiltration of precipitation. The calculated K values for the till soils ranged from 3.5×10^{-6} m/sec to 4.4×10^{-8} m/sec, with a site-wide geometric mean K of 6.1×10^{-7} m/sec.

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

Based upon the Site conditions, construction dewatering rates on the order of 50,000 L/day or less would be expected for a typical excavation. A registration on the MECP Environmental and Sector Registry (EASR) is required for all construction related water taking between 50,000 and 400,000 L/day. A Permit to Take Water (PTTW) is required for all water construction takings exceeding 400,000 L/day. Given the ubiquitous presence of low permeability soils present at the site, construction dewatering rates are expected to be low for the installation of site servicing or SWM pond excavations (i.e., <50,000 L/day) and be manageable by sump pumping from the base of the excavation. Under these conditions, a PTTW or a registration on the EASR is not expected to be required. Based on this, the radius of water table

drawdown would be minimal, no adverse effects to local water wells or natural features would be expected from the minor dewatering predicted.

5.2.10 Stormwater Pond

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

Based on the borehole logs (Appendix D), the soils at the SWM pond location are consistently Silty Clay Till of the Halton Till formation to a depth of at least 19.8 mbgs. At this location, the groundwater table is estimated to be at approximately 251 masl (5.5 m below grade at BH1). Based on this, it is interpreted that the SWM pond will be constructed above the water table in low permeability silty clay till soils. It is our opinion that the existing native Halton Till Aquitard is sufficient to protect groundwater quality at the pond location and a liner is not recommended.

6. Geotechnical

A Preliminary Geotechnical Investigation was completed by Soil Engineers Inc. (2018). to characterize the engineering properties of the soils for Site design and construction purposes. Since the Site is located in close proximity to a series of slopes of the Humber River valley, a slope stability study was also completed as part of the geotechnical investigation. A Supplementary Slope Stability Assessment was completed by Soil Engineers (2020) to determine slope stability and the Long-Term Stable Slope Line (LTSSL), which will be integrated with the natural environmental constraints (**Figure 4**) to define the limits of development for the Chickadee Lane Site.

This section summarizes the results of the Soil Engineers (2018 & 2020) geotechnical investigation and integrates the findings with the overall CEISMP Part A Report.

6.1 Geotechnical Site Characterization

6.1.1 Methodology

Twelve (12) boreholes were drilled by Soil Engineers Inc. between January 23 and 29, 2018 using a track-mounted continuous-flight power-auger equipped for soil sampling. The location of the boreholes is shown in **Appendix G** and the borehole logs are provided in **Appendix D**. Two of the boreholes (BH-2 and BH-12) were situated close to the top of slope and extended to a depth of 19.8 mbgs and 32 mbgs respectively. The remaining boreholes have depths of between 6.5 mbgs to 8.1 mbgs. Monitoring wells were installed at BH-5 and BH-6, and nested monitoring wells were installed at BH-2 and BH-12. Palmer completed groundwater level monitoring of the wells as part of the Hydrogeological Investigation.

6.1.2 Subsurface Conditions

Based on the results of borehole drilling, the following subsurface stratigraphic profile (from Soil Engineers, 2018) was encountered:

<u>Topsoil</u>

Topsoil was identified in all boreholes and ranged in thickness from 16 cm and 46 cm, however thicker topsoil is expected to occur in places such as treed or low-lying drainage areas. The topsoil is dark brown in colour and contains roots and humus.

<u>Earth Fill</u>

A layer of earth fill consisting of brown and grey silty clay, with sand and gravel, and occasional rootlets, wood and brick fragments was identified in boreholes BH-4, BH-5, BH-7, and BH-11, extending to a depth of between 0.6 mbgs to 2.4 mbgs. Its presence is likely due to prior site grading when the road and existing houses were constructed.

The obtained “N” values ranged from 3 to 30, with a median of 6 blows per 30 cm of penetration, indicating 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 to topsoil and any deleterious material, aerated, and properly compacted in layers.

Silty Clay Till

Silty clay till was identified in all boreholes. It is heterogeneous in structure and amorphous in places. Sand and clay seams were identified in some samples. The presence of cobbles and boulders was interpreted through intermittent hard resistance to augering.

The obtained "N" values ranged 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, where the soft till was found in the upper weathered zone near ground surface only. The consistency of the clay till was generally very stiff. The water content of the samples ranged from 12% to 32%. The Attenberg Limit was determined on four representative samples, and results indicate a range in liquid limit from 36 – 42, and a range in plastic limit from 19 – 21.

Based on the Atterberg Limits and the water content values, 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 determined from the "N" values. The high-water content samples that were obtained near ground surface may have been disturbed by weathering.

The engineering properties of the clay till pertaining to the project design are provided 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 sloughing;
- A poor pavement-supportive material, with an estimated California Bearing Ratio (CBR) value of 5%; and,
- Moderate corrosivity to buried metal, with an estimated electrical resistivity of 3500 ohm·cm.

Sandy Silt Till

The sandy silt till was encountered in boreholes BH-2 and BH-12 at depths below 16.5 m and 22.5 mbgs, respectively. It is heterogeneous in structure with occasional sand seams, cobbles, and boulders.

The obtained “N” values ranged from 28 to 78, with a median of 39 blows per 30 cm of penetration. This indicates that the relative density of the sandy silt till is compact to very dense, and is generally in the dense range. The water content of the samples ranged from 12% to 15%.

The properties of the sandy 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 sandy 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-supported material, with an estimated CBR value of 8%; and,
- Moderate corrosivity to buried metal, with an estimated electrical resistivity of 4000 ohm·cm.

6.1.3 Slope Stability Study

A slope stability study was conducted for the valley land to the western and eastern portions of the Site. It includes a visual inspection of the slope and stability analysis using force-moment equilibrium criteria of the Bishop’s method. The results of this analysis are provided in **Appendix G**.

A visual inspection of the slope was performed on March 20, 2018 by qualifies Soil Engineers staff. 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 erosion along the slope surface, except within multiple gully features. Surface erosion were present to the north and west of the property. Toe erosion scars were also evident along the Humber River outside of the Site boundary. Towards the east of the property, the bottom of the slope is a sports field park with no observed erosion hazard.

Three slope sections were selected for stability analysis based on field observation and the contours of slope inclination (**Appendix G**). Two (2) additional sections (Cross Sections D-D and E-E) were complete in 2020 to further delineate the LTSSL. The LTSSL, the staked top of slope and their associated set-backs are each presented on the Constraints Mapping for the Site (**Figure 4**).

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. The groundwater level recorded in these boreholes (3.0 mbgs to 6.1 mbgs) 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 7**.

The stability analysis was completed using "SLIDE", developed by Rocscience Inc. The Technical Guide "River and Stream Systems: Erosion Hazard Limit" of the Ministry of Natural Resources and Forestry (MNRF Guideline) was used for the management of erosion hazards along the bank.

Table 7. 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

Due to the low permeability of the 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 LTSSL, a 5 m toe erosion allowance was recommended by Soil Engineers (2018) along the gullies and river bank where there are signs of erosion, according to Table 3 of MNRF Guideline. Any new development will have to set back a minimum of 6 m from the LTSSL.

Table 8. Factors of Safety of Slope Sections

Cross Section (see Appendix G for location)	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
B-B	-	-	1.50	-	-
C-C	-	-	1.51	-	-
D-D	8.5	1.6H:1V	1.31	2H:1V	1.51
E-E	7.0	3.1 to 4.7 H:1V	2.40	-	-

The resulting FOS at the Cross-Section B-B, C-C, and 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 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 in **Appendix G**.

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

1. The prevailing vegetative cover must be maintained, since its extraction would deprive the slope of the rooting system that acts as a reinforcement against soil erosion by weathering. If for any reason the vegetative 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 screening 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 such as infiltration trenches which may cause runoff to pond at the top of the slope, as well as soil saturation at the tableland must not be permitted near the slope edge.
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 should be avoided. 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. This should be reviewed and are subject to the approval of TRCA.

7. Fluvial Geomorphology

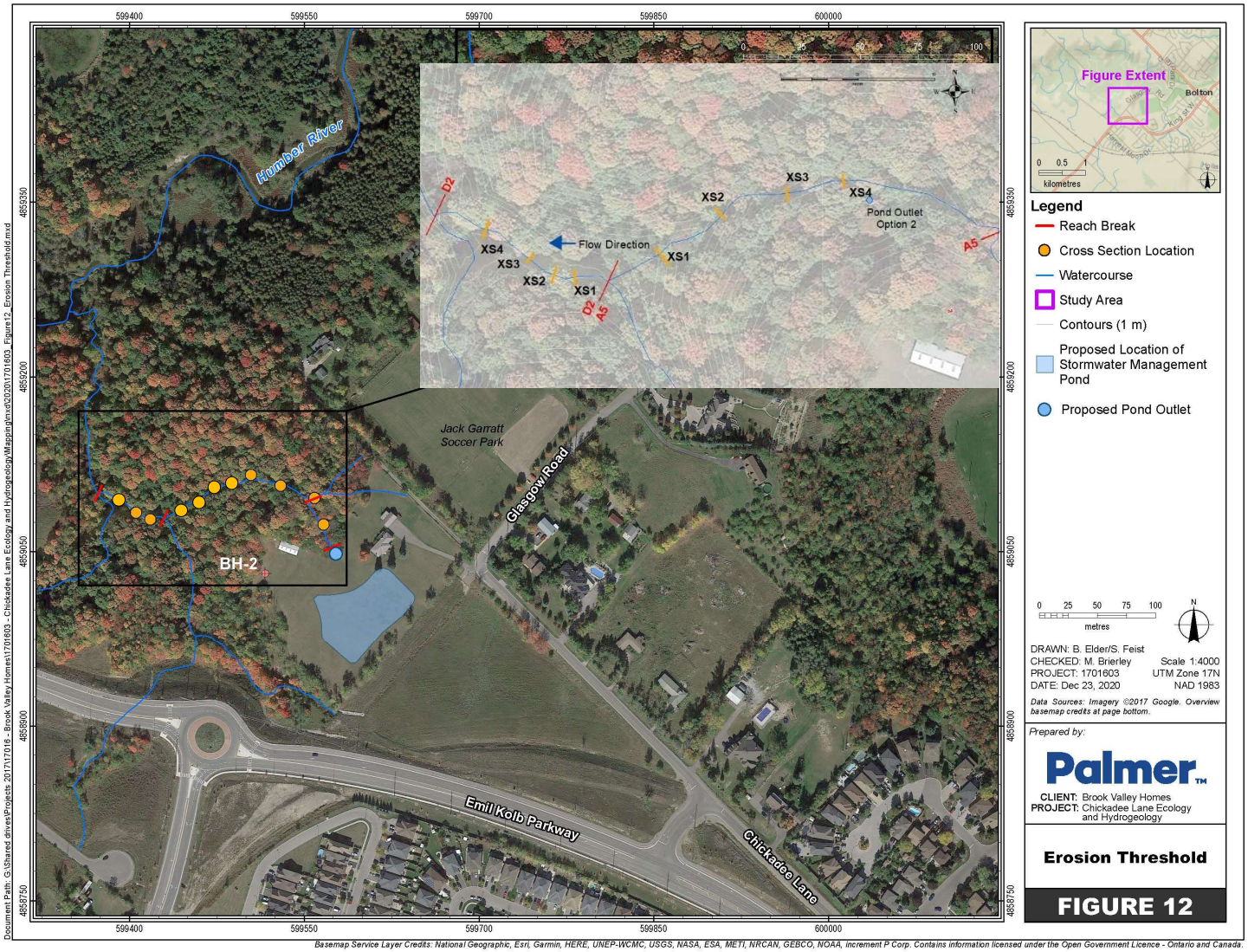
Initial geomorphological field reconnaissance was completed on February 5, 2019, to examine the conditions and erosional processes along a headwater gully system downstream of the proposed stormwater management (SWM) pond (**Figure 12; Appendix H & I**). TRCA, in comments received May 15, 2020, expressed 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, **Appendix L**).

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

7.1 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.



Basemap Service Layer Credits: 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.

7.2 Methodology

Palmer's initial field reconnaissance was completed February 5, 2019, immediately after a mid-winter thaw. The upstream reach is a gully that has head-cut into tableland with a rough V-shaped cross-section (Reach A4). The warm weather had melted the snow and ice along the Reach A4 gully, such that it could be properly examined, but remnant snow and ice cover precluded meaningful observation of the bed and banks along reaches A5 and D2.

A follow-up 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 12**; 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.

7.3 Description of Channel Morphology of Reach A4, A5 and D2

The planned SWM pond (**Appendix H**) is proposed to discharge into a well-defined network of gullies and channels that descends into the Humber River Valley (**Figure 12**). Detailed descriptions of each reach within the headwater drainage network are provided in **Appendix L**. Three outlet alternatives were identified during a field investigation on May 26, 2020 (**Figure 12**). 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. Channel morphology and erosional processes along Reach A4, Reach A5 and Reach D2 are provided below:

Reach A4 exhibits signs of active erosion along its sidewalls, influenced by scour along their toes. No mass movement failures, headward cut or seepage areas were observed. The gully has a high gradient (14%) and an irregular, stepped bed profile. The development of a stepped profile reflects local diversity in materials into which the gully has incised and how the channel moderates erosion to maintain stability. The banks are scoured and slightly undercut, exposing roots. All flows are confined to the V-shaped gully bottom without any floodplain. The gully-bottom cross-section is trapezoidal with a narrow bed (1 m) and shallow depth (0.2 m). Bed and bank materials consist of sandy silty-clay till, locally overlain by organic matter, sand, fine gravels, cobbles and anthropogenic debris (i.e. concrete rubble) (**Photo 15**).

Photo 15. Looking upstream from the downstream extent of Reach A4

The morphology of gullies (e.g., Reach A4) differs from the morphology of channels formed predominantly by fluvial processes (e.g., Reaches A5 and D2), which generally have concave-upward longitudinal profiles. Gullies tend to have steep sides, low width/depth ratios, and a stepped profile, characteristically having knickpoints from head-cutting (Knighton, 1998). Gully initiation and development

involve multiple episodes of channel erosion: downward scour, head-cutting, rapid enlargement, and stabilization. These erosional processes work as a positive feedback mechanism as the steep slope and low width/depth ratio lead to higher velocities and stream power, leading to enlargement of the gully (Gao, 2013). As a result, gullies are inherently erosive landforms that form where surface runoff concentrates down a slope. On steep slopes, major rainstorms are required to produce the necessary depth of concentrated flow that exceeds the threshold condition.

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 16**). 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 17**). 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 16. Upstream view of cobbly substrate along the bed near the downstream extent of Reach A5.

Photo 17. Upstream view of wood debris and organic matter accumulation along the bed which adds additional roughness.

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 18**). Till is exposed locally along the bed, mostly along the thalweg, and extensively along the lower banks.

Photo 18. Downstream view of channel incision that has lowered the bed 1.5 to 2.0 m below the floodplain.

Photo 19. Downstream view of gravel and cobble bed material locally overlain by sand.

7.4 Erosion Threshold Assessment

The proposed development is expected to increase the catchment of the gully by an order of magnitude, from approximately 0.95 ha to approximately 10.04 ha (conservatively assuming the entire land

development is ultimately drained by this gully although it is known that LID features will be implemented to reduce runoff and increase infiltration). Irrespective of the ability of stormwater management to maintain similar post- and pre-development peak flows, the marked increase in drainage area draining relatively low-permeability till will almost certainly increase the annual volume of flow conveyed to the headwater drainage network. Lower-magnitude, more frequent (<2 year) flows will also likely be higher than those under existing conditions.

7.4.1 Reach A4

Using the Hjulström (1935) approach, a critical discharge of 0.1 to 0.014 m^3/s is predicted based on a gully-bottom gradient of 14%, a Manning's n value of 0.075[2], and a dominant substrate grain size range from fine (D_{50} of 0.004 m) to coarse (D_{50} of 0.062 m) silt, respectively. These critical discharges equate to 86% of "bankfull" flow, assuming fine silt is representative, and 16% of "bankfull" flow, assuming coarse silt is representative. Bed structure (steps, knickpoints, roots, etc.), cohesive material and woody debris provide stability along the gully bottom, moderating erosive potential.

7.4.2 Reach A5 – Coarse-grained Material

Using the Shields (1936) approach[3], 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[4] (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.

7.4.3 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.

7.4.4 Reach D2

Using the Shields (1936) approach[5], 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,

---

[2] *To estimate bankfull hydraulics, a Manning's 'n' of 0.075 was chosen for Reach A4 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).*

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

[4] *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] *Critical Shields (1936) parameter assumed to be 0.045 (Church, 2006).*

which corresponds to approximately 8% of the bankfull flow[6] (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).

7.5 Fluvial Geomorphology Summary

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) is very similar to the proposed 2-year storm event discharge from the SWM pond (0.057 m^3/s) (FSR Report, Candevcon, 2020). This indicates that the receiving watercourse should be able to handle more frequent, smaller discharge events from the SWM pond without exceeding the erosion threshold. It is natural and expected that discharge in the intermittent channel would exceed this threshold during infrequent events (e.g. 100-year storm). The pond discharge following the 100-year storm (178 L/s) is less than the estimated bankfull discharge, further supporting the conclusion that erosion and channel instability in Reach D2 will not be increased from the proposed development.

[6] *To estimate bankfull hydraulics, a Manning's 'n' of 0.04 was chosen for Reach D2.*

PART B: IMPACT ASSESSMENT

8. Impact Assessment

The proposed Draft Plan of Subdivision, prepared by Humphries Planning (August 2021), is provided in **Appendix H.** **Figure 13** provides an illustration of the proposed development plan overlain with the environmental constraints and proposed mitigation measures. **Figure 13a** and **Figure 13b** show the interfaces between the proposed development and natural features in more detail for the northwest and southeast portions of the Site, respectively.

The Draft Plan proposes to subdivide the Site into 37 blocks and create four new public streets. This includes 25 street townhouse blocks, with a total of 151 units, and one single detached home block. The Plan also proposes to maintain two of the existing rural residential lots. In addition to these residential uses, the draft plan provides for one park block (located in the northwestern quadrant), a SWM block (located in the northwestern quadrant), three Open Space/Natural Heritage System Blocks (located approximately in the location of the existing EPA2 zones), two Restoration Area Blocks and a road widening along Glasgow Road.

Based on the assessment of environmental constraints and opportunities, the proposed development footprint is within areas of low constraint, predominately consisting of cultural meadow and existing rural residences with lawns. Potential impacts have been identified for the features of functions within and adjacent to the project Site and are discussed in the following report sections.

8.1 Terrestrial Ecology

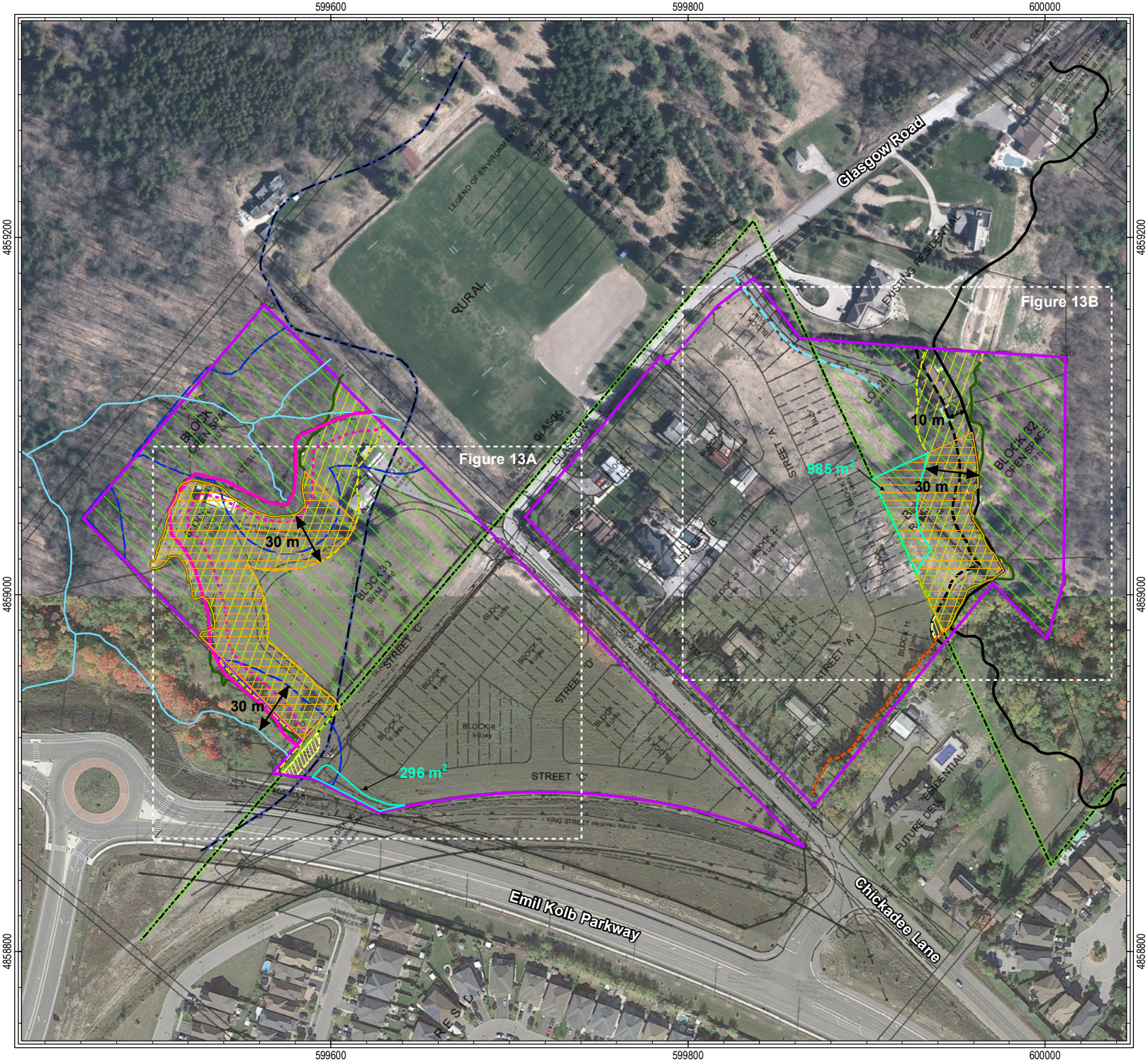
8.1.1 Vegetation

There will be no development or encroachment into key natural heritage features (i.e., significant woodland), designated as part of the NHS of the Greenbelt Plan. As shown on **Figure 13**, no encroachment is proposed into the Significant Woodlands (ELC code FOD5-8 through the northwestern portion of the Site and FOD4 to the southeast of the Site). The protection of these significant woodlands will be afforded through the establishment of appropriate setbacks (**Section 9.1.3**), and as such, no direct impacts are anticipated. No rare or sensitive species or communities occur within the proposed development lands.

Impacts to vegetation within the Site include:

- Removal of approximately 7 ha of Old Field Meadow (CUM1-1);
- Removal of residential landscape trees, shrubs and fencerow (TAGM5c).

The impacts and proposed mitigation associated with the removal of these landscape trees are described in the accompanying Tree Preservation Plan (**Appendix H**). A summary of tree removals is provided in **Table 9**.



Legend

- Approximate TRCA Generic Regulation Line
- TRCA Top of Bank and Natural Features Staked Line (23/02/16)
- TRCA Policy Top of Bank and Natural Features Setback Line (10 m)
- Significant Woodland Boundary (Palmer staked dripline - August 2018)
- Drainage Feature
- Tree Protection Zone as per Standard No. 707
- Long Term Stable Slope Line (LTSSL)
- LTSSL Erosion Hazard Setback (10m)
- Watercourse
- Watercourse Buffer (30 m)
- Greenbelt VPZ (30m)
- TRCA Policy Top of Bank and Natural Features Setback Line (10m)
- Greenbelt Protected Countryside
- Study Area
- Restoration
- Additional Restoration Areas

0 25 50 75
metres

N

DRAWN: SF/AL/BE
CHECKED: A. Adams
PROJECT: 1701603
DATE: Aug 16, 2021

Scale 1:3000
UTM Zone 17N
NAD 1983

Data Sources: Imagery ©2017 Google (southern portion). Overview basemap credits at page bottom.

Prepared by:

Palmer™

CLIENT: Brook Valley Homes
PROJECT: Chickadee Lane Ecology

Proposed Development Plan

FIGURE 13

Document Path: G:\Shared drives\Projects 2017\17016 - Brook Valley Homes\1701603 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\20211701603_Figure13_Development Plan.mxd

Legend

- Approximate TRCA Generic Regulation Line
- TRCA Top of Bank and Natural Features Staked Line (23/02/16)
- TRCA Policy Top of Bank and Natural Features Setback Line (10 m)
- Significant Woodland Boundary (Palmer staked dripline - August 2018)
- Drainage Feature
- Tree Protection Zone as per Standard No. 707
- Long Term Stable Slope Line (LTSSL)
- LTSSL Erosion Hazard Setback (10m)
- Watercourse
- Watercourse Buffer (30 m)
- Greenbelt VPZ (30m)
- TRCA Policy Top of Bank and Natural Features Setback Line (10m)
- Greenbelt Protected Countryside
- Study Area
- Restoration Area
- Additional Restoration Area

0 10 20
metres

N

DRAWN: SF/AL/BE
CHECKED: A. Adams
PROJECT: 1701603
DATE: Aug 16, 2021

Scale 1:1200
UTM Zone 17N
NAD 1983

Data Sources: Imagery ©2017 Google (southern portion). Overview basemap credits at page bottom.

Prepared by:

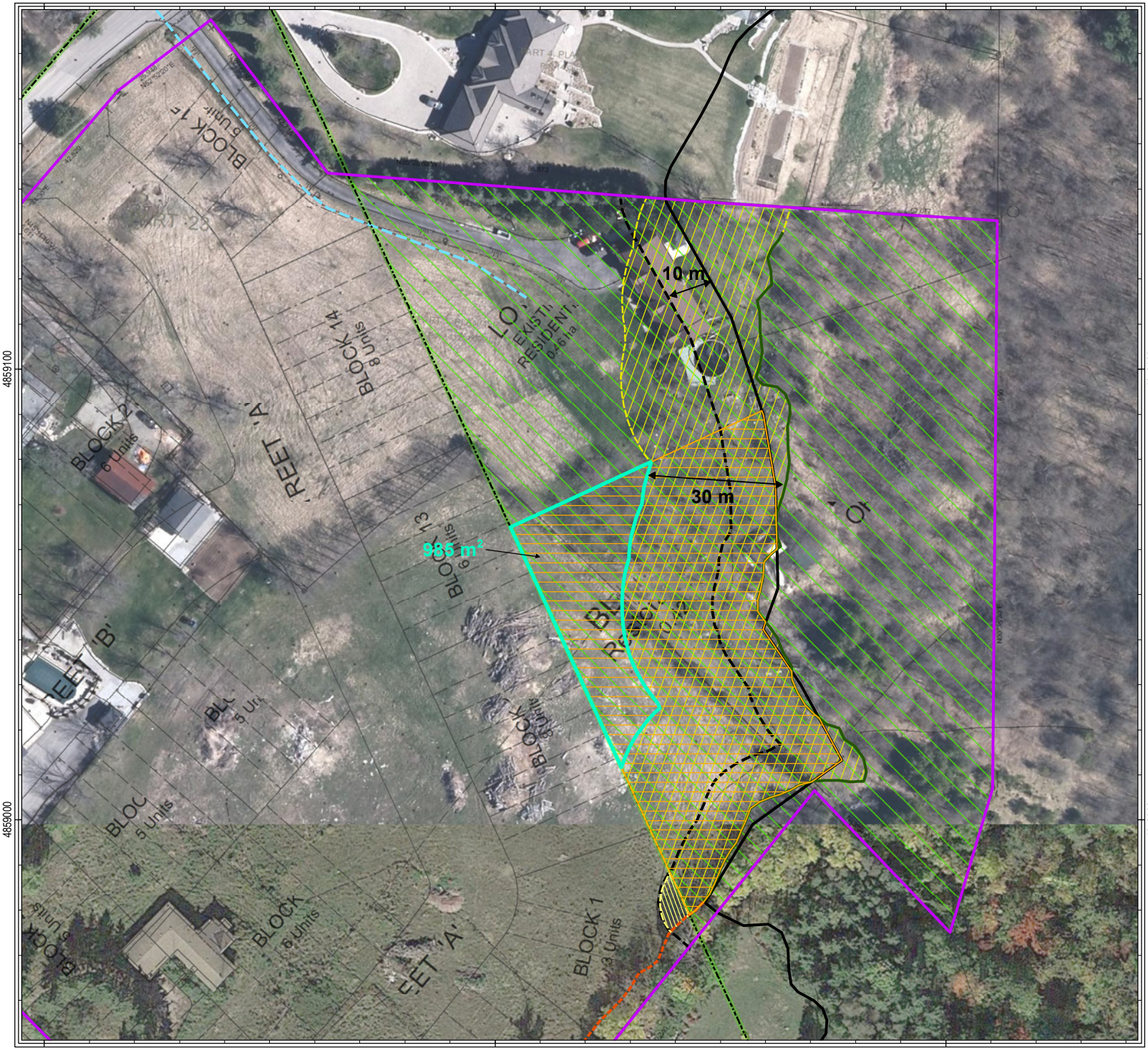
Palmer™

CLIENT: Brook Valley Homes
PROJECT: Chickadee Lane Ecology

Proposed Development Plan - NW

FIGURE 13A

Document Path: G:\Shared drives\Projects 2017\17016 - Brook Valley Homes\1701603 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\2021\1701603_Figure13A_Development Plan NW.mxd



Legend

- Approximate TRCA Generic Regulation Line
- TRCA Top of Bank and Natural Features Staked Line (23/02/16)
- TRCA Policy Top of Bank and Natural Features Setback Line (10 m)
- Significant Woodland Boundary (Palmer staked dripline - August 2018)
- Drainage Feature
- Tree Protection Zone as per Standard No. 707
- Long Term Stable Slope Line (LTSSL)
- LTSSL Erosion Hazard Setback (10m)
- Watercourse
- Watercourse Buffer (30 m)
- Greenbelt VPZ (30m)
- TRCA Policy Top of Bank and Natural Features Setback Line (10m)
- Greenbelt Protected Countryside
- Study Area
- Restoration Area
- Additional Restoration Areas

0 10 20
metres

N

DRAWN: SF/AL/BE
CHECKED: A. Adams
PROJECT: 1701603
DATE: Aug 16, 2021

Scale 1:1200
UTM Zone 17N
NAD 1983

Data Sources: Imagery ©2017 Google (southern portion). Overview basemap credits at page bottom.

Prepared by:

Palmer™

CLIENT: Brook Valley Homes
PROJECT: Chickadee Lane Ecology

Proposed Development Plan - SE

FIGURE 13B

Document Path: G:\Shared drives\Projects 2017\17016 - Brook Valley Homes\1701603 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\2021\1701603_Figure13B_Development Plan SE.mxd

Basemap Service Layer Credits: Contains information licensed under the Open Government Licence - Canada.

Table 9. Trees Proposed to be Removed

Scientific Name	Common Name	Fair to Good Health	Poor Health	Total Count
*Fraxinus americana**	White Ash	32	10	42
Acer x *freemanii**	Freeman's Maple	43	0	43
*Thuja occidentalis**	Eastern White Cedar	19	4	23
Acer negundo	Manitoba Maple	18	3	21
Acer platanoides	Norway Maple	22	2	24
Picea abies	Norway Spruce	15	1	16
Picea pungens	Blue Spruce	17	0	17
*Picea glauca**	White Spruce	12	0	12
*Ulmus americana**	American Elm	9	1	10
Populus alba	European Poplar	6	2	8
Pinus sylvestris	Scots Pine	3	3	6
*Acer saccharum**	Sugar Maple	5	0	5
*Betula papyrifera**	White Birch	4	0	4
Malus sp.	Apple species	3	0	3
Ulmus pumila	Siberian Elm	0	2	2
Salix babylonica	Weeping Willow	2	0	2
*Juglans nigra**	Black Walnut	2	0	2
Prunus sp.	Cherry species	0	0	0
Morus alba	White Mulberry	1	0	1
*Pinus strobus**	Eastern White Pine	1	0	1
*Fagus grandifolia**	American Beech	1	0	1
Prunus avium	Sweet Cherry	0	1	1
Malus baccata	Siberian Crab Apple	1	0	1
Total trees to be removed		**215**	**29**	**244**

8.1.2 Wildlife Habitat and SAR

Based on results of the SAR assessment, there is potential for impacts to SAR birds or their habitats in the area of proposed development. There are several open meadow areas on the Site that may provide habitat for open country birds, including Eastern Meadowlark and Bobolink. As the quality of the habitat is somewhat variable and generally of low quality, the necessity for species-specific surveys was reviewed by the MNRF (MNRF Correspondence, March 7, 2019 – **Appendix K**). The necessity for SAR bat surveys was also reviewed by the MNRF, as there is potential for bat maternity roost habitats in the wooded portions of the Site.

As part of the on-going consultation with MNRF, MNRF reviewed the proposed development plan and recommended avoidance and mitigation measures. MNRF concluded, based on this review, that no additional SAR or SWH surveys are required and that they had no concerns considering the proposed development plan and proposed avoidance and mitigation (**Section 9**) with the proposed development plan (MNRF Correspondence, March 7, 2019 – **Appendix K**).

Based on the results of field investigations, background review and agency consultation to date, **Table 10** below describes potential impacts to SAR and potential SAR habitat.

Table 10. SAR Impact Assessment

Feature/Function	Location	Potential Impact
SAR Bat Habitat	FOD5-8 Community	The FOD5-8 community (significant woodland) containing wildlife cavity trees of potential use as bat maternity habitat is adequately setback from the proposed development plan. Therefore, there is no potential for direct impact to SAR bat habitat. SAR bats, particularly Little Brown and Northern Long-eared Bats are tolerant of human activity and typically roost in urban environments. Therefore, no indirect impacts to their use of the woodland is expected as a result of the proposed development.
Eastern Wood Pewee	FOD5-8 Community	The FOD5-8 community (significant woodland) containing Eastern Wood Pewee habitat is adequately setback from the proposed development plan. Therefore, there is no potential for direct impact to Eastern Wood Pewee or its habitat. With the implementation of the management plan described in Section 9, including timing windows, buffer sizing and enhancements, and general mitigation recommendations, no indirect impacts are anticipated for this species (and other woodland birds).
Eastern Meadowlark and Bobolink – Potential Habitat	Open Meadow Area	Several open meadow areas with the Site may provide habitat for open country birds including Eastern Meadowlark and Bobolink. The quality of this habitat is somewhat variable and generally low quality. MNRF has review the proposed development plan and concluded that they have no concerns with respect to SAR and SAR habitat.

8.1.3 Significant Valleylands

Valleylands occur to the northwest and southeast of the Site and are associated with current and historical tributaries of the Humber River. The top of slope and natural features limit line was staked by the TRCA (February 2016) through the eastern portion of the property (**Figure 4**). Subsequently, a detailed slope stability assessment was completed by Soil Engineers Ltd (2018 & 2020) to confirm the LTSSL for the western valleylands. Both the northwestern and southeastern dripline/valley limits were delineated by Palmer in August 2018; the greater of the TRCA or Palmer delineations have been used to determine the limits of the features. There is no encroachment into the limits of the valleys (LTSSL, top of slope) proposed as part of the development plan and no potential impacts have been identified. Protection of valleyland features and functions is afforded through the establishment of appropriate setbacks (**Section 9.1.1**).

8.2 Aquatic Ecology

8.2.1 Fish Habitat

Though of limited potential, the watercourses in the forested western corner of the Site are considered to contain contributing fish habitat. No direct impacts associated with the implementation of the proposed development plan have been identified for fish and fish habitat. The protection of these aquatic features and functions are protected will be afforded through the establishment of appropriate setbacks (**Section 9.1**).

Palmer's erosion threshold assessment concluded that erosion and sedimentation would not be increased by the proposed SWM Pond outlet into the Humber River tributary at Option 2. Therefore, no impacts to fish habitat are expected as channel erosion will not be increased.

Implementation of the proposed development plan would result in the removal of a small hydrological drainage feature that occurs through the northern corner of the Site, just south of Glasgow Road. According to the results from the 2018 Palmer survey and assessment following the TRCA HDF Guidelines (TRCA, 2014), this feature can be removed with no management recommendations required.

8.2.2 Channel Erosion

Palmer completed an erosion threshold assessment along two headwater tributaries (A5 and D2) downstream of a proposed SWM pond outlet (**Figure 12**). 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) is very similar to the proposed 2-year storm event discharge from the SWM pond (0.057 m^3/s) (FSR Report, Candevcon, 2020).

This indicates that the receiving watercourse should be able to handle more frequent, smaller discharge events from the SWM pond without exceeding the erosion threshold. It is natural and expected that discharge in the intermittent channel would exceed this threshold during infrequent events (e.g. 100-year storm). The pond discharge following the 100-year storm (178 L/s) is less than the estimated bankfull

discharge, further supporting the conclusion that erosion and channel instability in Reach D2 will not be increased from the proposed development.

8.3 Hydrogeology

8.3.1 Post-Development Water Balance

8.3.1.1 Methodology

A post-development water balance was conducted using the same monthly soil-moisture balance approach (Thornthwaite and Mather, 1957) using in the pre-development water balance assessment completed in **Section 5.2.7.** and incorporates the proposed site plan land use design provided by Humphries Planning Group (HPG, 2021; **Appendix H** and **Appendix J**). The post-development was completed under two scenarios; 1) without the implementation of LIDs, and 2) with the implementation of LIDs. Doing so provides a target infiltration volume which is required to be met using LIDs to balance infiltration pre-to-post development, and also indicates if the proposed LID design is sufficient to meet those targets.

As impervious surfaces lack vegetation and prevent infiltration, the transpiration (T) component of the water balance is removed over these areas. Therefore, water available for both runoff and infiltration over impervious surfaces is precipitation minus evaporation (P-E). 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. The impervious factors that were applied to each proposed land use were based on the standard values specified in the MOE SWM Manual, combined with our current understanding of the site plan (**Appendix J**). Annual precipitation sums were determined using daily climate data through 1981 – 2010 from Albion Field Centre Climate Station.

Based on the available infiltration plan drawings for the Site (Candevcon, 2020; Drawing IT-1A; **Appendix J**) it is understood that rear year infiltration trenches are proposed within Blocks 2 – 6, 7 – 8, 16 – 21, and 22 – 26 of the development plan to enhance infiltration. These trenches have been designed to a width of 1.0 m, accommodate water to a depth of 1.0 m, and achieve a void ratio of 0.4 using filler material. Each of the proposed LID features has been designed to be at least 1 m above the true water table (as previously discussed) and also above the April 2018 groundwater level, which is considered representative of the spring high groundwater elevation. Within the townhome blocks, LIDs were designed to capture approximately 50% of rooftop runoff, as well as runoff from the contributing rear yards.

The maximum volume of water that each LID is capable of infiltrating was determined using the capture area of each LID compared with the volume of the LID available for infiltration. Runoff from the LIDs would be expected following any storm event where the volume of water directed to the LIDs exceeds the infiltration capacity. It is expected that this runoff will be directed to the SWM pond. The total annual infiltration retailed by the LIDs was determined using the sum of precipitation events over a year which are less than or equal to the size of storm event that can be held within the LID (i.e., 5 mm, 10 mm, etc.).

8.3.1.2 Results

A post-development water balance was first completed assuming no mitigation measures (such as LID strategies) are implemented at the Site (**Table 11**). Based on the most recent site plan (HPG, 2021; **Appendix H**), the total infiltration following development is estimated to be 4,257 m^3/yr, and the total runoff is approximately 46,542 m^3/yr. This represents a decrease in infiltration by approximately 53% from the pre-development scenario (9,186 m^3/yr), and an increase in runoff by approximately 110% from pre-development (46,534 m^3/yr). Note that these values represent a "worst-case" scenario as they do not account for the infiltration provided by LIDs.

A series of rear-yard catch basin style LIDs have been proposed by Candevcon in the FSR to capture runoff and promote infiltration. The design plan is provided in **Appendix J**. Based on the proposed Infiltration Plan IF-1A it is expected that these LIDs will retain 5,305 m^3/yr of infiltration (**Table 12**). This exceeds the infiltration target of 4,929 m^3/yr, and represents an overall increase of 4% from pre-development (376 m^3/yr) (**Table 13**). Post-development runoff volumes are expected to increase to 41,237 m^3/year, which represents an increase of 86% from pre-development (22,113 m^3/yr).

Ecological studies completed by Palmer did not identify any groundwater supported natural features (i.e., groundwater supported wetlands or watercourses) on or within 120 m the Site that would specifically rely on groundwater recharge from the Site. However, by increasing the groundwater recharge at the Site though the use of LID's by 4%, the water balance has been maintained, which provides an overall benefit to the Humber River watershed.

Table 11. Post-Development Water Balance (Without Mitigation)

ID	Surficial Geology	Catchment Area (ha)	Percent Impervious (%)	Impervious Area (ha)	Water Surplus on Impervious Surfaces (m/yr)	Runoff from Impervious Area (m^3/yr)	Est. Pervious Area (ha)	Water Surplus on Pervious Areas (m/yr)	Pervious Areas Runoff Coefficient	Runoff from Pervious Area (m^3/yr)	Pervious Areas Infiltration Coefficient	Infiltration from Pervious Area (m^3/yr)	Total Runoff (m^3/yr)	Total Infiltration (m^3/yr)
Single Detached Residential	Silty Clay Till	0.06	0.60	0.04	0.707	255	0.02	0.287	0.66	45	0.34	23	300	23
Street Townhouses	Silty Clay Till	3.95	0.70	2.77	0.707	19,560	1.19	0.287	0.66	2,241	0.34	1,155	21,801	1,155
Existing Residential	Silty Clay Till	0.99	0.25	0.25	0.707	1,751	0.74	0.287	0.66	1,404	0.34	724	3,155	724
Park	Silty Clay Till	0.63	0.25	0.16	0.707	1,114	0.47	0.287	0.66	894	0.34	460	2,008	460
SWM Pond	Silty Clay Till	0.60	1.00	0.60	0.707	4,244	0.00	0.287	0.66	0	0.34	0	4,244	0
Natural Heritage System	Silty Clay Till	1.75	0.00	0.00	0.707	0	1.75	0.284	0.74	3,673	0.26	1,290	3,673	1,290
Restoration Area	Silty Clay Till	0.46	0.00	0.00	0.707	0	0.46	0.287	0.66	871	0.34	449	871	449
Road + Road Widening	Silty Clay Till	1.60	0.90	1.44	0.707	10,187	0.16	0.287	0.66	303	0.34	156	10,489	156
TOTALS		**10.04**		**5.25**		**37,110**	**4.79**		**0.67**	**9,432**	**0.33**	**4,257**	**46,542**	**4,257**

Table 12. Infiltration from Proposed LIDs

LID ID	LID Trench Width (m)	LID Trench Length (m)	Area (m^2)	Depth to Water Table (approx.) (m)	Separation b/w Water Table and Base of LID (m)	LID Depth (m)	Depth of Water in LID (m)	Porosity	LID Volume (m^3)	Contributing Area (m^2)	Runoff Coefficient	Rainfall Event Storage (mm)	Runoff Volume to LID based on Rainfall Event (m^3)	Percolation Rate (mm/hr)	Drawdown Time (hr)	Annual Rainfall based on Event Storage (mm/y)	Infiltration (m^3/yr)
Block 3 and 4	1.0	107	107	4.50	3.50	1.00	0.66	0.40	28.37	1800	0.75	20.0	27.00	27.0	24.4	699.5	944.3
Block 5	1.0	48	48	4.50	3.50	1.00	0.66	0.40	12.69	900	0.75	17.5	11.81	27.0	24.4	678.2	457.8
Block 6	1.0	34	34	4.50	3.50	1.00	0.66	0.40	8.86	1100	0.75	10.0	8.25	27.0	24.4	559.4	461.5
Block 7	1.0	26	26	4.50	3.50	1.00	0.66	0.40	6.81	500	0.75	17.5	6.56	27.0	24.4	678.2	254.3
Blocks 9 and 10	1.0	91	91	4.50	3.50	1.00	0.66	0.40	23.97	1600	0.75	17.5	21.00	27.0	24.4	678.2	813.9
Block 16 and 17	1.0	46	46	4.50	3.50	1.00	0.66	0.40	12.10	700	0.75	20.0	10.50	27.0	24.4	699.5	367.2
Block 18	1.0	78	78	4.50	3.50	1.00	0.66	0.40	20.69	1400	0.75	17.5	18.38	27.0	24.4	678.2	712.1
Block 19 and 20	1.0	52	52	4.50	3.50	1.00	0.66	0.40	13.60	900	0.75	20.0	13.50	27.0	24.4	699.5	472.2
Block 21 and 22	1.0	56	56	4.50	3.50	1.00	0.66	0.40	14.72	1100	0.75	17.5	14.44	27.0	24.4	678.2	559.5
Block 23	1.0	30	30	4.50	3.50	1.00	0.66	0.40	8.05	500	0.75	20.0	7.50	27.0	24.4	699.5	262.3
TOTALS																	***5,305***

Table 13. Summary of Pre- to Post-Development Water Budget Results

Stage	Units	Runoff	Infiltration
Pre-Development	m^3/yr	22,113	9,186
Post-Development (no LID)	m^3/yr	46,542	4,257
Change Pre-to-Post Development (no LID)	% Change	110%	-54%
	Difference (m^3)	24,429	-4,929
LID Mitigation	Additional Infiltration from LID (m^3/yr)	-5,305	5,305
	Totals (m^3/yr)	41,237	9,562
Change Pre-to-Post Development (with LID)	% Change	**86%**	**4%**
	Difference (m^3/yr)	**19,124**	**376**

PART C: DETAILED ANALYSIS AND IMPLEMENTATION

9. Management Plan

The following management plan was prepared to provide guidance for the planning, design and construction of the proposed development plan, based on the results of the Part A: Existing Conditions and Part B: Impact Assessment.

9.1 Setbacks and Buffers

The term “buffer” refers to an area of land neighboring natural features that are alongside lands that are planned to undergo site alteration or development. A buffer is the lands needed to protect the ecological functions and features of the woodland from site alteration or the proposed development. The buffer width depends on the sensitivity of the feature being protected and consists of natural vegetation of variable widths. The establishment of a development “setback” is a specified distance between natural features and proposed development; a setback should encompass all necessary buffer distances (e.g., ecological, geotechnical, cultural use) from the natural features to be protected, typically with a margin of safety.

9.1.1 Valleyland

The top of slope and natural features limit line was staked by the TRCA (February 2016) through the southeastern portion of the property. Both the northwestern and southeastern valley limits were also delineated by Palmer in August 2018; the greater of the TRCA or Palmer delineations have been used to determine the limits of the features. A 10 m setback has been applied to the greater of these lines as the vegetation protection zone required under TRCA development policies. This buffer is sufficient to protect the valleyland features and associated functions from impacts associated with the proposed development. No intrusions are proposed into this valleyland/top of slope setback area, which are all contained within the 30 m significant woodland MVPZ.

The LTSSL has been determined in the western portion of the Site associated with valleylands for a tributary of the Humber River and a 10 m erosion hazard limit established. The top of slope and natural features limit line was staked by the TRCA (February 2016) through the eastern portion of the property. A 10 m setback has been applied to the top of slope line to address setback from the hazard lands, and a 10 m vegetation protection zone has been established from the staked natural features limit as required under TRCA development policies

9.1.2 Watercourses

The watercourses in the forested northwestern corner of the Site contain contributing fish habitat. The proposed development plan provides for a 30 m setback from these features. These setbacks are

contained within the overall significant woodland setback (**Section 9.1.3**) and are sufficient to protect watercourse features from potential impacts.

9.1.3 Woodland

The significant woodland adjacent to the proposed development lands supports the following ecological features and functions:

- Mature Sugar Maple dominated forest with diverse representation of flora;
- Habitat for a Special Concern species (Eastern Wood-Pewee);
- Woodland habitat for forest bird species, including area-sensitive species;
- Surface water infiltration, attenuation and sediment retention; and
- Wildlife movement corridor and linkage.

The proposed Draft Plan of Subdivision has been designed to provide the necessary setbacks to significant woodlands, namely a 30 m MVPZ within the Greenbelt Plan area, and 10 m setbacks outside, as per Regional and Municipal Official Plan policies and TRCA development policies, following the Greenbelt Plan Technical Paper (OMNR, 2012). To ensure a net environmental gain, additional restoration areas have also been provided adjacent to the required setbacks, including 296 m^2 in the northwest (**Figure 13a**) and 985 m^2 in the southeast (**Figure 13b**).

In the southeast corner, Lots 11 and 12 have been adjusted to accommodate the TRCA 10 m development policy setback, incorporating the Top of Slope and contiguous vegetation.

In the northwest, a minor encroachment is required into the 10 m setback outside the Greenbelt Plan, to facilitate the redevelopment of the existing road allowance (Street C, **Figure 13a**). Street C, as proposed, utilizes an existing roadway between Glasglow Road and Emil Kolb Parkway that has been stopped up and closed under by-law 2014-065. This road is existing infrastructure to be re-invigorated, subject to the Environmental Assessment process, and serves the significant growth and economic development expected in southern Ontario beyond the Greenbelt. The redevelopment of this roadway (Street C) would result in approximately 165 m^2(0.0165 ha) within the 10 m policy setback, with no encroachment into the natural features themselves.

The development of the Stormwater Management Pond (**Figure 13a**) may require grading within the 30 m MVPZ during construction, but will be located outside the MVPZ post-construction. A recreational trail is proposed immediately adjacent to the 2021 updated SWM pond location to allow for passive recreational use of the area and will be constructed within lands graded to accommodate the SWM pond to not increase the disturbance within the MVPZ. Restoration of the MVPZ (**Section 9.3**) will improve the 30 m MVPZ, including grading to a condition better than current conditions.

The additional restoration areas are far in excess of the minor encroachments described above, which utilize existing disturbances in the case of Street C, and are temporary in the case of grading for the Stormwater Management Pond. There are no encroachments into the features themselves, and the additional restoration area ensures a net ecological gain in area (**Section 9.2**).

9.2 Net Ecological Gain

The proposed management plan outlines the methods to be implemented that will increase the extent and diversity of the natural heritage system from that which exists pre-development. By providing the proposed additional restoration lands, and restoration measures for both the ecological setbacks and the additional restoration lands, a net ecological gain shall be achieved by increasing the net area of woodland and implementing related habitat enhancements.

9.2.1 Additional Restoration Area

It is an objective of the proposed development plan to improve ecological conditions (compared to pre-development). Towards that end, an additional restoration area is proposed that is contiguous with the southeastern MVPZ area (**Figure 13b).** This approach maintains the current natural features and corridors in this location, while providing a net gain of 985 m^2 to the natural heritage system and MVPZ. In the northwest, another 296 m^2 additional restoration is available, which could be considered to offset the 165 m^2 minor encroachment necessary for the re-invigoration of Street C (**Figure 13a**).

9.3 Restoration

9.3.1 Restoration and Enhancement

The management plan also proposes to provide enhancement/re-vegetation of setback areas and additional restoration areas to augment the existing natural areas and ecological functions. To support the enhancement of the setbacks and additional restoration areas and achieve the intended ecological functions, the following approaches are proposed to be implemented as part of the development. This includes the establishment and management of the setback land, including the additional restoration area.

Additional mitigation and enhancement in the required setbacks and additional restoration areas will include tree and shrub plantings so that the area will support *natural self-sustaining vegetation*. Enhancing setbacks (plantings) is an approach that provides for the early establishment of vegetation and habitat opportunities for many species. To further support the development and enhancement of the setbacks and achieve the intended functions, the following plan is proposed:

- Develop a setback planting plan and management/monitoring requirements in consultation with the relevant agencies.
- Where required, remove soil compaction and enrich soils with organics (e.g., compost/mulch).
- Proactively remove the shed and garbage from the southeast area that is currently within the forest edge.
- Implement a plan for the management of invasive species.
- Complete the vegetation planting as early as possible as part of the build-out phase of the development; this would include the establishment of barrier and sediment/erosion control fencing between the development and the restoration areas, and regular environmental inspection.
- Management and monitoring in accordance with recommendations made in Section 11.

9.3.2 Restoration Areas

The proposed development plan includes two primary restoration areas, located in the northwestern portion of the Site (Block 29, **Figure 13a**) and the southeastern portion of the Site (Block 34, **Figure 13b**). The restoration area includes the 30 m MVPZ within these blocks, and also includes the additional restoration area of and 985 m^2 (0.099 ha) in the southeast. A recommended planting plan for this area has been developed as part of the accompanying Arborist Report (**Appendix H**).

An additional 296 m^2 (0.03 ha) area with restoration potential has been included in the proposed plan (Block 35, **Figure 13a**). Despite the small size and fairly isolated nature, it does provide some limited restoration potential. It is recommended that this area also be planted with native tree and/or shrub species.

9.4 Timing Windows

An avoidance window of late April – October 31 is recommended to both avoid potential conflicts with bat SAR and provide compliance with the Migratory Bird Convention Act. Although the gully feature is not considered fish habitat, erosion mitigation works within the gully feature should occur outside of the warm water fisheries timing window.

9.5 Low Impact Development (LID)

LID Swales (rear-yard infiltration trenches) will be located at the rear of Blocks 2 – 6, 7 – 8, 16 – 21, and 22 – 26 of the development plan to enhance infiltration, as detailed in **Table 12** and **Appendix J**. These trenches have been designed to a width of 1.0 m, accommodate water to a depth of 1.0 m, and achieve a void ratio of 0.4 using filler material. Each of the proposed LID features has been designed to be at least 1 m above the true water table (as previously discussed) and also above the April 2018 groundwater level, which is considered representative of the spring high groundwater elevation. Within the townhome blocks, LIDs were designed to capture approximately 50% of rooftop runoff, as well as runoff from the contributing rear yards.

The results of the water balance analysis determined that pre-to-post development infiltration will be increased by 4%. While no groundwater supported natural features were identified within 120 m of the study area, this result provides an overall environmental benefit to the Humber River watershed.

9.6 Stormwater Management

Stormwater management facilities are permitted within the Greenbelt Plan, Protected Countryside Area. Facility and outfall designs (determined through the Functional Servicing Report and detailed engineering design) have been established in a manner that minimizes ecological impacts to the valley system and associated ecological features and functions. The location of the proposed SWM pond is shown on **Figure 13a**. The proposed naturalized SWM facility design details will be provided in the accompanying Servicing Report. The SWM Pond design is presented in **Appendix I**.

Construction of the SWM Pond outlet will be completed using a combination of directional drilling and/ or open cut excavations between the SWM Pond and the outfall location in Reach A5. The outfall path presented on the SWM drawings in **Appendix I** was specifically selected to avoid mature trees, minimize vegetation removals and allow for a safe working slope. Additional mitigation details and a construction plan can be provided to TRCA and the Town for comment during detailed design.

9.7 Erosion and Sediment Control

The following erosion and sediment control recommendations are provided for incorporation into the final Erosion and Sediment Plan:

- To minimize the potential for erosion and off-site transport of sediment into surface drainage areas and the natural environment, the project will implement Best Practices related to erosion and sediment control (ESC). ESC measures used by the contractor on all construction should meet guidelines as outlined in Erosion and Sediment Control Guideline for Urban Construction, December 2006 (ESC Guideline), prepared by the Greater Golden Horseshoe Area Conservation Authorities (GGHACA), or equivalent standards.

- Sediment and erosion control fencing should remain in place until the woodland buffer and enhancement plantings have been completed.

- All exposed and newly constructed surfaces should be stabilized using appropriate means in accordance with the characteristics of the exposed soils. These surfaces should be fully stabilized and re-vegetated as quickly as possible following the completion of the works, with native vegetation ground cover.

- Construction of the SWM pond headwall in Reach A5 will be completed to minimize vegetation removals and works in the channel. A construction plan can be provided to TRCA and the Town for comment during detailed design. Works should be timed such that the channel will be dry.

10. Policy Conformity

10.1 Provincial Policy Statement

The Provincial Policy Statement lists natural heritage features for which development and site alternation are not permitted under the policies of the PPS, or are not permitted *"unless it has been demonstrated that there will be no negative impacts on the natural features or their ecological functions*". Within the project study area, the following natural heritage features have been identified:

- Significant Woodlands;
- Significant Valleylands
- Candidate Significant Wildlife Habitat;
- Fish habitat; and
- Potential Habitat of Endangered and Threatened species.

The proposed development plan does not encroach into these features. Through the implementation of setbacks and proposed mitigation measures, no impacts are anticipated to these features or their functions.

10.2 Greenbelt Plan

Under the Greenbelt Plan, lands through the northwestern and southeastern corners of the property are designated as part of the Natural Heritage System of the Protected Countryside. Proposed development must demonstrate that there will be no negative impacts to key natural heritage features and key hydrologic features or their functions, as well as no negative impact on biodiversity or connectivity of the Natural Heritage System.

General infrastructure and Stormwater Management policies for lands within the Protected Countryside are set out in Section 4.2.1 and Section 4.2.3 of the Greenbelt Plan, respectively. **Table 14** below summarizes relevant policies of the Greenbelt Plan and the manner in which the proposed development plan meets the requirements of the Plan.

Table 14. Conformity with the Greenbelt Plan – Natural Environment

Policy Section	Plan Intent/Objective	Proposed Development Plan Implications and Conformity
3.2.2 Natural Heritage System Policies	(3) New development or site alteration in the Natural Heritage System (as permitted by the policies of this Plan) shall demonstrate that:	
	(a) There will be no *negative* impacts on *key natural heritage features* or *key hydrologic features* or their functions;	KNHF and KHF have been identified within and adjacent to the project Site, and a 30 m MVPZ applied to these features. No development or site alternation is proposed within the identified KNHF or their MVPZ, with the exception of temporary grading and access trail (portions), necessary to develop the stormwater management pond. Restoration will improve the grading area to conditions better than current conditions. No negative impacts are anticipated to KNHF or KHF or their functions as a result of the implementation of the proposed development plan.
	(b) *Connectivity* along the system and between *key natural heritage features* and *key hydrologic features* located within 240 m of each other will be maintained or, where possible enhanced for the movement of native plants and animals across the landscape;	Connectivity between features is maintained and enhanced through the incorporation of setbacks/buffers and the proposed restoration of buffer areas and additional restoration areas with the objective to enhance existing features and their functions, and connectivity between features of the Natural Heritage System.

Policy Section	Plan Intent/Objective	Proposed Development Plan Implications and Conformity
	(c) The removal of other natural features not identified as *key natural heritage features* or *key hydrologic features* should be avoided. Such features should be incorporated into the planning and design of the proposed use whenever possible;	The proposed plan has aimed to avoid and minimize the removal and/or impact to natural heritage features where possible. The restoration plan for the Site aims to offset the removal of any natural heritage features in a manner that enhances the quality and function of existing features.
3.2.5 Key Natural Heritage Features and Key Hydrologic Features Policies	For lands within a key natural heritage feature or a key hydrologic feature in the Protected Countryside, the following policies shall apply:	
	(1) Development or site alteration is not permitted in *key hydrologic features* and *key natural heritage features* within the Natural Heritage System, including any associated *vegetation protection zone*, with the exception of: c) *Infrastructure*, aggregate, *recreational*, shoreline and existing uses, as described by and subject to the policies of section 4.	As noted above, no development or site alternation is proposed within the identified KNHF, KHF or their VPZ, with the exception of temporary grading and access trail within the VPZ to develop the stormwater management pond, where currently developed lawn area will be restored to better than current conditions. The trail is permissible under section 4.
	(4) In the case of *wetlands*, *seepage areas and springs, fish habitat, permanent and intermittent streams, lakes* and *significant woodlands*, the minimum vegetation protection zone shall be a minimum of 30 m measured from the outside boundary of the key natural heritage feature or key hydrologic feature.	A 30 m VPZ has been applied to KNHF and KHF, within which no development or site alternation is proposed (with the exception of temporary grading and access trail, which will be restored to better than current conditions). The trail is permissible under section 4.
4.1.2 Recreational Use Policies	(2) An application to establish or expand a major recreational use in the Natural Heritage System shall be accompanied by a vegetation enhancement plan that incorporates planning, design, landscaping and construction measures that:	
	a) Maintain or, where possible, enhance the amount of self-sustaining vegetation on the site and the connectivity between adjacent *key natural heritage features* or *key hydrologic features;*	While not considered a major recreational use, or within the NHS, these policies are reviewed in relation to the trail adjacent to the SWM Pond, which will become part of the local trail network.
	b) Wherever possible, keep intermittent stream channels and drainage swales in a free-to-grow, low-maintenance conditions,	Adjacent to KNHF, recreational uses are limited to a trail area along the stormwater management berm, partially located within the

Policy Section	Plan Intent/Objective	Proposed Development Plan Implications and Conformity
	c) Minimize the application and use of pesticide and fertilizers; and	30 m woodland MVPZ. This area will be planted with *natural, self-sustaining vegetation*, to enhance the ecological functions and connectivity of the adjacent KNHF and VPZ. The limited amount of trail system located within the MVPZ is small-scale and permitted by policy 4.1.2.4. The amount of trail within the MVPZ has been minimized by the SWM pond design, and will be mitigated by restoration.
	d) Locate new *natural self-sustaining vegetation* in areas that maximize the *ecological functions* and *ecological value* of the area.	
	3. An application to expand or establish a *major recreational use* shall be accompanied by a conservation plan demonstrating how water, nutrient and biocide use shall be kept to a minimum, including through the establishment and monitoring of targets.	
	4. Small-scale structure for recreational use (such as boardwalks, footbridges, fences, docks and picnic facilities) are permitted within *key natural heritage features* and *key hydrologic features*; however, the number of such structures and the negative impacts on these features should be minimized.	
Section 4.2.1 General Infrastructure Policies	(1) All existing, expanded or new infrastructure subject to and approved under the Canadian Environmental Assessment Act, the Environmental Assessment Act, the Planning Act or which receives a similar environmental approval, is permitted within the Protected Countryside, subject to the polices of this section.	
4.2.3 Stormwater Management Policies	Stormwater management systems are prohibited in the key natural heritage feature and their associated vegetation protection zones… e) Within those portions of the Protected Countryside that define major river valleys that connect the Niagara Escarpment and Oak Ridges Moraine to Lake Ontario, naturalized stormwater management systems may be permitted within the *vegetation protection zone* of a *significant valleyland*, provided they are located a minimum of 30 m from the river or stream and they are located outside the *vegetation protection zone* of any other *key natural heritage feature* or *key hydrologic feature*.	The accompanying Servicing Plan demonstrates conformity with the requirements/intent of the policies of Section 4.2.3 related to the planning, design and construction practices. The proposed naturalized stormwater management facility is located entirely outside of key natural heritage and key hydrologic features and their MVPZ. Temporary grading is required within the MVPZ to develop the stormwater management pond, which will be restored to better than current conditions. Limited portions of the adjacent trail/access will be within the 30 m woodland MVPZ, but are permissible under 4.1.2.4.

10.3 Region of Peel Official Plan

The natural heritage features in the Region of Peel are protected by its Greenlands System (Official Plan – Schedule A). The northwestern portion of the Site and areas to the southeast of the Site are designated as Core Areas of the Regional Greenlands System. These areas are designated as significant woodland and are protected as part of the development plan.

10.4 Town of Caledon Official Plan

Schedule C of the Town of Caledon Official Plan identifies designated Environmental Policy Area (EPA) through the western section and adjacent to the southeastern corner of the Site (**Section 2.1.3**). These EPAs are primarily within designated Protected Countryside under the Greenbelt Plan. EPA within the Site (northwest corner) will be protected and an appropriate buffer has been provided along the significant woodland feature in this area.

10.5 Endangered Species Act

Screening for significant habitat of endangered or threatened species and/or significant wildlife habitat show that there are potential SAR habitats within and adjacent to the Site. However, these habitats will either be avoided by development or hold ecological limitations as viable habitats. As part of the proposed mitigation/management plan, enhancement of buffer habitats will be implemented. Correspondence with the MNRF confirms that considering the proposed development plan and proposed avoidance and mitigation (Section 9) there are no SAR concerns related to the proposed development plan (MNRF Correspondence, March 7, 2019 – **Appendix K**).

10.6 TRCA Ont. Reg. 166/06 and the Living City Policies and Regulations

The project Site falls within the jurisdiction of the TRCA. Watercourses and their associated flood limit within the Site, are regulated under the TRCA O. Reg. 166/06 – Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses. TRCA Regulated Area lands exist within the limits of the Site, at the northwestern and southeastern corners, in association with watercourse and valleyland features. Development within these areas will be subject to approvals and permitting from the TRCA.

The proposed development plan conforms to the buffer requirements as stated in the Living City Policies (TRCA, 2014), for valley or stream corridors. The proposed plan provides for a *10 m buffer from the greater of the long-term stable top of slope/bank, stable toe of slope, Regulatory flood plain, meander belt and any contiguous natural features or areas*. The HDF feature within the project area was determined to be of a class that does not require management. There were no wetlands or other water features observed within the Site.

11. Monitoring and Adaptive Management

A scoped post-development monitoring program is recommended to assess the performance of the implemented design. Monitoring observations can also be used to determine the need for remedial works. The recommended monitoring program includes vegetation survivorship and composition monitoring within the proposed restoration areas, and erosion monitoring of the SWM Pond outlet channel.

11.1 Restoration Area(s)

It is recommended that the integrity of the restoration areas be assessed over time in order to effectively monitor the (i) structure and composition, (ii) buffer condition, and (iii) survivorship of planted material. This vegetation monitoring will provide qualitative data to describe changes to vegetation structure and composition over time, identify type and magnitude of construction-related disturbances and evaluate the effectiveness of restoration plantings for woody and non-woody material. It is recommended that monitoring be initiated in the year of planting/restoration and repeated annually for the guarantee period of the planted stock.

Based on the monitoring outcomes, the adaptive management response may involve the implementation of management strategies as necessary to achieve the desired vegetation form (structure and composition) and to reduce establishment stress. Planting failures should be rectified to achieve the desired density and height.

11.2 Erosion Management

A erosion management program should be developed to document adjustment in morphology along the gully bottom and sidewalls, and the connecting drainage networks, and adapt erosion controls as needed during and following completion of the SWM Pond. This monitoring program should focus on Reaches A4 and A5 downsteam of the Site. (**Figure 12**). The following erosion monitoring program is recommneded:

- Monitor the establishment and success of the erosion mitigations seasonally during subdivision construction, and following high flow events; and
- Collect a photograph record of the channel from the same vantage point during each monitoring event.

Based on the monitoring outcomes, a qualified person should assess the erosion potential and make recommendations for further actions, if required. The adaptive management response may involve the implementation of additional mitigation measures as necessary. Adaptive alternatives for SWM pond discharge could include:

- Maintanace, additional of cobble/boulder steps and headwall pile, woody debris, and live stakes along the base and sidewall of the gully; or
- Dissipate the volume of flow discharged from the SWM pond by more broadly distributing it across the northern portion of the Site. Additional erosion mitigations may be requried depending upon the discharge location and volume of flow.

12. Summary

Part A of the CEISMP provides a summary of the natural heritage and hydrogeological findings to date to identify the local Natural Heritage System to guide the development potential of the Chickadee Lane Rounding Out Area B lands. Environmental constraints have been determined, as part of this process, through field investigations, assessment of significance and through agency consultation.

For Part B of the CEISMP, a review and confirmation of the constraints and opportunities was completed with the design and planning teams before proposing the preferred land use planning scenarios. Through collaboration with technical experts and the land use planning team, the optimum development plan, which minimizes environmental impact and meets integrated community design objectives was developed. The EIS component of Part B utilizes the existing ecological conditions established in Part A as a foundation for the determination/confirmation of appropriate development limits, the identification of potential impacts and the recommendation of appropriate general and site-specific mitigation measures.

An Arborist Report has also been completed by Palmer as a component of the CEISMP Part B and EIS Report, which includes information collected during the tree inventory, the identification of trees for removal, replacement tree recommendations and tree protection measures.

Part C of the CEISMP includes recommendations for monitoring and adaptive management, with a focus on ensuring success of the proposed restoration and managing the potential for downstream erosion. Pre-to-post development infiltration rates have been increased and the optimal SWM Pond outlet location has been selected based on a comparative analysis assessment.

13. Certification

This report was prepared and reviewed by the undersigned.

In recognition of the Practice of Geoscience and Ecology in Ontario, this report was originally prepared by Adrian Lo, GIT., and Jennifer Paterson, M.Sc., who are no longer with Palmer.

The minor report updates from the December 29, 2021 version of this report to reflect the 2021 Draft Plan were completed by Austin Adams, M.Sc., EP and Jason Cole, M.Sc., P.Geo.

Reviewed by:

Austin Adams, M.Sc., EP
Senior Terrestrial Ecologist

Reviewed and Approved by:

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

References

Bird Studies Canada. 2001. Ontario Breeding Bird Atlas Guide for Participants. Retrieved from: https://www.birdsontario.org/download/atlas_feb03.pdf

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

COSEWIC. 2018. Committee on the Status of Endangered Wildlife in Canada. Retrieved from: https://www.canada.ca/en/environment-climate-change/services/committee-status-endangered-wildlife.html

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

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

Gao, P. (2013). Rill and Gully Development Processes. In *Treatise on Geomorphology* (Vol. 7, pp. 122-131). Elsevier Inc.

Harrelson, C.C., C. Rawlins, and J. Potyondy, 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Techniques. USDA Forest Service Rocky Mountain Forest and Range Experiment Station General Technical Report RM-245, 67 p.

Hjulstrom, 1935. Studies of the morphological activity of rivers as illistrated by the River Fyris, Bulletin of the Geological Institute University of Uppssala 25, npg 221-527.

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

Knighton, D., 1998. Fluvial Forms & Processes. A New Perspective. Arnold, London.

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

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

Ministry of Municipal Housing and Affairs. 2020. Provincial Policy Statement 2020. Ministry of Municipal Housing and Affairs. Toronto.

Ministry of Natural Resources and Forestry (MNRF). 2015: Significant Wildlife Habitat Criteria Schedules For Ecoregion 7E.

Ministry of Natural Resources and Forestry (MNRF). 2018. Natural Heritage Information Centre Species Lists. https://www.ontario.ca/page/get-natural-heritage-information

Natureserve. 2018. Natureserve Canada. Retrieved from: http://www.natureserve.org/natureserve-network/canada/about-our-cdcs

North-South Environmental Inc., Dougan & Associates and Sorensen Gravely Lowes. 2009. *Peel-Caledon Significant Woodlands and Significant Wildlife Habitat Study*. Report prepared for the Region of Peel and the Town of Caledon, Ontario. *xi* + 187 pp + app.

Ontario Ministry of Natural Resources (OMNR). 2000. Significant Wildlife Habitat Technical Guide. 151 pp.

Ontario Ministry of Natural Resources (OMNR). 2012. Greenbelt Plan 2005 – Technical Paper 1: Technical Definitions and Criteria for Key Natural Heritage Features in the Natural Heritage System of the Protected Countryside Area. http://www.mah.gov.on.ca/AssetFactory.aspx?did=13608

Palmer. 2018. Hydrogeological Investigation – Chickadee Lane Rounding Out Area B, Bolton, Ontario.

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

Soil Engineers, Aug 2020. A Supplementary Slope Stability Assessment Proposed Residential Development, Chickadee Lane and Glasgow Road, Town of Caledon. No. 1801-S032

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

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

Toronto and Region Conservation Authority (TRCA). (2008a). Planning and Development Procedural Manual.

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

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

Toronto and Region Conservation Authority and Credit Valley Conservation. 2013. Evaluation, Classification and Management of Headwater Drainage Features Guideline. TRCA Approval July 2013 (Finalized January 2014).

Toronto and Region Conservation Authority (TRCA). 2014. The Living City Policies for Planning and Development in the Watersheds of the Toronto and Region Conservation Authority.

Wolman, M.G., 1954. A method of sampling coarse river-bed material. Transactions of the American Geophysical Union, 35(6), p. 951-956.

Appendix A

Phase 3 Preliminary Natural Heritage System Study (Dougan & Associates, 2014)

BOLTON RESIDENTIAL EXPANSION STUDY: PHASE 3
TECHNICAL MEMORANDUM – DEVELOPMENT OF A PRELIMINARY NATURAL HERITAGE SYSTEM

Sunrise over The Gore Road, July 2013.

Revised June 16, 2014

Prepared for

Town of Caledon

By

Dougan & Associates
Aquafor Beech Ltd.
Cam Portt & Associates
BluePlan Engineering Consultants Ltd.
Meridian Planning

TABLE OF CONTENTS

FIGURES

APPENDICES

1. INTRODUCTION

Dougan & Associates was retained by the Town of Caledon in May 2013 to undertake an Environmental Impact Study (EIS) for a preferred residential expansion area, as part of the larger Bolton Residential Expansion Study (BRES). For the preparation of the Preliminary Natural Heritage System, Dougan & Associates is being supported by C. Portt and Associates (fisheries biologists) and Aquafor Beech Limited.

Phase 1 of this project involved developing evaluation criteria to be used to evaluate the Options for expansion, including environmental impacts and opportunities for enhancement. Phase 2 involved the screening and ranking of the Options, with the results summarized in a technical memorandum dated June 19, 2013. This memorandum summarized the data sources accessed to document the BRES area, the criteria applied to the six (6) residential expansion Options, rationale for factors considered to rank Options, and important considerations regarding the approach.

Phase 3 of this project involved developing a Preliminary Natural Heritage System (NHS), in accordance with Region of Peel requirements, for the two option areas (1 and 3) that were identified by Council as requiring further evaluation in June 2013. Phase 3 also involved a review of the three Rounding Out Areas that are also being brought forward for consideration by the Study Team. This technical memorandum summarizes the field work undertaken to gather the necessary natural heritage information, the map layers used to determine the boundaries of the NHS, the policies that determined the appropriate buffers for various components of the NHS, and, finally, presents a conceptual map of the NHS for Options 1 and 3 as well as the three Rounding Out Areas.

The phases outlined above are part of the larger Comprehensive Environmental Impact Study and Management Plan (CEISMP) process for the Bolton Residential Expansion Study. A work plan for the CEISMP was circulated to the Region of Peel and TRCA in November 2013. It is our understanding that the work plan was considered acceptable by the TRCA.

2. BACKGROUND DATA COLLECTION

2.1. NATURAL HERITAGE AND AQUATIC RESOURCES

Data were obtained from the Town of Caledon and Toronto and Region Conservation Authority (TRCA), and encompasses a wide range of relevant digital data available from the Town and TRCA through their internal departments, and through their data sharing agreements with the Ontario Ministry of Natural Resources and Region of Peel. This data is summarized in Appendix 1 of the *Bolton Residential Expansion Study: Phase 2, Technical Memorandum – Natural Heritage*, dated June 19, 2013.
In summary, this digital data included the following:

- Significant faunal and plant records (TRCA data);
- Caledon wetlands (TRCA);
- Humber River Fisheries Management Plan stream classification (TRCA);
- Caledon Earth and Life Science ANSIs (MNR);
- Greenbelt limits (Town of Caledon);
- Peel and Caledon Significant Woodlands (Peel Region);
- MNR and TRCA fisheries data (species location records) for the Humber River watershed; and
- Redside Dace Occupied Habitat (Peel Region).

Additional background information that was reviewed includes the following:

- Natural Heritage Information Centre element occurrence database;
- Various faunal resources (e.g. Ontario Mammal Atlas, Ontario Herpetofaunal Atlas);
- Ontario Breeding Bird Atlas (2001 – 2005);
- Ontbirds listserve observational data (2008 – 2013);
- Bolton North Hill Preliminary Natural Heritage Review and Preliminary Community Structure Plan (Beacon Environmental 2013) which covers significant portions of BRES Option 1 lands;
- South Albion-Bolton Community Plan – Employment Land Needs Study and North Hill Supermarket Comprehensive Environmental Impact Study and Management Plan Phase 1 Report (Aquafor Beech and NRSI 2009) which covers parts of BRES Option 1 land and areas adjacent to both BRES Options 1 and 3 lands;
- Bolton Arterial Road Environmental Assessment data (for parts of Option 1 area);
- Evaluation, Classification and Management of Headwater Drainage Features: Interim Guidelines (CVC & TRCA 2009); and
- Region of Peel Watermain Environmental Assessment.

An Information Request Form was submitted to the MNR on November 1, 2013, for any natural heritage features and element occurrences in the Bolton Residential Expansion Study area. A Species-at-Risk Screening letter was received on January 2, 2014, outlining records for the following five Species-at-Risk: Bobolink, Butternut, Eastern Meadowlark, Redside Dace, and Snapping Turtle. All of these species will be searched for during the 2014 field season.

The MNR was contacted regarding background wetland information for the option areas. This correspondence is as follows:

- July 31, 2013 – information request to Steve Varga (OMNR Aurora District Wetland Biologist) for wetland mapping for the study area;
- April 18, 2014 – second information request to Steve Varga (MNR Aurora District Wetland Biologist) to request wetland mapping for the study area.

A formal response has not been received from MNR however we have included all identified wetlands within the Preliminary NHS.

2.2. HEADWATER DRAINAGE FEATURES

Aquafor Beech Limited accessed all watercourses on the option 1 and 3 lands, and produced a report *Preliminary Headwater Drainage Feature Assessment: Mapping and Management Recommendations* (November 25, 2013).

Unlike a watercourse with an identifiable and permanent channel in which flow of water occurs regularly or continuously, a headwater drainage feature (HDF) is not considered to be a permanently flowing drainage feature and are often first order or zero order intermittent and ephemeral channels. The alteration or removal of an HDF can have broad implications for water quality and quantity, recharge/infiltration, and the overall health of local HDFs and downstream habitats.

Evaluation of all HDFs within Option 1 and 3 lands follows the most recent protocol developed by TRCA. The protocol *Evaluation, Classification and Management of Headwater Drainage Features* (TRCA, 2013), utilizes standard survey methods and a tiered study design to establish risk of functional impairment to an HDF through land development. The protocol takes into consideration the existing form and function of the HDF, and uses existing modules of the *Ontario Stream Assessment Protocol* (OSAP) to facilitate effective comparisons between features and ultimately the management recommendation.

Steps involved in HDF assessment include:

- Evaluation; desktop evaluation of HDFs to determine sampling locations and project scope,
- Classification; proper classification of HDF hydrology, riparian corridor and terrestrial habitat, aquatic habitat and fish communities.
- Management Recommendation; each HDF will be given a management recommendation based on above assigned classification. Potential recommendations include; protection, conservation, mitigation, recharge, maintain terrestrial linkage and no management required.

3. SUMMARY OF FIELD INVESTIGATIONS

3.1. NATURAL HERITAGE

In November and December 2013, Dougan & Associates collected Ecological Land Classification data for both Options 1 and 3, as well as the three Rounding Out Areas. All properties with potential significant natural heritage features were visited after the Town had arranged permission to access. Furthermore, adjacent lands to 120 metres beyond the boundaries of the study area were assessed, including TRCA lands. Wetland boundaries were mapped if not already evaluated; MNR has been contacted to verify wetland records.

Additional visits were made to the study area to screen for seasonal indicators of Significant Wildlife Habitat in November and December 2013, with particular attention paid to potential suitable habitats for open country Species-at-Risk birds that are presumed to exist: Barn Swallow, Bobolink and Eastern Meadowlark. Other key wildlife habitat, including candidate Significant Wildlife Habitat and habitats for other potentially occurring Species-at-Risk, such as Chimney Swift and Monarch, were also searched for.

Potential restoration and enhancement areas and drainage features were identified during November by Dougan & Associates. These areas have been mapped accordingly on the Preliminary NHS maps.

Finally, Dougan & Associates conducted preliminary roadside breeding bird surveys in early July 2013. These surveys allowed for the collection of some breeding bird data and will assist in scoping the surveys planned for June 2014.

3.2. *HEADWATER DRAINAGE FEATURES*

In November 2013 Aquafor Beech undertook the field component of the HDF assessment, investigating all features for Option 1 and 3 lands as identified from preliminary review of historical aerial images, and prior site knowledge. TRCAs presence was requested for the on-site investigation but was not available. Due to site conditions in November (light snow, low flow in channels) the assessment of the HDFs should be viewed as preliminary and may require review and further field work at a later date.

During the field investigation of Option 3, a total of 4 HDFs were viewed and subsequently separated into a total of 16 reaches. The field investigation of Option 1 produced a total of 8 HDFs subsequently separated into 24 reaches. These are shown on Figures 1 and 2, respectively. Stream reaches are lengths of channel that display relative homogeneity with respect to the controlling and modifying influences of channel form. As such, channel characteristics, functions and processes are relatively constant within a reach, and reaches can be used to help identify management objectives and restoration opportunities. Reaches were defined by key factors, including hydrology, gradient, geology, valley setting, sinuosity, and riparian vegetation.

Each reach delineation, developed through desktop practices and confirmed in the field, received a classification and ranking based on hydrology, riparian corridor/ terrestrial habitat and aquatics/ fish habitat to which a management recommendation was applied.

Within Option 3 lands, 3 HDF reaches received a recommendation for protection or conservation based on contributing important hydrology and riparian vegetation (Figure 1). For reaches recommended for protection, the relocation of the channel is not permitted, however enhancement can be made using natural channel design, groundwater access must be maintained or enhanced and there can be no disruption to downstream connections. HDF reaches recommended for conservation may be relocated using natural channel design but not preferred. The remaining reaches recommended for mitigation require the land remain open with maintained or replicated groundwater recharge using bioswales, LIDs or constructed wetlands.

Within option 1 lands, all HDFs that received a management recommendation of protection or conservation are outside the proposed boundary limits for development (Figure 2). The remaining HDF reaches are recommended as mitigation (implications for development mentioned above) and maintain recharge for which the overall groundwater infiltration rates must be maintained.

Spring assessments of the HDFs are currently underway (spring 2014) to confirm and finalize reach classifications and management recommendations.

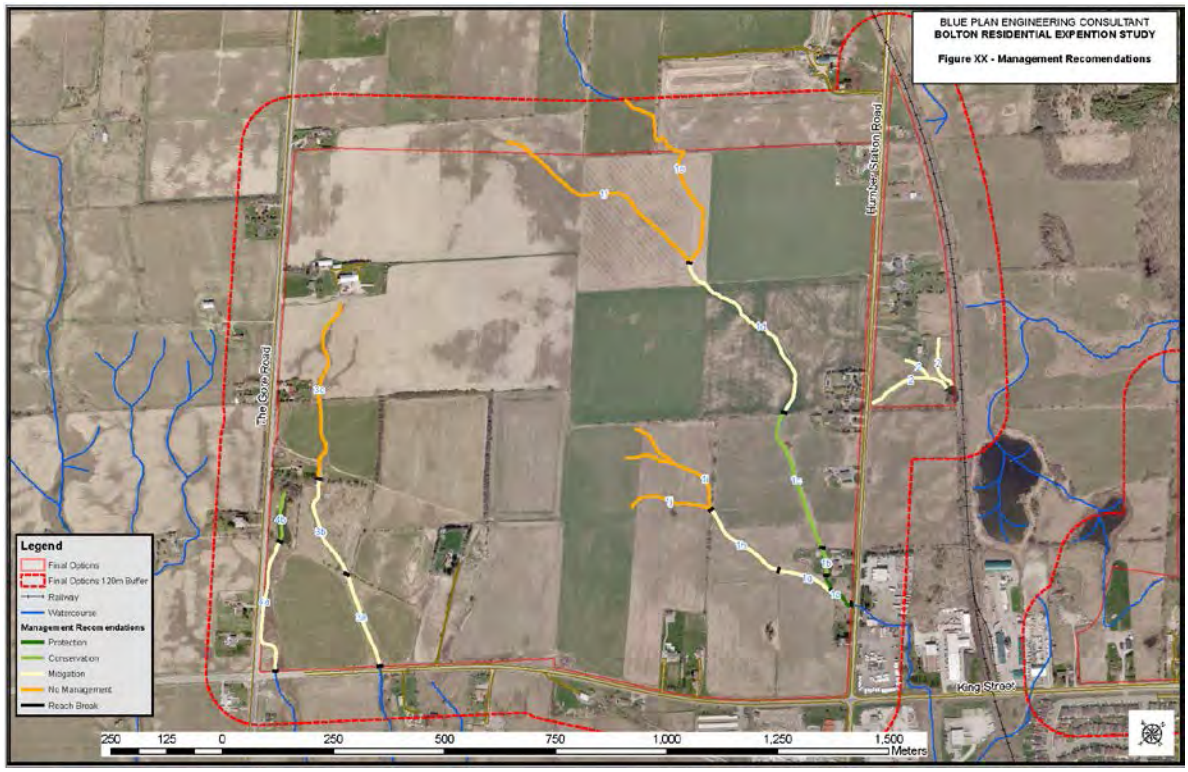


Figure 3: Option 3 Lands Management Recommendations to Reach Scale

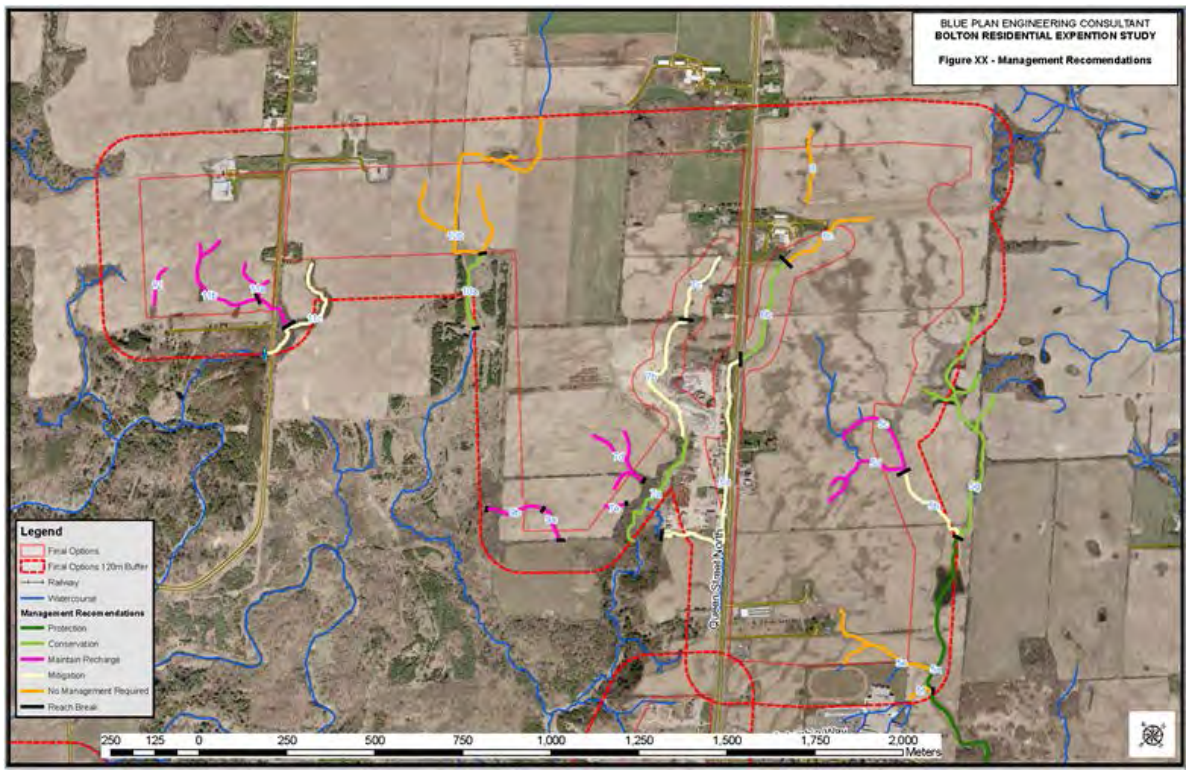


Figure 4: Option 1 Lands Management Recommendations to Reach Scale

3.3. AQUATIC RESOURCES

An initial field examination of all watercourses exiting or entering the periphery of the proposed urban expansion option areas that were accessible by public road was undertaken on August 23, 2013, to primarily record the amount of water, flow and the instream habitat condition during this typically dry season. On October 15, 2013, all locations that held water on August 23, as well as a select number of other locations, were electrofished using a Halltech Model HT 2000 backpack electrofisher. On December 3 and 4, 2013, the watercourses in urban expansion Options 1 and 3, and three Rounding Out Areas were walked and examined and the habitat characterized and photographed.

4. POLICY CONSIDERATIONS FOR PRELIMINARY NATURAL HERITAGE SYSTEM AND BUFFERS

The three attached figures (Option 1, Option 3, Rounding Out) present the Preliminary Natural Heritage System for the Option 1 and Option 3 lands, and the Rounding Out Areas. Natural features and watercourses form the basis for the basic NHS framework, supplemented by restoration and enhancement areas. Appropriate buffers for the natural heritage components were assigned under relevant environmental legislation and policies, including:

- Region of Peel and Town of Caledon policies reflecting the Provincial Policy Statement (2005) issued under the Planning Act
- Endangered Species Act
- Greenbelt Plan
- Federal Fisheries Act
- Conservation Authorities Act (TRCA Regulation)

Based on the guiding legislation and policies, the following categories of natural heritage features and ecological functions were used to delineate the NHS:

1. **Significant Habitat of Endangered and Threatened Species** – this category was divided into a) terrestrial and b) aquatic. Species at Risk are on record in the vicinity of the BRES Study Area, including terrestrial, aquatic and avian species. The determination of whether significant habitat is present in the study area requires more detailed study; however most of the candidate habitat would likely be contained within the proposed NHS. The key exception is open country birds associated with agricultural lands; these will be further assessed in 2014 and discussion is underway with MNR regarding a comprehensive strategy for the listed species (see Section 5).

2. **Wetlands** – this category was further divided into a) Provincial Significant Wetlands (PSW); b) evaluated wetlands that are non-PSW; and c) wetlands that have not been evaluated by the OMNR. These are regulated under TRCA, and addressed in Town of Caledon and Region of Peel policies. Based on available mapping, no PSW's are present within either Option 1 or 3, or the Rounding Out Areas; PSWs are present in adjacent lands to both option areas and to one Rounding Out Area. All identified wetlands in the Option 1 and 3 lands and their adjacent lands have been included in the proposed NHS.

3. **Significant Woodlands** – The Region of Peel and Town of Caledon have significant woodland policies in conformity with the PPS. Based on the Region's policies, Core Woodlands occur in adjacent lands to Option 1, and a woodland meeting Potential Natural Areas and Corridors (PNAC) criteria extends into the Option 1 lands; these are protected in the proposed NHS. Option 3 lands do not contain any woodlands within or adjacent to the defined option boundary. Rounding Out Areas do not contain significant woodlands but they are present within the adjacent lands of each ROA.

4. **Significant Valleylands** – The Region of Peel has significant valleyland policies in conformity with the PPS. It is our understanding that significant valleylands are represented within the BRES Study Area only by ravines of the main branch and major tributaries of the Humber River, which extend into adjacent lands of Option 1. Option 3 does not contain ravine features. Valleylands have been included where appropriate within the proposed NHS. Where valley features are evident, the top-of-bank will be used to determine setbacks/buffers.

5. **Significant Wildlife Habitat** – the Region of Peel and Town of Caledon have significant wildlife habitat (SWH) policies in conformity with the PPS, although there is no Town, MNR or TRCA data or mapping of SWH to date. The determination of whether significant wildlife habitat is present within the BRES Study Area requires more detailed study which may identify habitats of seasonal concentrations of animals, rare vegetation communities or specialized habitat for wildlife, habitat of species of conservation concern, and/or animal movement corridors. However, a preliminary assessment in October and November 2013 did identify some candidate areas. In general, SWH is usually aligned with specialized habitats such as wetlands, larger forested areas, extensive successional cover, or vegetated valleylands and, as such, all of these areas are included within the proposed NHS.

6. **Fish Habitat** – has been classed using the *Evaluation, Classification and Management of Headwater Drainage Features: Interim Guidelines* (CVC and TRCA, 2009), since all watercourses within the Option areas are small first or second order watercourses. This system classes small watercourses as Permanent (continuously flowing), Seasonal (flows intermittently but has a fish community), Complex Contributing (intermittent flow, no fish, and with hydrophilic vegetation and/or a flow-formed channel), Simple Contributing (ephemeral flow, no fish, and with terrestrial vegetation and/or no flow-formed channel), and Not Fish Habitat. It should be noted that, based on mapping provided to the Town of Caledon by the Ontario Ministry of Natural Resources, there is occupied Redside Dace habitat downstream from both Options 1 and 3. Therefore, since most of Option 3 and smaller portions of Option 1 ultimately drain to occupied habitat tributaries, headwater drainage features, wetlands and groundwater recharge or discharge areas within those areas may be considered indirect Redside Dace habitat if they affect occupied habitats downstream. As such, the maintenance of baseflows, cool or coldwater conditions, and water quality are all important functional considerations. However, irrespective of whether Redside Dace is supported, fish habitats are federally regulated resources that are reliant on physical conditions (surficial soils and topography, surface and groundwater).

   Only drainage features with watercourse management recommendations of “Protection” (Permanent) and “Conservation” (Seasonal) were included within the proposed NHS; these must be either protected in place, or may be relocated, respectively. Other drainage features classed as Complex Contributing or Simple Contributing have the watercourse management recommendation of "Mitigation", and can be removed subject to replication of functions.

7. **Greenbelt Plan and Oak Ridges Moraine Conservation Plan Boundaries** – portions of the Greenbelt Protected Countryside border components of the study area, and the Oak Ridges Moraine Conservation Plan includes lands immediately north of Option 1. These

contain rural and agricultural land uses and relatively high concentrations of natural habitat. Greenbelt lands also occur on adjacent lands to the three Rounding Out Areas.

8. **Regulated Areas** – features and watercourses are present within the BRES Study Area that are regulated by TRCA. Based on the preliminary work conducted by Aquafor Beech and C. Portt and Associates, those watercourses with regulated limits are shown on the proposed NHS map for Option 1, with a revised watercourse configuration west of Highway 50, that was identified in the Fall of 2013. Regulated areas are also associated with wetlands and floodplains; regulated features are present in Option 1 and 3 and their adjacent lands. They are only present in the adjacent lands to Rounding Out Areas. The features triggering Regulated Areas are protected within the proposed NHS.

9. **Vegetated Protection Zones (VPZ)** – the widths of these buffer zones were determined based on applicable legislation and policy for each of the natural heritage features. Natural feature buffers and watercourse setbacks are shown as 30 metres.

10. **Corridors** – these have been delineated in association with identified watercourses that are to be retained based on assessments in November 2013. Hedgerows have been identified on the Preliminary NHS map, but are not considered part of the proposed NHS due to their limited size and vegetative composition.

11. **Restoration and Enhancement Areas** – these were identified based on ELC categorization (e.g. cultural woodlands or successional habitats), pre-existing restoration areas (e.g. plantings in cultural meadows), proposed buffers, and proposed watercourse corridors. They are part of the proposed NHS and are buffered accordingly.

Areas of Natural and Scientific Interest (ANSIs) are not present in the vicinity of the BRES Study Area and therefore are not included in the Preliminary NHS.

NATURAL HERITAGE SYSTEM BUFFERS

NHS COMPONENT	GUIDING LEGISLATION / POLICY						PROPOSED BUFFER
	Region	Town	FFA	ESA	GbP/ORM	TRCA	
Significant Habitat of Endangered and Threatened Species	X	X		X			**TBD**
Wetlands: Provincially Significant and Non-significant (Evaluated)	X	X					**30 metres**
Wetlands: Unevaluated	X	X					**15 metres**
Significant Woodlands	X	X					**30 metres**
Significant Valleylands	X	X					**TBD**
Significant Wildlife Habitat	X	X		X			**30 metres**
Fish Habitat			X	X			**15-30 metres**
Greenbelt / ORM NHS					X		**30 metres where features extend into option area**
Regulated Areas						X	**15-30 metres from regulated feature**

- Region of Peel and Town of Caledon policies reflecting the Provincial Policy Statement (2005) issued under the Planning Act (1990)
- FFA - Federal Fisheries Act (1985)
- ESA - Endangered Species Act (2007)
- GbP - Greenbelt Plan (2005)
- ORM – Oak Ridges Moraine Conservation Plan (2002)
- Conservation Authorities Act (TRCA Regulation) – Section 3(1) of the Regulation permits development within regulated areas
- TBD – requires further field study and/or confirmation with MNR or TRCA

5. SPECIES-AT-RISK APPROACH

OMNR was contacted in November 2013 to initiate engagement regarding potential approaches to address any Species at Risk (SAR) issues that may arise on the Option 1 and 3 lands. To date the interactions with OMNR have been as follows:

- November 1, 2013 – submitted Species at Risk Information Request Form for the BRES Option 1 and 3 study areas to Aurora District OMNR;

- November 13, 2013 – correspondence with Steve Strong (District Planner, Aurora MNR) to arrange a meeting to discuss SAR approach for the study area;
- December 19, 2013 – meeting at Caledon East Town Hall with Steve Strong and Jackie Burkhart (Planners, Aurora OMNR) to discuss SAR matters and an integrated approach to accommodating these species early in the residential expansion planning process;
- January 2, 2014 – Species-at-Risk screening letter received from Melinda Thompson (SAR Biologist, Aurora District) listed five (5) Species-at-Risk as being on record in the vicinity: Redside Dace, Butternut, Bobolink, Eastern Meadowlark, and Snapping Turtle;
- April 25, 2014 – communication with Mark Heaton, Aurora District OMNR Biologist regarding fish sampling in Option 1 and 3 Areas.

The discussion with OMNR planning staff in December 2013 concerned the fact that the lands in the recommended option area will likely not undergo development until after 2017-2018 based on the timing of approvals that are required, which therefore affords an opportunity to plan for SAR in a more strategic manner. Specifically, OMNR would like to move toward addressing protection of SAR habitats and species at a landscape system level rather than on a case-by-case basis. This would require that the Town and Region, in cooperation with OMNR, proceed with a larger scale examination of an approach to identify or create "stronghold areas" for individual SAR. If Species-at-Risk are determined to be present in the residential expansion area, compensation that helps to create and maintain strongholds will result in a "net benefit" for the species, as per the ESA (2007), in a manner that addresses the anticipated expansion of the Town in Bolton and elsewhere.

During 2014, further seasonal field studies will be undertaken for BRES, to clarify the status of SAR already on record in the vicinity, and to determine if others may be present. The findings will be summarized in the CEISMP Part A Characterization Report in the Fall of 2014, and impacts will be evaluated in the Part B Report in 2015 once a Secondary Plan concept is available. By this time it is recommended that discussions between the Town of Caledon, Region of Peel and OMNR should proceeded towards a separate study to identify a comprehensive, landscape system approach to ensure "net benefit" for particular SAR species and their habitats.

The screening undertaken to date indicates that the Option 1 and 3 lands themselves have comparable SAR issues including open country bird habitat and sensitive downstream conditions, which can be addressed through best management and/or compensation strategies. Option 1 has much more extensive and diverse habitats in Adjacent Lands that are located immediately outside the option area in the Greenbelt, which are known to support Species ay Risk. Option 3 is part of a larger, relatively open agricultural landscape with limited natural habitat cover in the vicinity.

6. 2014 STUDIES

As per the TRCA Terms of Reference for the Bolton Residential Study Comprehensive Environmental Impact Study and Management Plan (CEISMP), dated August 20, 2013, and the study team's proposed work plan (November 2013), additional field work will be undertaken in 2014 to gather all of the required data. These next steps are detailed below.

6.1. NATURAL HERITAGE

6.1.1. ELC REFINEMENT

Refinement of the ELC boundaries determined in October and November, 2013, will be undertaken in spring, 2014. Particular attention will be paid to wetland features as TRCA requirements for these habitats are that they should be delineated after May 1. However, it is not anticipated that the boundaries will change significantly based on these refinement surveys, and most wetlands are outside the potential development areas. The Preliminary NHS feature boundaries will be updated accordingly to reflect this new information. All ELC determination will follow that of Lee et al. (1998).

6.1.2. BREEDING BIRD SURVEYS

Breeding bird surveys will be conducted on all land areas of Options 1 and 3 and the three Rounding Out Areas. They will follow protocols established by the Ontario Breeding Bird Atlas (OBBA 2001), which require that two surveys will take place at least one week apart, between May 24 and July 12. The surveys will take place between dawn and 10:00 a.m., and under appropriate weather conditions, that is, with light winds and no heavy rain. Any Species-at-Risk occurrences will be highlighted and mapped. Constraint maps will be updated as required and the Preliminary NHS will be adjusted accordingly.

6.1.3. AMPHIBIAN SURVEYS

Nocturnal amphibian surveys will be conducted in wetland areas identified within the Preliminary NHS in April and May, 2014. These surveys will follow the Marsh Monitoring Program Protocols (BSC 2003) which stipulate that the surveys take place from April 15 – 30 and May 15 – 31, respectively. The surveys will take place between sunset and midnight, and with light winds, no heavy rain, and temperatures of at least 5 °C (April) and 10 °C (May). Additional surveys for salamanders will take place in key habitats identified within the study area. For all amphibian surveys, any Species-at-Risk occurrences will be highlighted and mapped. Constraint maps will be updated as required and the Preliminary NHS will be adjusted accordingly.

6.1.4. VEGETATION SURVEYS

Spring and summer vegetation surveys will take place in all key natural heritage features during 2014. This data on floral species will be mapped accordingly, with any Species-at-Risk highlighted. Constraint maps will be updated as required and the Preliminary NHS will be adjusted accordingly.

The additional wildlife, floral, and ELC data to be collected in 2014, as outlined above, will be used to clarify constraint and opportunities mapping. Data deficiencies for woodlands, wetlands, faunal and floral species distribution, or any other natural heritage features, will be identified, and an appropriate work plan to address these information gaps will be outlined. As such, this additional field work and mapping will fulfill all of the existing conditions and characterization requirements from the TRCA Terms of Reference (August 20, 2013). This data and mapping will be summarized in the Natural Heritage Report (Part A) of the CEISMP, which will be submitted in draft form to the Town of Caledon, the Region of Peel, and the TRCA for review and approval prior to proceeding to Part B of the CEISMP.

6.2. HEADWATER DRAINAGE FEATURES

Spring and summer assessments of the HDFs may be undertaken to confirm and finalize reach classifications and management recommendations. Assessing the features during spring/summer conditions will allow for enhanced understanding of the hydroperiod as well as identification of potential barriers missed due to snow cover.

6.3. AQUATIC RESOURCES

Field assessments will be required during the spring of 2014 to characterize fish communities and fish habitat under spring and early summer conditions, and to search for migratory spawning fishes in the headwater areas. A dry period habitat assessment, typically undertaken in August or September, is also required to further identify groundwater discharge locations, as well as the headwater aquatic habitats that this supports.

6.4. GROUNDWATER AND SURFACE WATER RESOURCES

Hydraulic modeling will be finalized in order to define floodplain hazard lands where drainage areas are greater than 50ha. For this, TRCA must complete an update on existing hydraulic models for the Humber River watershed.

Following the establishment of floodplain hazard areas, hydrologic modelling and stormwater management assessments will be carried out to establish the appropriate sizing and location of potential SWM ponds. The assessments will also aid in the identification and placement of low impact development (LID) requirements to meet TRCA stormwater criteria and to address water balance issues.

To date no work has been done on groundwater as the component has not been approved by the client.

7. SUMMARY OF PRELIMINARY NATURAL HERITAGE SYSTEM

The following summarizes the general landscape conditions and characteristics of the Preliminary NHS for Option 1, Option 3 and the Rounding Out Areas.

Option 1 Context and Preliminary NHS

Context: The lands are surrounded by the Protected Countryside of the Greenbelt on the south and east, and by the Oak Ridges Moraine plan area to the immediate north. Option 1 lands are predominantly in active agriculture. The terrain is gently rolling but with steep slopes / ravines into the Humber River system to the south. The Bolton Arterial Road (under construction) transects the option area, and existing land uses along Highway 50 have impacted one tributary feature. Other key characteristics are as follows:

- There are no Provincially Significant Wetlands (PSW) in the option area;
- There is a small wetland in the fields west of Highway 50 and small wetlands within the Significant Woodland along the northern boundary;
- PSWs exist in the 120 m Adjacent Lands along the eastern edge and in the Humber River valley;
- Significant Woodland extends into the northern edge of the area west of Highway 50;
- Restoration and enhancement areas have been identified mostly in the buffers around the southern edge of the area, west of Highway 50;
- A restoration and enhancement opportunity area exists along the south side of the Significant Woodland;
- Restoration and enhancement areas are identified in the margins of western-most lobe and on the regulated watercourses east and west of Hwy 50; and
- The Option 1 Preliminary NHS, including natural features and restoration and enhancement areas, represents approximately 5.5% of the available land area.

Option 3 Context and Preliminary NHS

Context: The lands are well outside the Greenbelt, predominantly in active agriculture; the terrain is gently rolling. Other key characteristics are as follows:

- The streams are mostly headwaters, while the only tributary in southeast sector has floodplain functions;
- One watercourse is ranked as "Conservation" (i.e. must remain on landscape but can be moved/realigned) in southwest corner;
- There is no occupied Redside Dace (Endangered fish) habitat present;
- There are few natural heritage features in the option area;
- There are unevaluated wetlands associated with the tributaries at the south end;
- There are no PSWs in the option area, however a PSW is located within the 120 metre Adjacent Lands east of the railroad tracks;
- There are no Significant Woodland, or other woodlands, in the option area;
- Restoration and enhancement areas exist in the southwest corner due to the presence of tributaries and a farm pond;
- Regulated floodplain area exists west of Humber Station Road; and

- The Option 3 Preliminary NHS, including natural features and restoration and enhancement areas, represents approximately 12.5% of the available land area.

Rounding Out Areas Context and Preliminary NHS

- There are no natural heritage features within the three Rounding Out Areas;
- No watercourses with categories of Conservation or Protection are present;
- The Chickadee Rounding Out Area has no key natural features but there are small areas within 120 metres of the Greenbelt;
- A small restoration and enhancement area was identified in the Highway 50/Columbia Way Rounding Out Area;
- There is a small wetland feature in the Duffy's Lane Rounding Out Area;
- The Greenbelt boundary is within 120 metres of the Duffy's Lane Rounding Out Area;
- The Rounding Out Areas Preliminary NHS is 1 all restoration and enhancement area (i.e. no natural features are present).

It should be emphasized that the sizes of the Preliminary NHS for Options 1 and 3 are not directly comparable as the Option 1 area includes extensive areas of restoration and enhancement that are outside of the residential study area (but within the 120 m adjacent lands). The land area that is constrained by existing policies is greater within Option 3 than Option 1, however, Option 1 is surrounded by lands with greater policy complexity and restrictions, i.e. the Greenbelt Plan and Oak Ridges Moraine Conservation Plan. These adjacent areas contain concentrations of natural features and ecological functions (PSW, Significant Woodlands, Significant Valleylands, Significant Wildlife Habitat, Fish Habitat, and Habitat of Species at Risk) that are potentially vulnerable to cumulative adverse impacts from residential expansion since they are within 120 metres of the proposed development area. In Option 3 the landscape is a headwater area surrounded by active agriculture, with some discrete riparian features (meadow marsh wetlands) along watercourses in the southern half of the area, and very localized natural features in the adjacent lands; this requires feature protection and enhancement, along with best management practices for water resource management. Option 1 and 3 are located upstream of sensitive aquatic resources (Redside Dace occupied habitat and/or coldwater reaches)

8. CONCLUSIONS

This Preliminary NHS, as illustrated in the three attached figures, is considered preliminary, with further refinement from other disciplines required. Based on existing information, we believe that this is an adequate interpretation of natural heritage conditions to meet Region of Peel policies for an Official Plan Amendment to expand the existing urban boundary. Additional field work to be conducted by Dougan & Associates, Cam Portt & Associates, and Aquafor Beech Ltd. in 2014 may further refine some of the boundaries to specific features. All data collected will be summarized in the Existing Conditions and Characterization Report (Part A of the CEISMP process) with content for each discipline.

Respectfully submitted:

Jim Dougan, B.Sc., M.Sc., OALA (Hon)
Principal and Senior Ecologist
Dougan & Associates

9. REFERENCES

BSC (Bird Studies Canada). 2003. Marsh Monitoring Program - Training Kit and Instructions for Surveying Marsh Birds, Amphibians and their Habitats. 2003 Edition. 40 pages. Published by Bird Studies Canada in cooperation with Environment Canada and the U.S. Environmental Protection Agency. March 2003.

CVC (Credit Valley Conservation) & TRCA (Toronto and Region Conservation Authority). 2009. Evaluation, Classification and Management of Headwater Drainage Features: Interim Guidelines. Updated March 2009. A report prepared by Credit Valley Conservation and the Toronto and Region Conservation Authority. 21 pages. Available at: http://www.trca.on.ca/dotAsset/50335.pdf

Lee, H.T., W.D. Bakowsky, J. Riley, J. Bowles, M. Puddister, P.Ulhig, and S. McMurray. 1998. Ecological Land Classification for Southern Ontario: First Approximation and its Application. Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfer Branch. SCSS Field Guide FG-02.)

OBBA (Ontario Breeding Bird Atlas). 2001. Guide for Participants. Atlas Management Board, Federation of Ontario Naturalists, Don Mills. 34pp.

OMNR (Ontario Ministry of Natural Resources). 2011. DRAFT Guidance for Development Activities in Redside Dace Protected Habitat. Ontario Ministry of Natural Resources, Peterborough, Ontario. ii+42 pages.

OMNR (Ontario Ministry of Natural Resources) & TRCA (Toronto and Region Conservation Authority). 2005. Humber River Fisheries Management Plan. Published by the Ontario Ministry of Natural Resources and the Toronto and Region Conservation Authority. Queens Printer for Ontario. 200 pages. Available at: http://trca.on.ca/dotAsset/25855.pdf

King Street

King Street West

Queen Street North

Highway 50

0 125 250 500

Metres

Stream ratings based on most conservative stream designations (Headwater Drainage Feature vs. Fish Habitat) from Aquafor Beech Ltd. and C. Portt & Associates (December 2013).

Legend

Aquatic Habitat Classes

- Protection
- Conservation
- Mitigation / No Management
- Watercourse (unevaluated)

Wetlands

- Provincially Significant Wetland
- Other Wetland
- Unevaluated Wetland
- PSW 30m Buffer

NHS Features

- Enhancement / Restoration
- Greenbelt Plan Boundary
- Oak Ridges Moraine
- Significant Woodlands (>4ha)

Map Base

- Railway
- Final Options
- Final Options, 120m Buffer

Bolton Residential Expansion Study
Preliminary Natural Heritage System
June 2014

DOUGAN & ASSOCIATES
ECOLOGICAL CONSULTING & DESIGN
77 Wyndham Street South • Guelph ON N1E 5R7
T 519.822.1609 • F 519.822.5389 • www.dougan.ca

PROJECT: DA13-041-01

CLIENT:

DATE: JUNE 2014

SCALE: 1:7,000

DRAWN BY: LW

CHECKED BY: JD/IR

UTM Zone 17 NAD83

Figure:

Rounding Out

Appendix B

Breeding Bird Species List

Breeding Birds of Chickadee Lane - 2018

Common Name	Scientific Name	Status						Locations			Observed on site visit	
		National Species at Risk COSEWICa	Species at Risk in Ontario Listing a	Provincial breeding season SRANK [b]	TRCA Status	Area-sensitive (OMNR)c	Breeding Code	Forest	Meadow	Residential area	01-Jun-18	26-Jun-18
Killdeer	*Charadrius vociferus*			S5	L4		S		1		1	
Mourning Dove	*Zenaida macroura*			S5	L5		S7			1	1	1
Northern Flicker	*Colaptes auratus*			S4	L4		S7	1			1	1
Eastern Wood-Pewee	*Contopus virens*	SC	SC	S4	L4		S7	1			1	1
Eastern Phoebe	*Sayornis phoebe*			S5	L5		S			1		1
Great Crested Flycatcher	*Myiarchus crinitus*			S4	L4		S	1			1	
Blue Jay	*Cyanocitta cristata*			S5	L5		S7	1			1	1
American Crow	*Corvus brachyrhynchos*			S5	L5		S7	1			1	3
Black-capped Chickadee	*Poecile atricapillus*			S5	L5		S7			1	2	4
White-breasted Nuthatch	*Sitta carolinensis*			S5	L4	A	S7	1		1	1	1
American Robin	*Turdus migratorius*			S5	L5		S7			1	2	3
Gray Catbird	*Dumetella carolinensis*			S4	L4		S	1				1
Cedar Waxwing	*Bombycilla cedrorum*			S5	L5		ON	1			1	2
European Starling	*Sturnus vulgaris*			SE	L+		S7			1	7	6
Red-eyed Vireo	*Vireo olivaceus*			S5	L4		S7	1			2	3
Northern Cardinal	*Cardinalis cardinalis*			S5	L5		S7			1	1	1
Rose-breasted Grosbeak	*Pheucticus ludovicianus*			S4	L4		S7	1			1	1
Indigo Bunting	*Passerina cyanea*			S4	L4		S	1			1	
Song Sparrow	*Melospiza melodia*			S5	L5		S7		1	1	5	8
Red-winged Blackbird	*Agelaius phoeniceus*			S4	L5		M		1		10	8
American Goldfinch	*Cardeulis tristis*			S5	L5		S7		1	1	5	5

Field Work Conducted On:	***Date***	**Temp (C)**	**Wind speed (km/h)**	**Cloud cover (%)**	**Start time**	**End time**	**Level of effort (h:min)**	**Number of species observed**
Site visit 1	*01-Jun-18*	19	6	60	6:45	8:45	2:00	13
Site visit 2	*26-Jun-18*	15	5	25	7:00	9:00	2:00	16
Location 1 -	*Wooded upland*							
Location 2 -	*Grassland*							
Location 3 -	*Anthropogenic houses/sheds*							
Number of Species:		21						
Number of (provincial and national) Species at Risk:		1						
Number of S1 to S3 (provincially rare) Species:		0						
Number of Regionally Rare Species:		0						
Number of Area-sensitive Species:		1						
Location 1	**Wooded upland**							
Number of Species:		11						
Number of (provincial and national) Species at Risk:		0						
Number of S1 to S3 (provincially rare) Species:		0						
Number of Regionally Rare Species:		0						
Number of Area-sensitive Species:		1						
Location 2		**Grassland**						
Number of Species:		4						
Number of (provincial and national) Species at Risk:		0						
Number of S1 to S3 (provincially rare) Species:		0						
Number of Regionally Rare Species:		0						
Number of Area-sensitive Species:		0						
Location 3	**Anthropogenic houses**							
Number of Species:		9						
Number of (provincial and national) Species at Risk:		0						
Number of S1 to S3 (provincially rare) Species:		0						
Number of Regionally Rare Species:		0						
Number of Area-sensitive Species:		1						

Appendix C

Plant Species List

Chickadee Lane Plant Species List

CUM1-1a	CUM1-1b	CUM1-1c	CUM1-1d	FOD5-8	FOD4	SAGM2	TAGM5a	TAGM5b	TAGM5c	TAGM5d	ScientificName	CommonName (accepted)	GRank	SRANK	TRCA
X	X	X	X		X						Solidago canadensis	Canada Goldenrod	G5	S5	L5
X	X	X	X			X					Daucus carota	wild carrot	G?	SE5	L+
X	X	X			X						Erigeron philadelphicu	Philadelphia Fleabane	G5T?	S5	L5
X	X	X									Cirsium arvense	Canada Thistle	G?	SE5	L+
X	X	X									Vicia cracca	Tufted Vetch	G?	SE5	L+
X	X		X								Asclepias syriaca	Common Milkweed	G5	S5	L5
X	X		X								Phleum pratense	Common Timothy	G?	SE5	L+
X	X			X	X				X		Rhamnus cathartica	European Buckthorn	G?	SE5	L+
X	X				X			X		X	Acer negundo	Manitoba Maple	G5	S5	L+?
X	X										Bromus inermis	Smooth Brome	G4G5T?	SE5	L+
X	X										Rumex crispus	Curled Dock	G?	SE5	L+
X		X	X								Sonchus sp	Sowthistle Species			
X		X									Carex vulpinoidea	Fox Sedge	G5	S5	L5
X		X									Phalaris arundinacea	Reed Canarygrass	G5	S5	L+?
X											Cichorium intybus	wild chicory	G?	SE5	L+
X											Medicago lupulina	Black Medic	G?	SE5	L+
X											Plantago lanceolata	English Plantain	G5	SE5	L+
X											Trifolium hybridum	Alsike Clover	G?	SE5	L+
	X	X									Agrostis sp	Bentgrass Species			
	X		X								Cirsium sp	Thistle Species			
	X		X								Fragaria virginiana ssp	wild Strawberry	G5?	SU	L5
	X					X					Dipsacus fullonum	Common Teasel	G?T?	SE5	L+
	X										Mentha sp	Mint Species			
	X										Populus alba	White Poplar	G5	SE5	L+
	X										Potentilla recta	Sulphur Cinquefoil	G?	SE5	L+
	X										Rosa sp	Rose Species			
		X			X						Taraxacum officinale	Common Dandelion	G5	SE5	L+
		X									Juncus sp	Rush Species			
		X									Panicum capillare	Common Panicgrass	G5	S5	L5
		X									Typha latifolia	Broad-leaved Cattail	G5	S5	L4
			X	X	X				X		Acer saccharum var. s	Sugar Maple	G5T?	S5	L5
			X		X	X					Elymus repens	Quackgrass	G?	SE5	L+
			X		X			X			Picea glauca	White Spruce	G5	S5	L3
			X					X			Acer saccharinum	Silver Maple	G5	S5	L4
			X								Poa pratensis ssp. prat	Kentucky Bluegrass	G5T	S5	L+
				X	X		X		X		Fraxinus pennsylvanic	Green Ash	G5	S5	L5
				X	X			X	X		Tilia americana	Basswood	G5	S5	L5
				X	X						Aster sp	Aster Species			
				X	X						Prunus virginiana var.	Choke Cherry	G5T?	S5	L5
				X							Amphicarpaea bractea	American Hog peanut	G5	S5	L5
				X							Athyrium filix-femina	Northeastern Lady fern	G5T5	S5	L5
				X							Circaea alpina	Small Enchanter's Nightshade	G5	S5	L3
				X							Fagus grandifolia	American Beech	G5	S5	L4
				X							Ostrya virginiana	Eastern Hop-hornbeam	G5	S5	L5
				X							Prunus nigra	Canada Plum	G4G5	S4	L3
				X							Trillium sp	Trillium Species			

CUM1-1a	CUM1-1b	CUM1-1c	CUM1-1d	FOD5-8	FOD4	SAGM2	TAGM5a	TAGM5b	TAGM5c	TAGM5d	ScientificName	CommonName (accepted)	GRank	SRANK	TRCA
				X							Tsuga canadensis	Eastern Hemlock	G5	S5	L4
					X		X				Lonicera tatarica	Tatarian Honeysuckle	G?	SE5	L+
					X						Acer rubrum	Red Maple	G5	S5	L4
					X						Circaea canadensis ssp	Canada Enchanter's Nightshade	G5T5	S5	L5
					X						Parthenocissus quinqu	Virginia Creeper	G5	S4?	L5
					X						Vitis riparia	Riverbank Grape	G5	S5	L5
						X	X				Malus sp	Apple Species			
						X					Morus sp	Mulberry Species			
						X					Prunus sp	Cherry Species			
						X					Pyrus communis	Common Pear	G5	SE4	L+
							X				Acer X freemanii	Freeman's Maple	G?	S5	L4
							X				Picea abies	Norway Spruce	G?	SE3	L+
							X				Pinus strobus	Eastern White Pine	G5	S5	L4
							X				Quercus rubra	Northern Red Oak	G5	S5	L4
							X				Viburnum opulus	cranberry viburnum	G5	SE4	L+
								X	X		Juglans nigra	Black Walnut	G5	S4	L5
								X			Populus deltoides ssp.	Eastern Cottonwood	G5T?	SU	L5
								X			Ulmus americana	White Elm	G5?	S5	L5
										X	Fraxinus sp	Ash Species			
										X	Salix alba	White Willow	G5	SE4	L+
				X							N/A	Ornamental garden species			

Appendix D

Borehole Logs

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Residential Development

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

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

DRILLING DATE: January 26, 2018

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

50 (Moisture Content)

Dry on completion

Soil Engineers Ltd.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed Residential Development

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

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

DRILLING DATE: January 26, 2018

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

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

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed Residential Development

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

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

DRILLING DATE: January 26, 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
		11	DO	21	12		18	Cave
		12	DO	22	13		18	
		13	DO	21	14		16	
		14	DO	28	15		12	
		15	DO	39	16		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.**				17 18 19 20 21 22			

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 2N

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed Residential Development

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

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

DRILLING DATE: January 26, 2018

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

Soil Engineers Ltd.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed Residential Development

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

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

DRILLING DATE: January 26, 2018

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

Dry on completion

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4

PROJECT DESCRIPTION: Proposed Residential Development

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

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

DRILLING DATE: January 29, 2018

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

Soil Engineers Ltd.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 5

FIGURE NO.: 5

PROJECT DESCRIPTION: Proposed Residential Development

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

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

DRILLING DATE: January 29, 2018

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

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 6

PROJECT DESCRIPTION: Proposed Residential Development

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

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

DRILLING DATE: January 25, 2018

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

Soil Engineers Ltd.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 7

PROJECT DESCRIPTION: Proposed Residential Development

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

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

DRILLING DATE: January 23, 2018

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

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 8

FIGURE NO.: 8

PROJECT DESCRIPTION: Proposed Residential Development

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

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

DRILLING DATE: January 23, 2018

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

Soil Engineers Ltd.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 9

FIGURE NO.: 9

PROJECT DESCRIPTION: Proposed Residential Development

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

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

DRILLING DATE: January 23, 2018

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

Moisture Content (%): 38, 20, 25, 19, 16, 16, 19

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

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 11

FIGURE NO.: 11

PROJECT DESCRIPTION: Proposed Residential Development

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

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

DRILLING DATE: January 23, 2018

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

Soil Engineers Ltd.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 12

FIGURE NO.: 12

PROJECT DESCRIPTION: Proposed Residential Development

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

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

DRILLING DATE: January 24, 2018

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

W.L @ Ele. 252.2 m upon completion.

Soil Engineers Ltd.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 12

FIGURE NO.: 12

PROJECT DESCRIPTION: Proposed Residential Development

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

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

DRILLING DATE: January 24, 2018

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

Cave-In @ Ele. 243.1 m upon completion.

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 12

FIGURE NO.: 12

PROJECT DESCRIPTION: Proposed Residential Development

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

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

DRILLING DATE: January 24, 2018

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

JOB NO.: 1801-S032

LOG OF BOREHOLE NO.: 12N

FIGURE NO.: 12

PROJECT DESCRIPTION: Proposed Residential Development

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

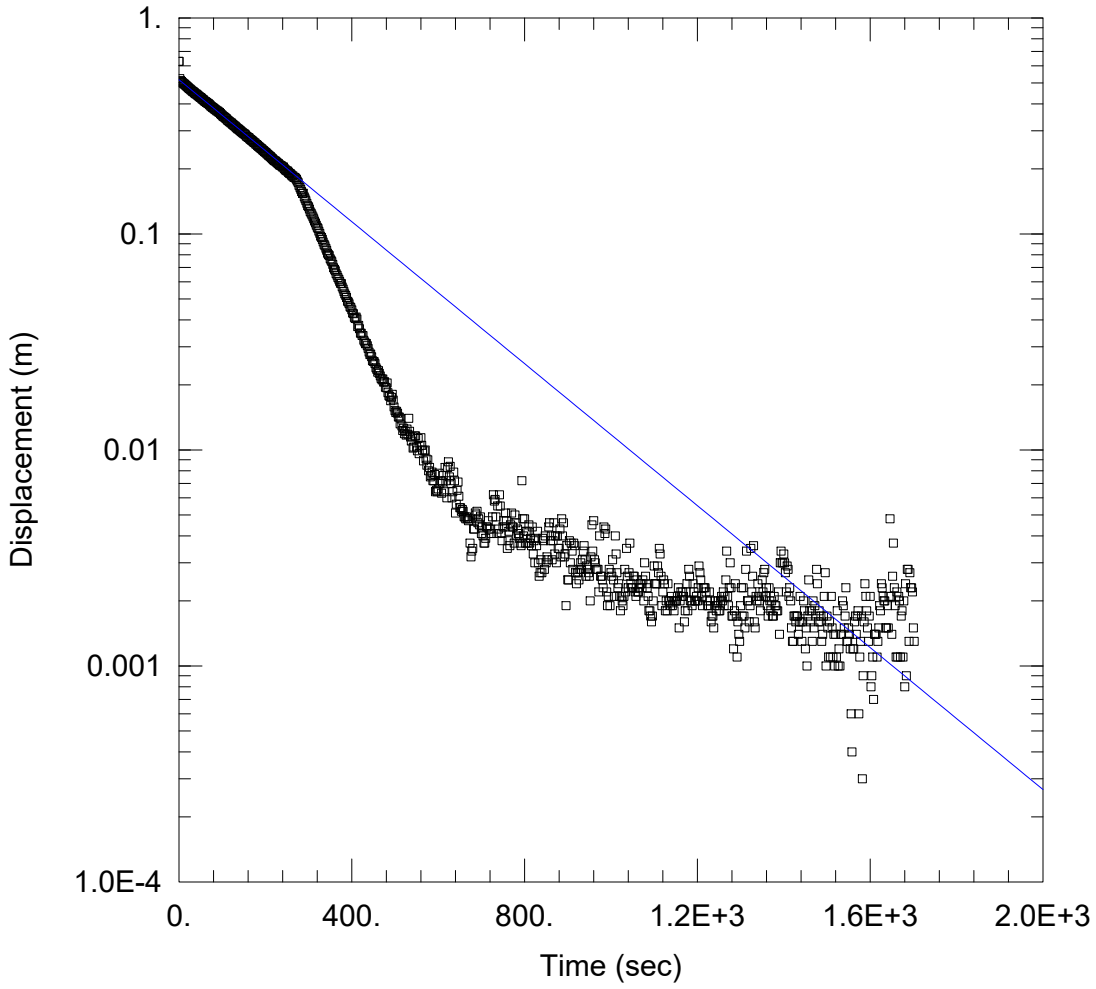
PROJECT LOCATION: Chickadee Lane and Glasgow Road, Town of Caledon

DRILLING DATE: January 24, 2018

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

Appendix E

Single Well Response Test Analyses



WELL TEST ANALYSIS

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

PROJECT INFORMATION

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

AQUIFER DATA

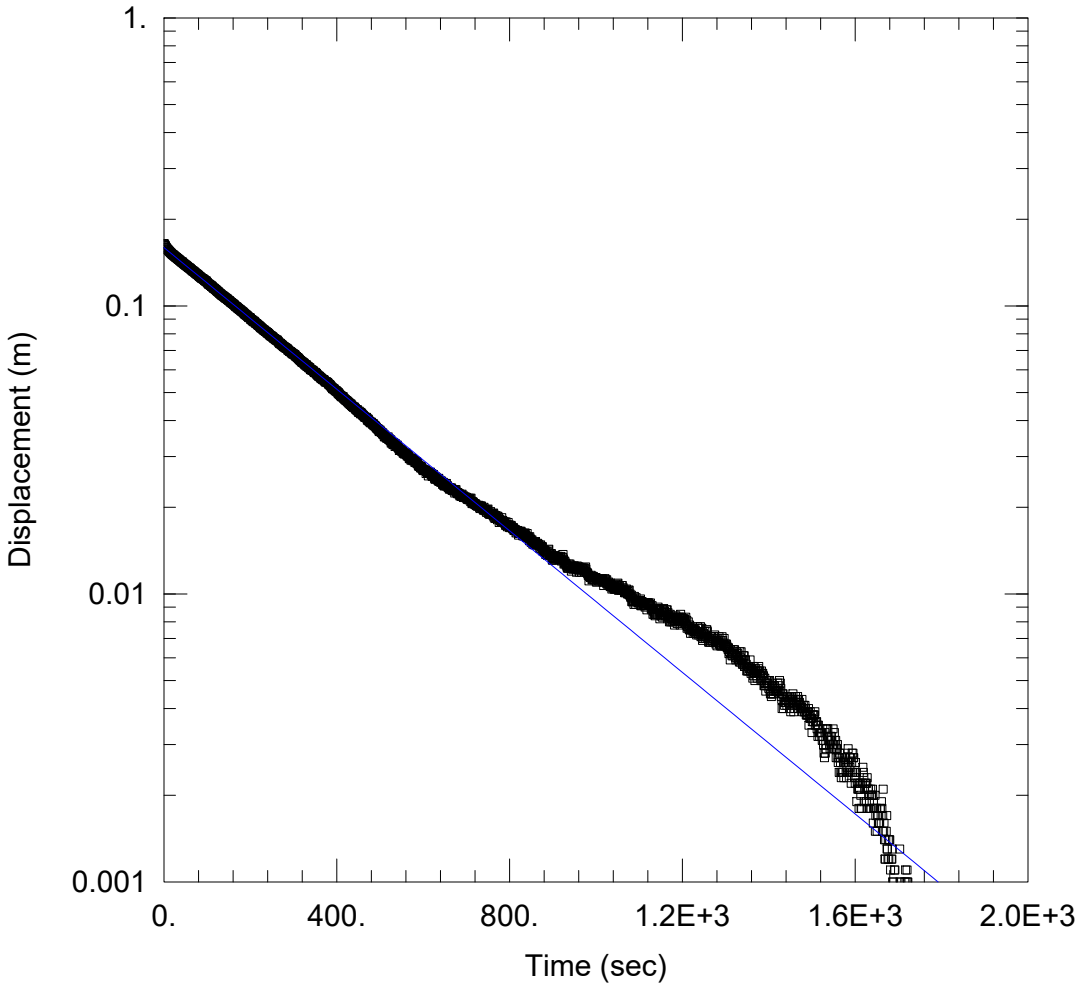
Saturated Thickness: 5.94 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW6)

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

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 4.255E-6 m/sec
y0 = 0.5174 m



WELL TEST ANALYSIS

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

PROJECT INFORMATION

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

AQUIFER DATA

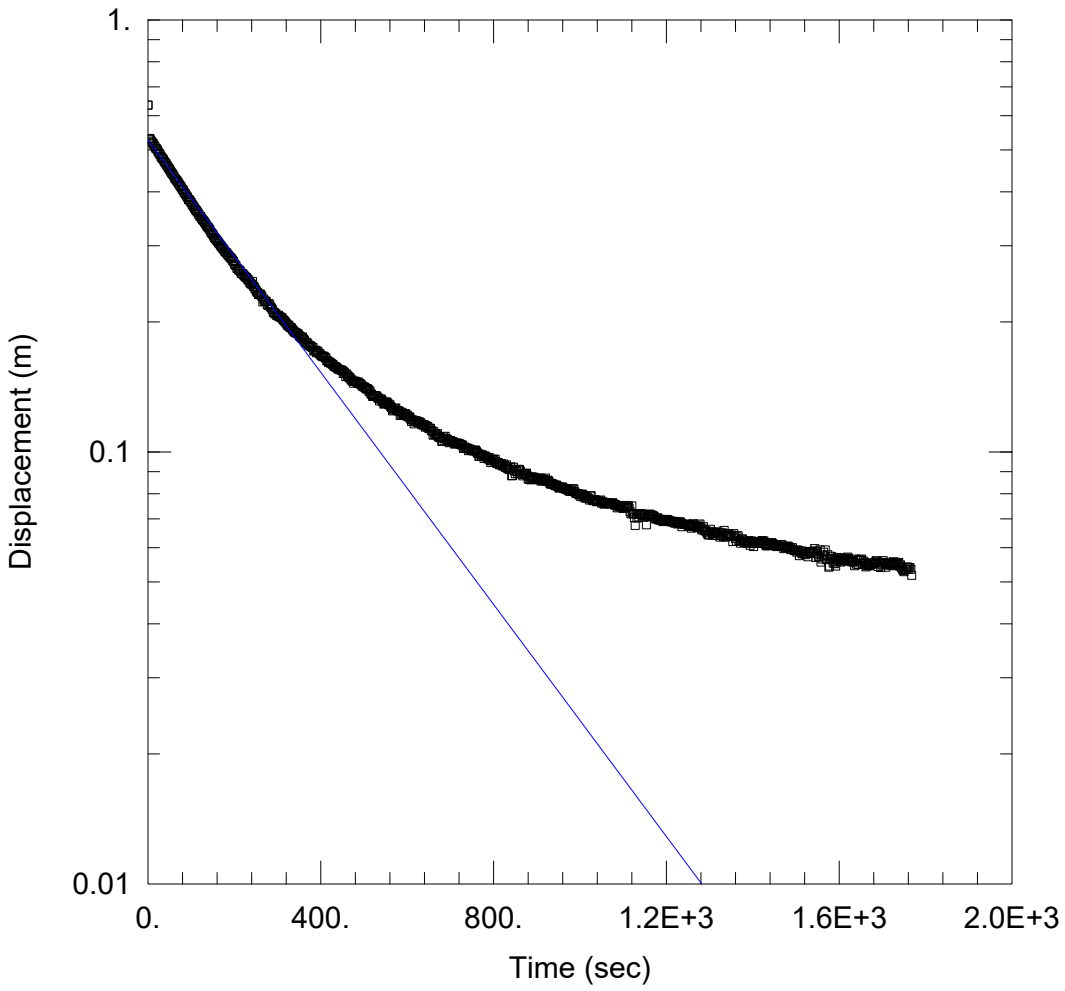
Saturated Thickness: 4.62 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW6)

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

SOLUTION

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



WELL TEST ANALYSIS

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

PROJECT INFORMATION

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

AQUIFER DATA

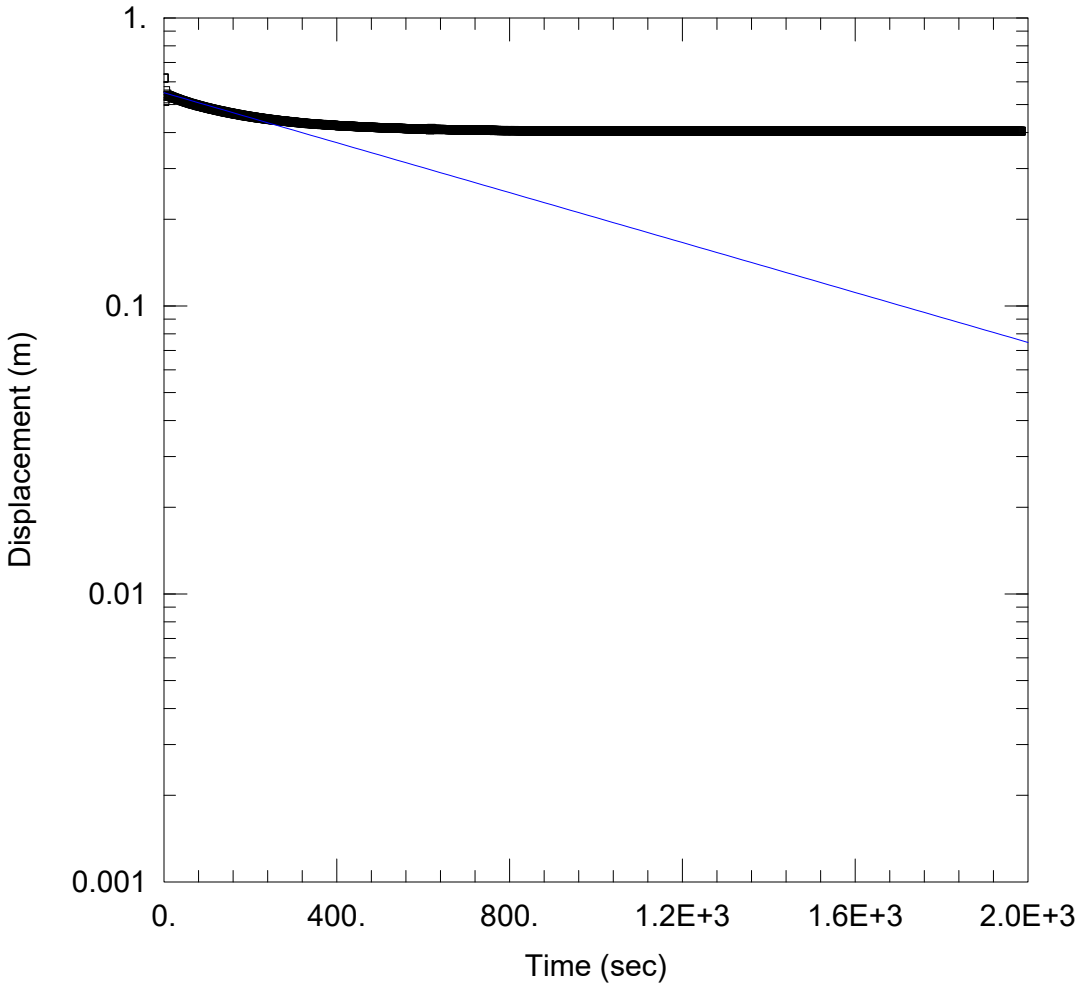
Saturated Thickness: 5.94 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW6)

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

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 3.478E-6 m/sec
y0 = 0.5265 m



WELL TEST ANALYSIS

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

PROJECT INFORMATION

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

AQUIFER DATA

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

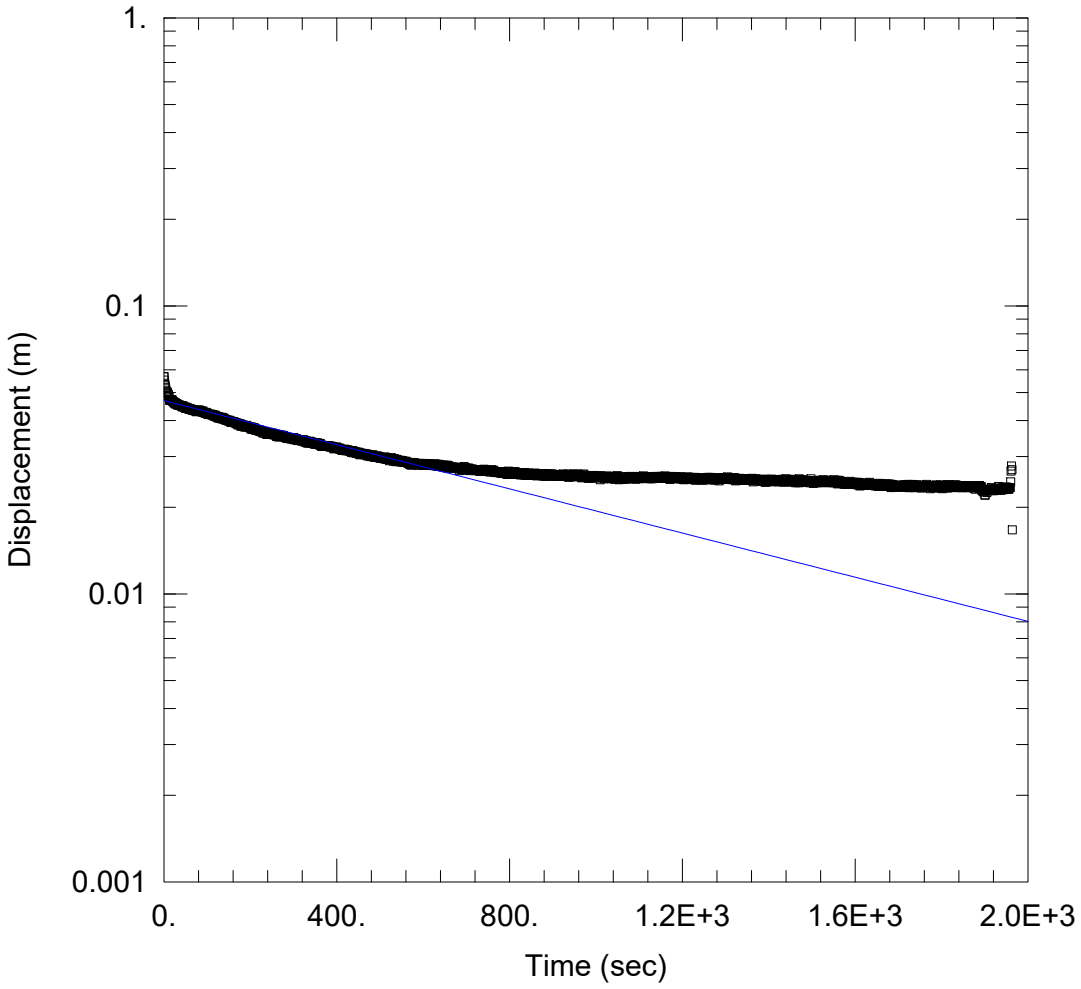
WELL DATA (MW6)

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

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

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



WELL TEST ANALYSIS

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

PROJECT INFORMATION

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

AQUIFER DATA

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

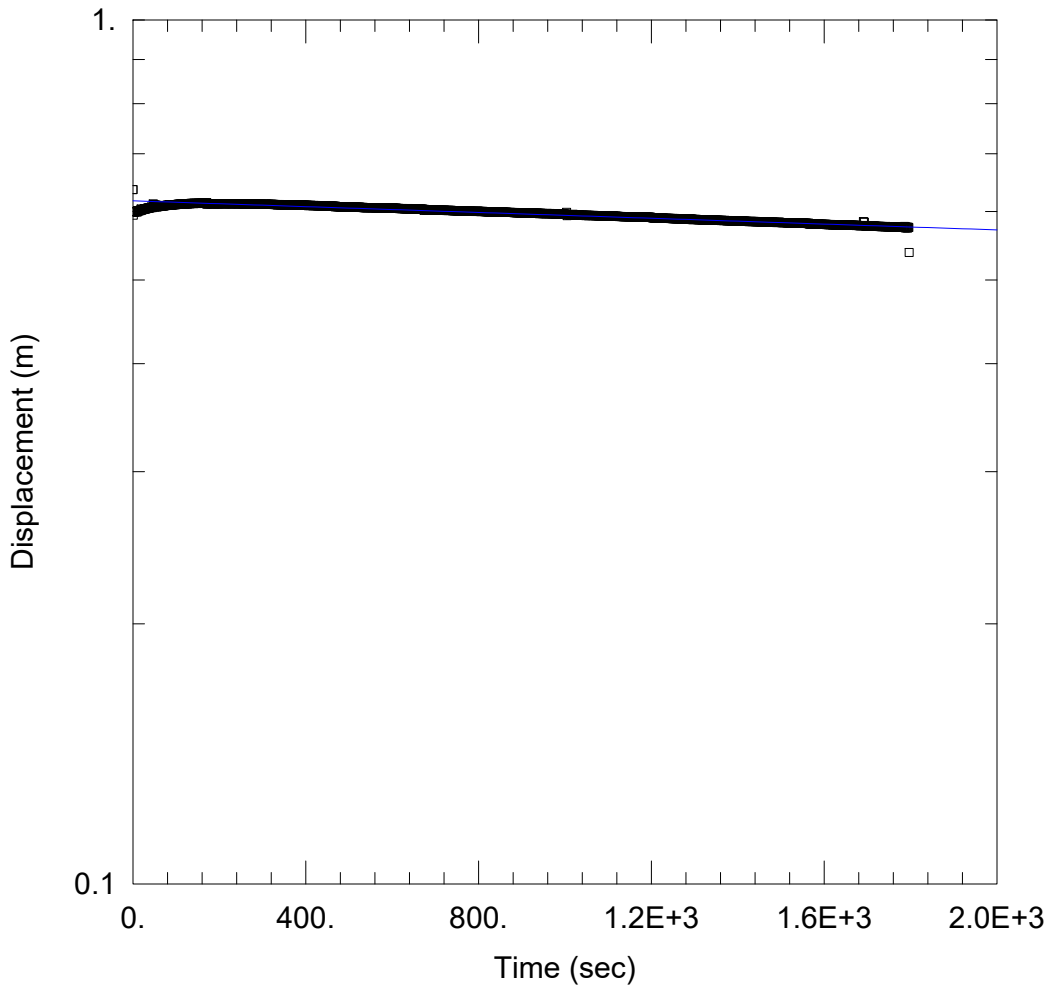
WELL DATA (MW5)

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

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 9.929E-7 m/sec y0 = 0.04692 m



WELL TEST ANALYSIS

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

PROJECT INFORMATION

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

AQUIFER DATA

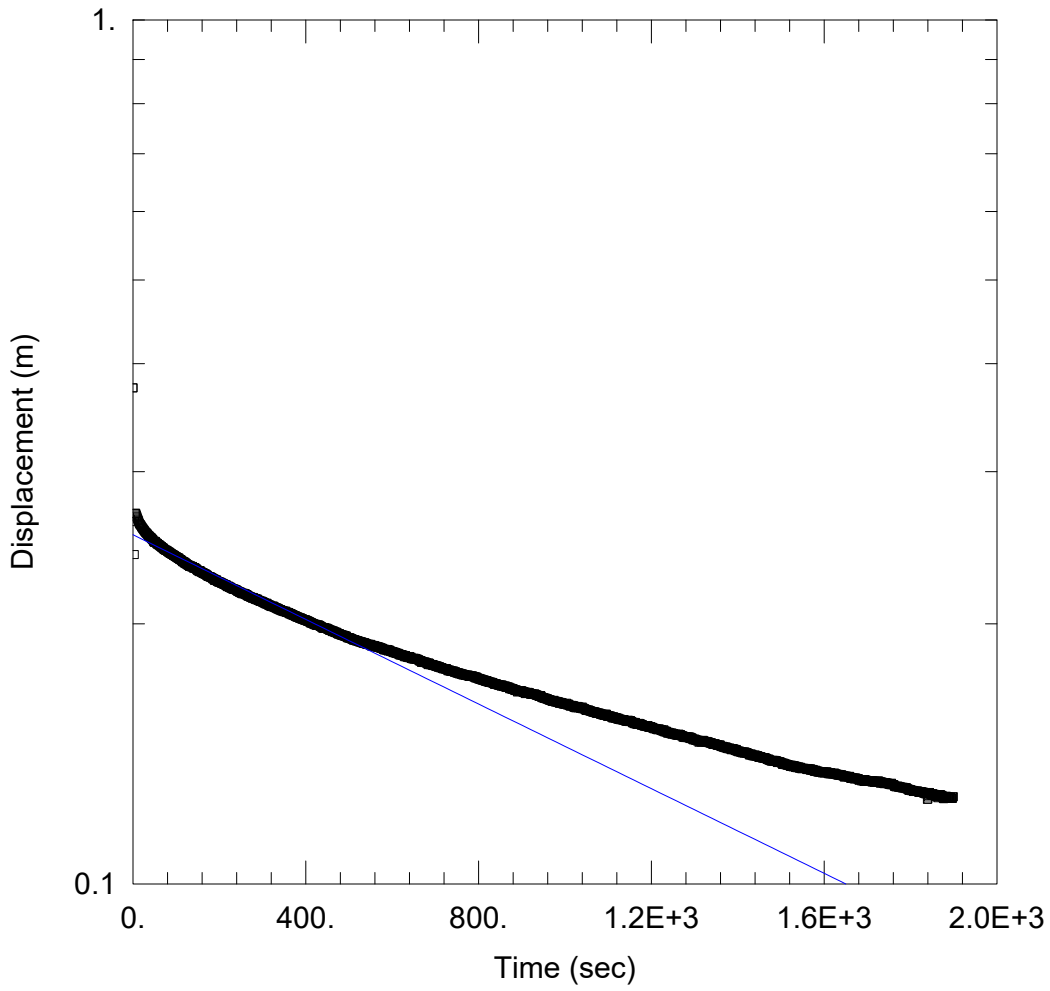
Saturated Thickness: 5.52 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW5)

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

SOLUTION

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



WELL TEST ANALYSIS

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

PROJECT INFORMATION

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

AQUIFER DATA

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

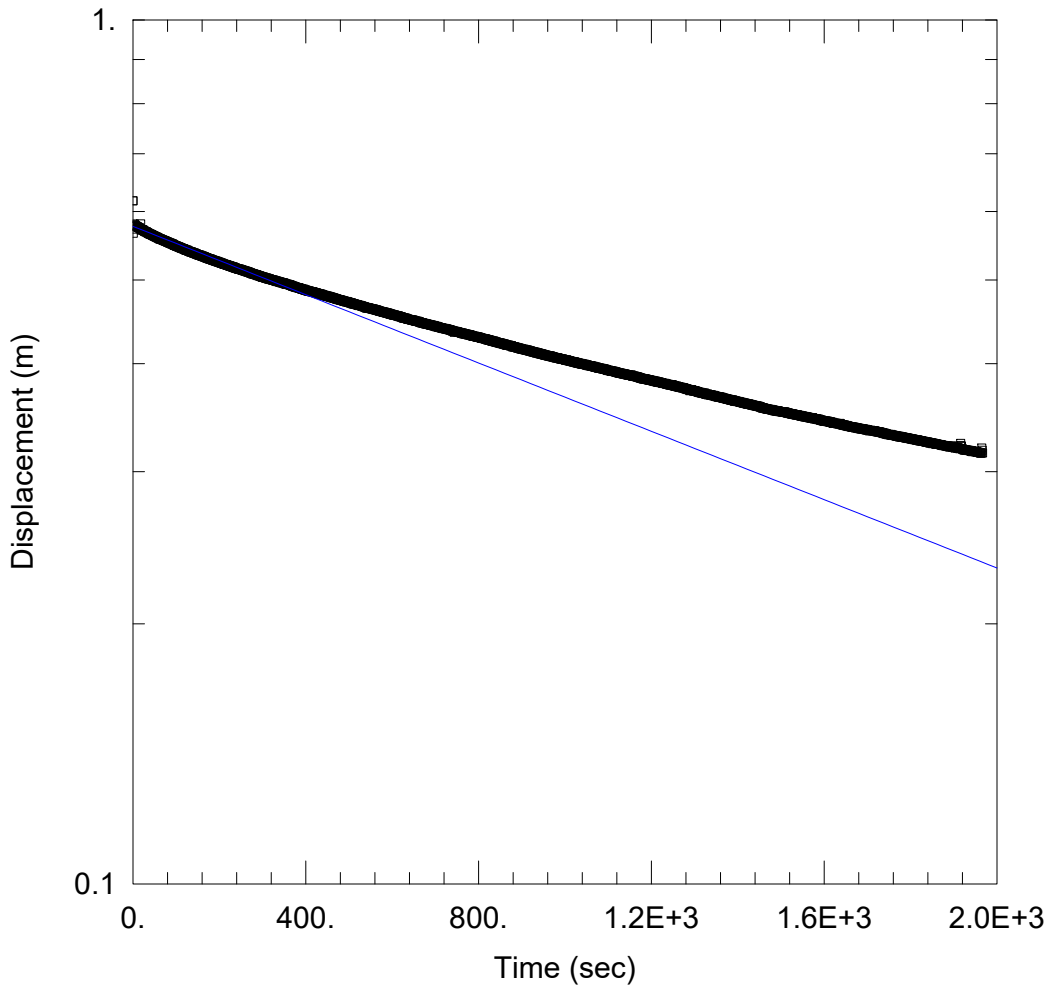
WELL DATA (MW2S)

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

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

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



WELL TEST ANALYSIS

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

PROJECT INFORMATION

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

AQUIFER DATA

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

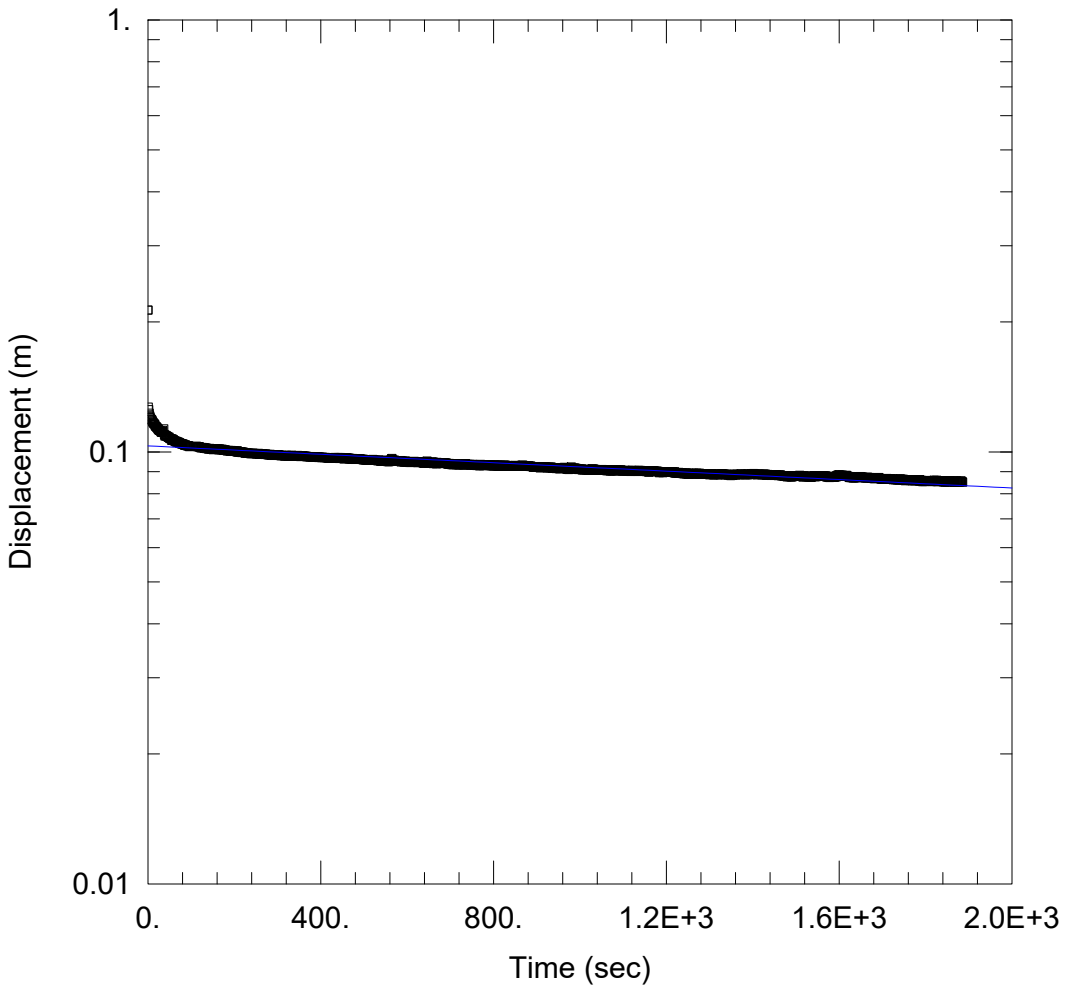
WELL DATA (MW2S)

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

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

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



WELL TEST ANALYSIS

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

PROJECT INFORMATION

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

AQUIFER DATA

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

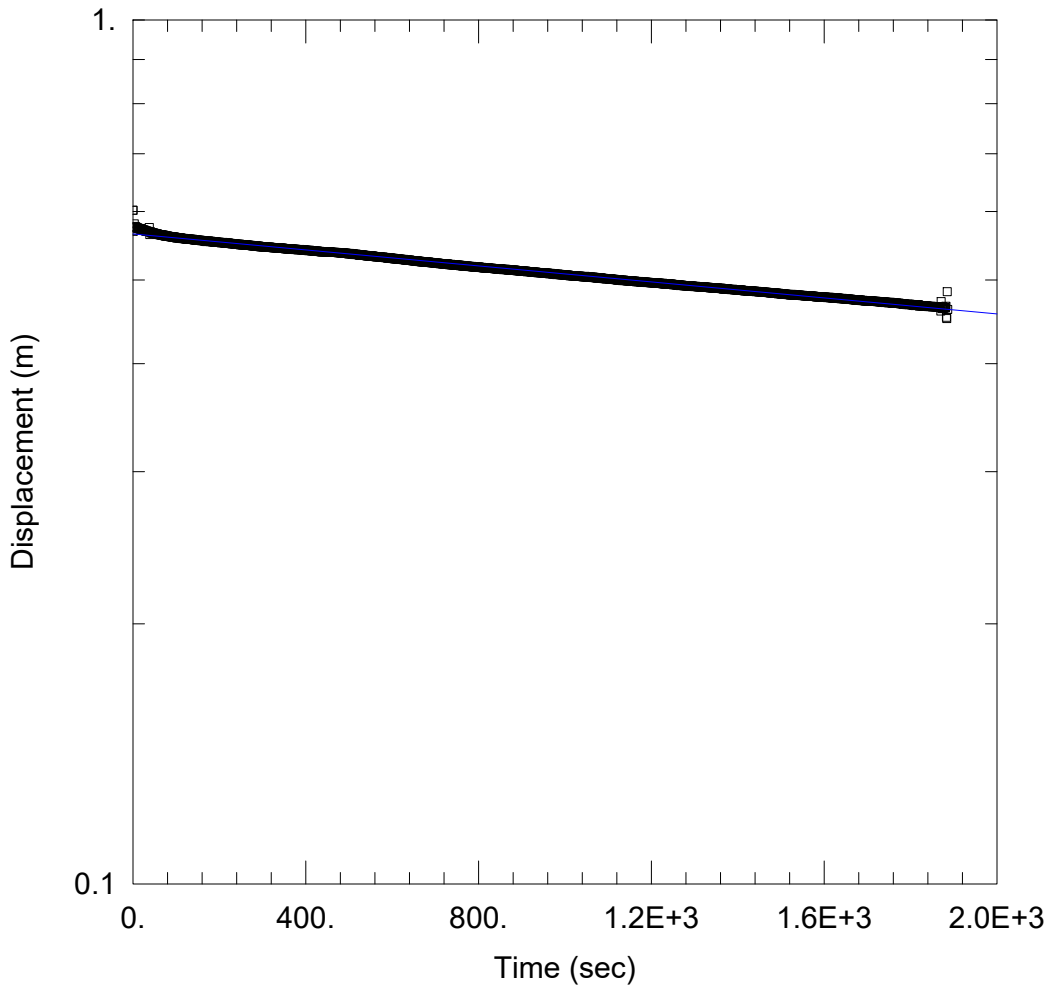
WELL DATA (MW2D)

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

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 1.262E-7 m/sec
y0 = 0.1033 m



WELL TEST ANALYSIS

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

PROJECT INFORMATION

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

AQUIFER DATA

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

WELL DATA (MW2D)

Initial Displacement: 0.6021 m
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

Appendix F

Groundwater Chemistry Results and Certificate of Analysis

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

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

Client Phone: 647-795-8153

Certificate of Analysis

Lab Work Order #: L2068971

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

Amanda Fazekas
Account Manager

170163 CHICKADEE LANE

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

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

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

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

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

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

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

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

Reference Information

Sample Parameter Qualifier key listed:

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

Methods Listed (if applicable):

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

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

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

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

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

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

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

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

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

COLOUR-APPARENT-WT	Water	Colour	APHA 2120

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

EC-WT	Water	Conductivity	APHA 2510 B

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

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

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

HARDNESS-CALC-WT	Water	Hardness	APHA 2340 B

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

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

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

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

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

NH3-WT	Water	Ammonia, Total as N	EPA 350.1

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

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

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

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

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

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

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

PH-WT	Water	pH	APHA 4500 H-Electrode

Water samples are analyzed directly by a calibrated pH meter.

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

Reference Information

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

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

REDOX-POTENTIAL-WT	Water	Redox Potential	APHA 2580

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

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

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

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

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

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

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

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

TURBIDITY-WT	Water	Turbidity	APHA 2130 B

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

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

Chain of Custody numbers:

17-622480

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

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

GLOSSARY OF REPORT TERMS

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

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

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

Quality Control Report

Workorder: L2068971 Report Date: 23-MAR-18

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

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

Quality Control Report

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

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

Quality Control Report

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

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

Quality Control Report

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

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

Quality Control Report

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

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

Quality Control Report

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

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

Quality Control Report

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

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

Quality Control Report

Workorder: L2068971 Report Date: 23-MAR-18

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

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

Quality Control Report

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

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

Quality Control Report

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

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

Quality Control Report

Workorder: L2068971 Report Date: 23-MAR-18

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

Legend:

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

Sample Parameter Qualifier Definitions:

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

Quality Control Report

Workorder: L2068971 Report Date: 23-MAR-18

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

Hold Time Exceedances:

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

Legend & Qualifier Definitions:

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

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

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

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

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

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2068971-COFC

COC Number: 17 - 622480

Page of

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

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

Analysis Request

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

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

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

SAMPLE CONDITION AS RECEIVED (lab use only)

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

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

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

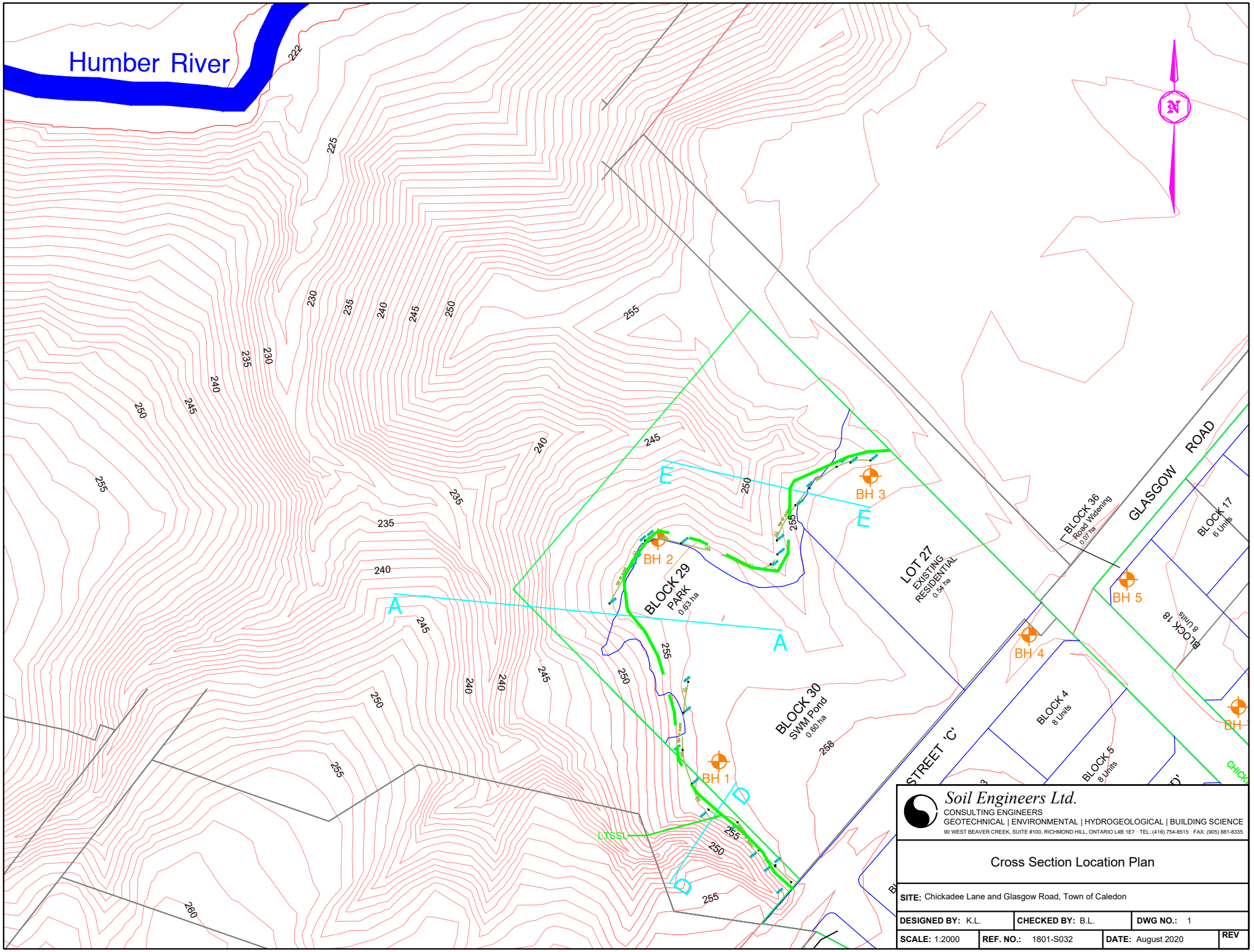
JULY 2017 FRONT

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

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

Appendix G

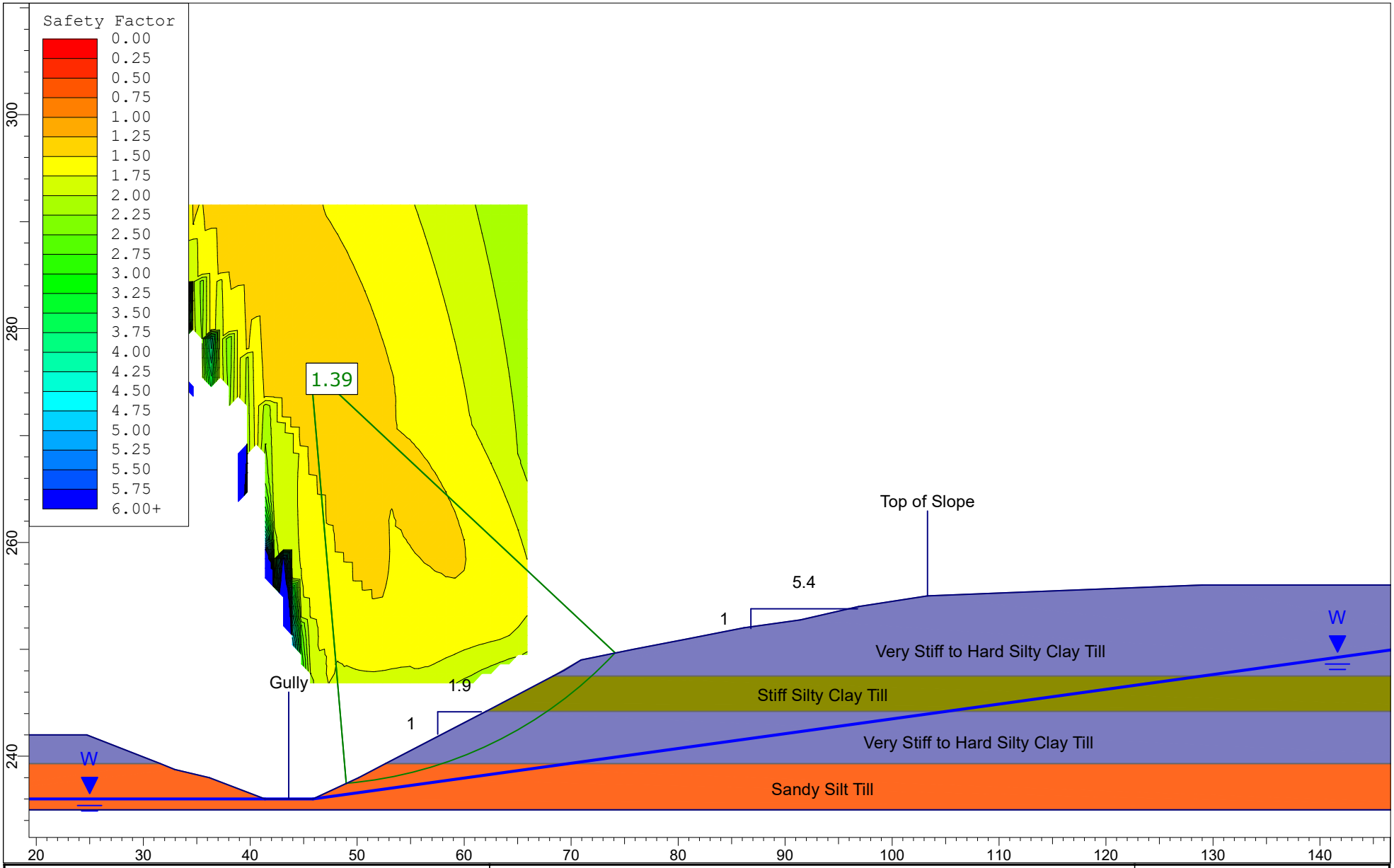
Geotechnical Boreholes and Slope Stability Analysis



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

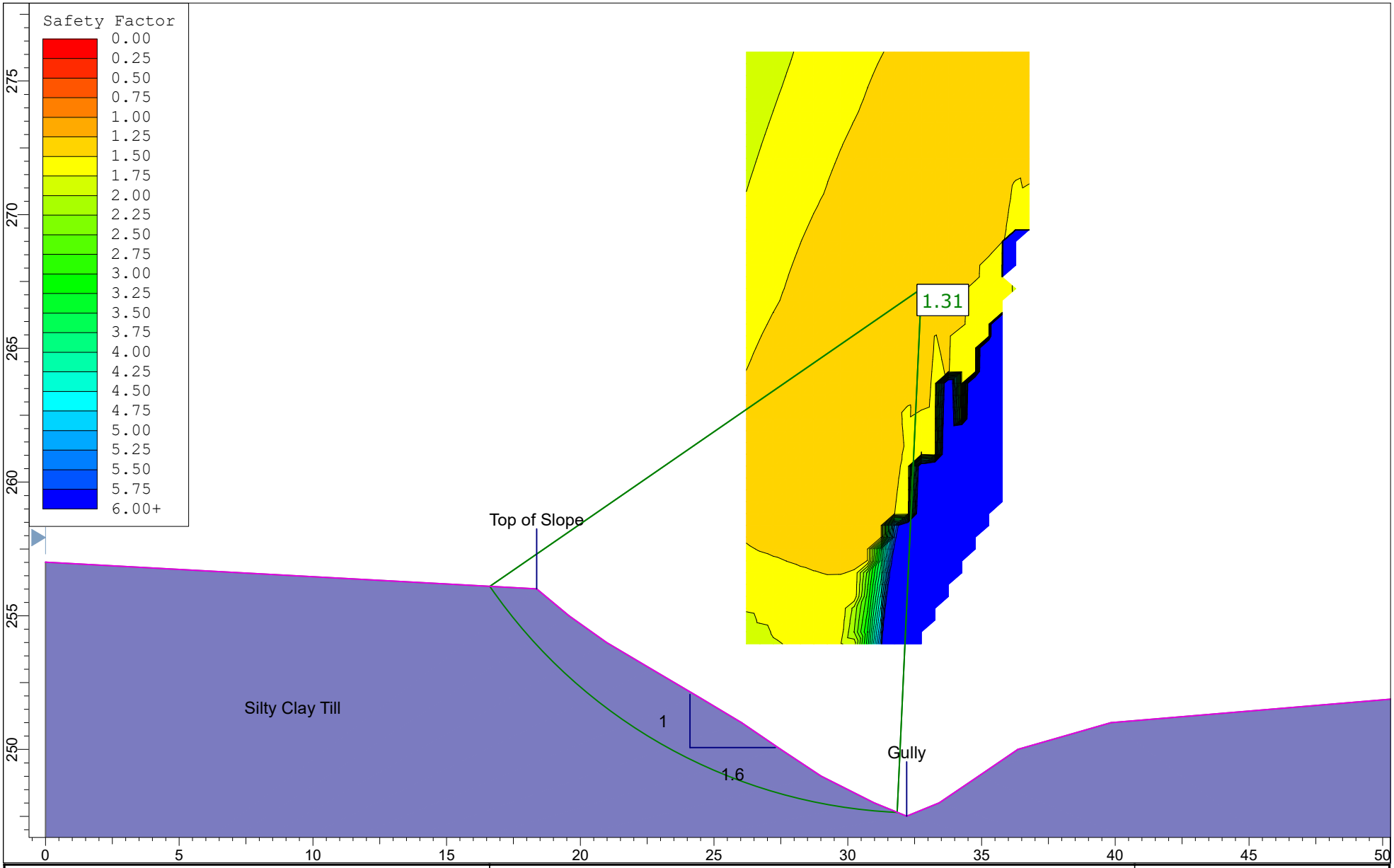
Cross Section Location Plan

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**



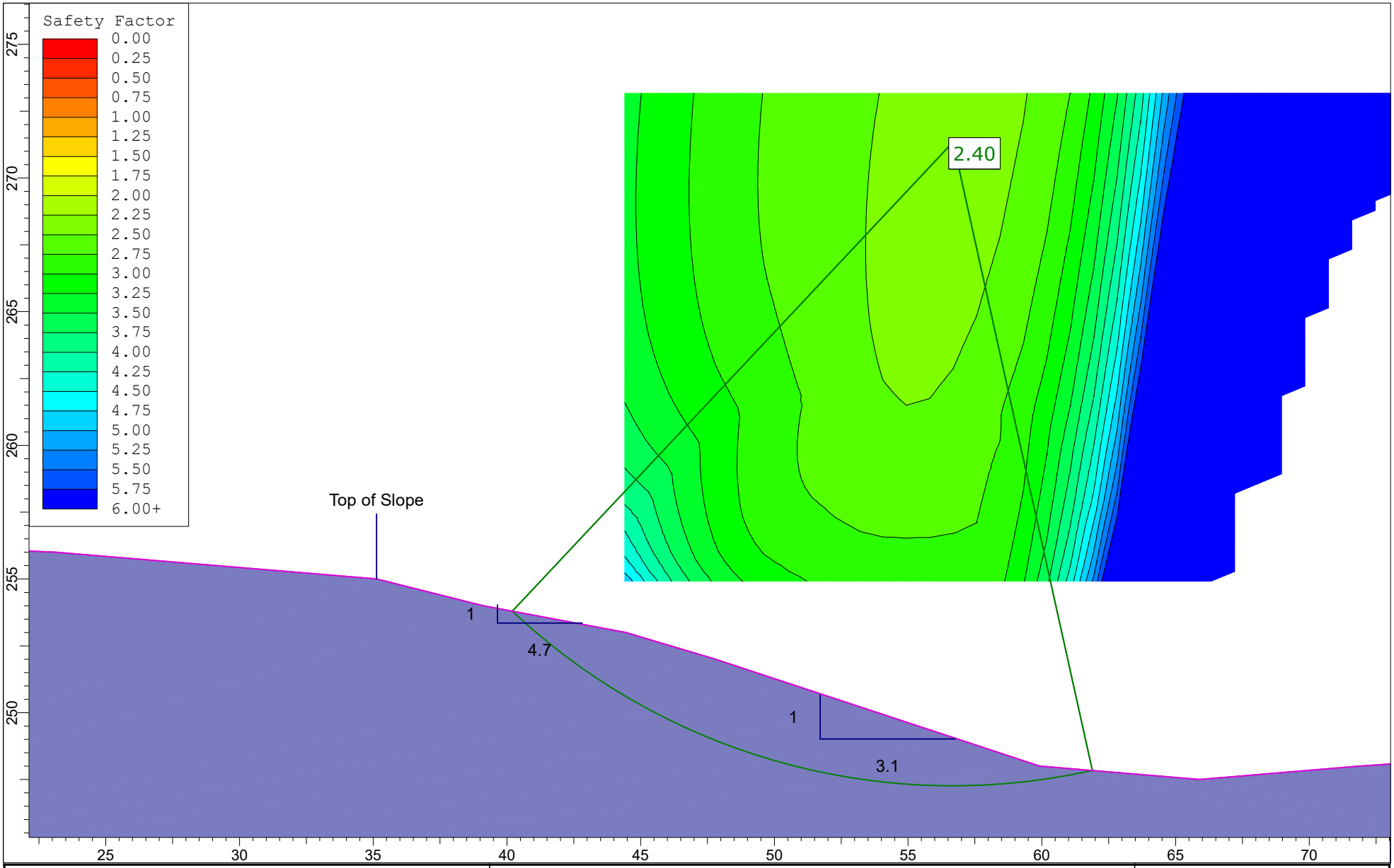
Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE
90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

Project Title: Slope Stability Assessment - Cross Section 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



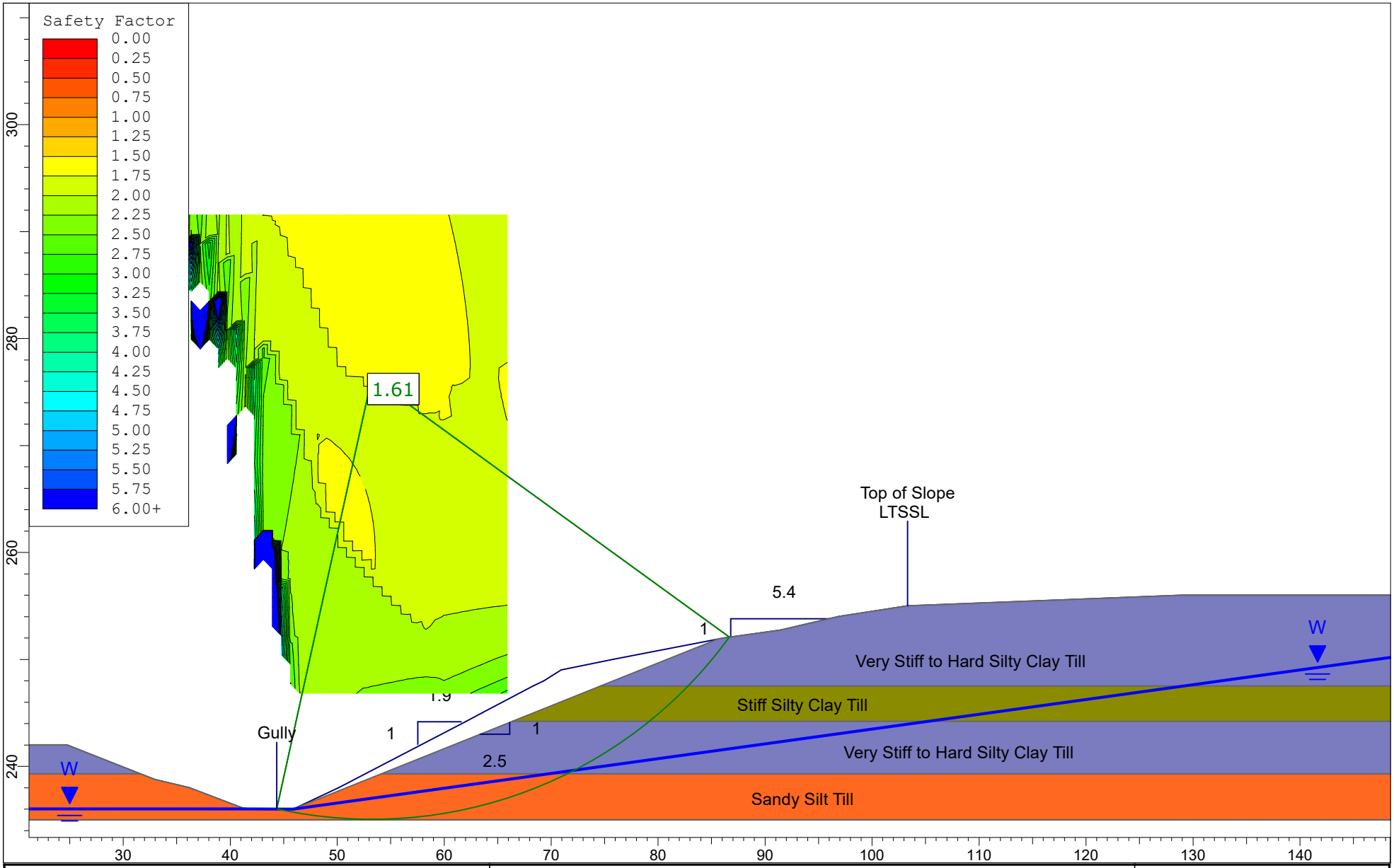
Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE
90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

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



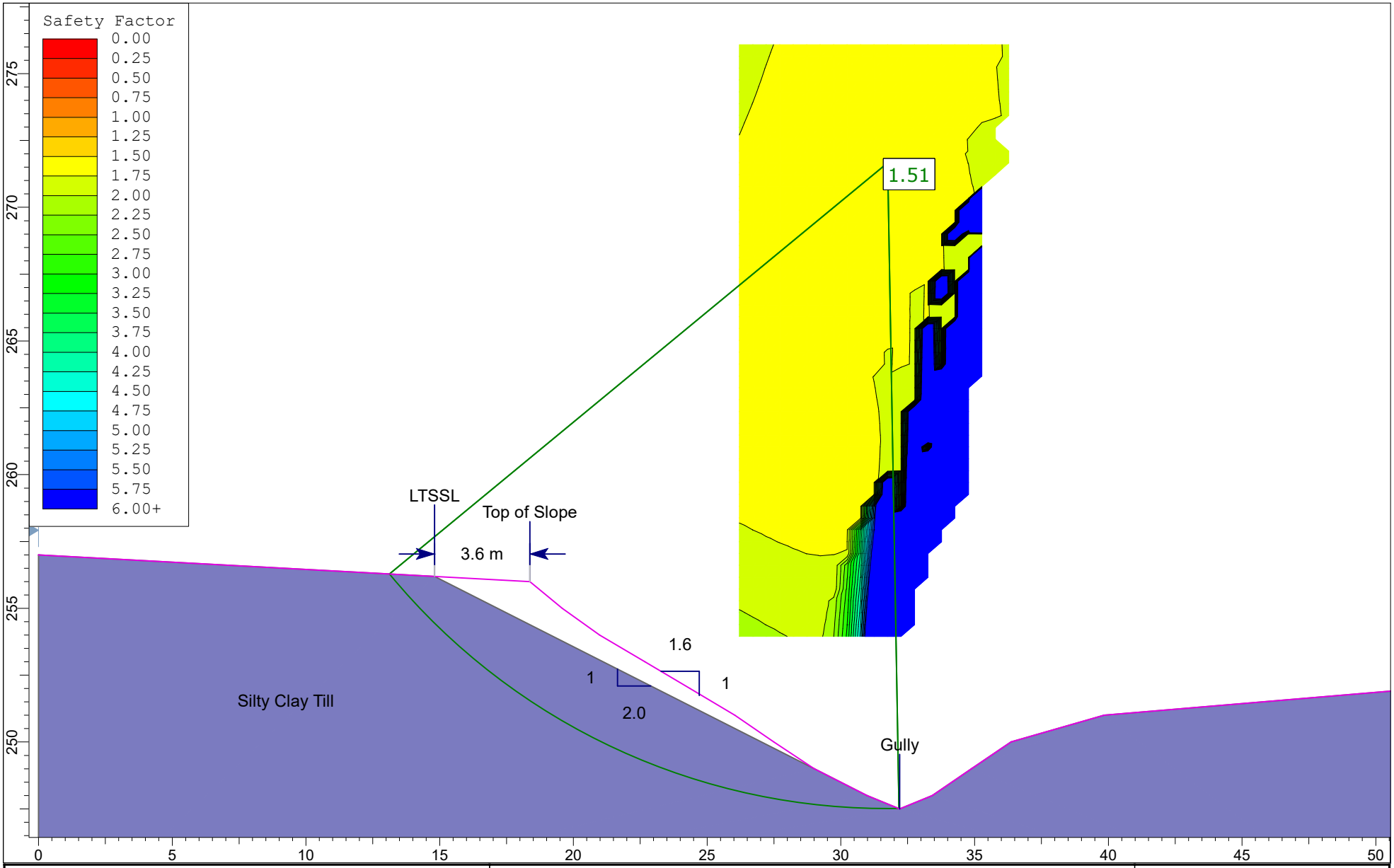
Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE
90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

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



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 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

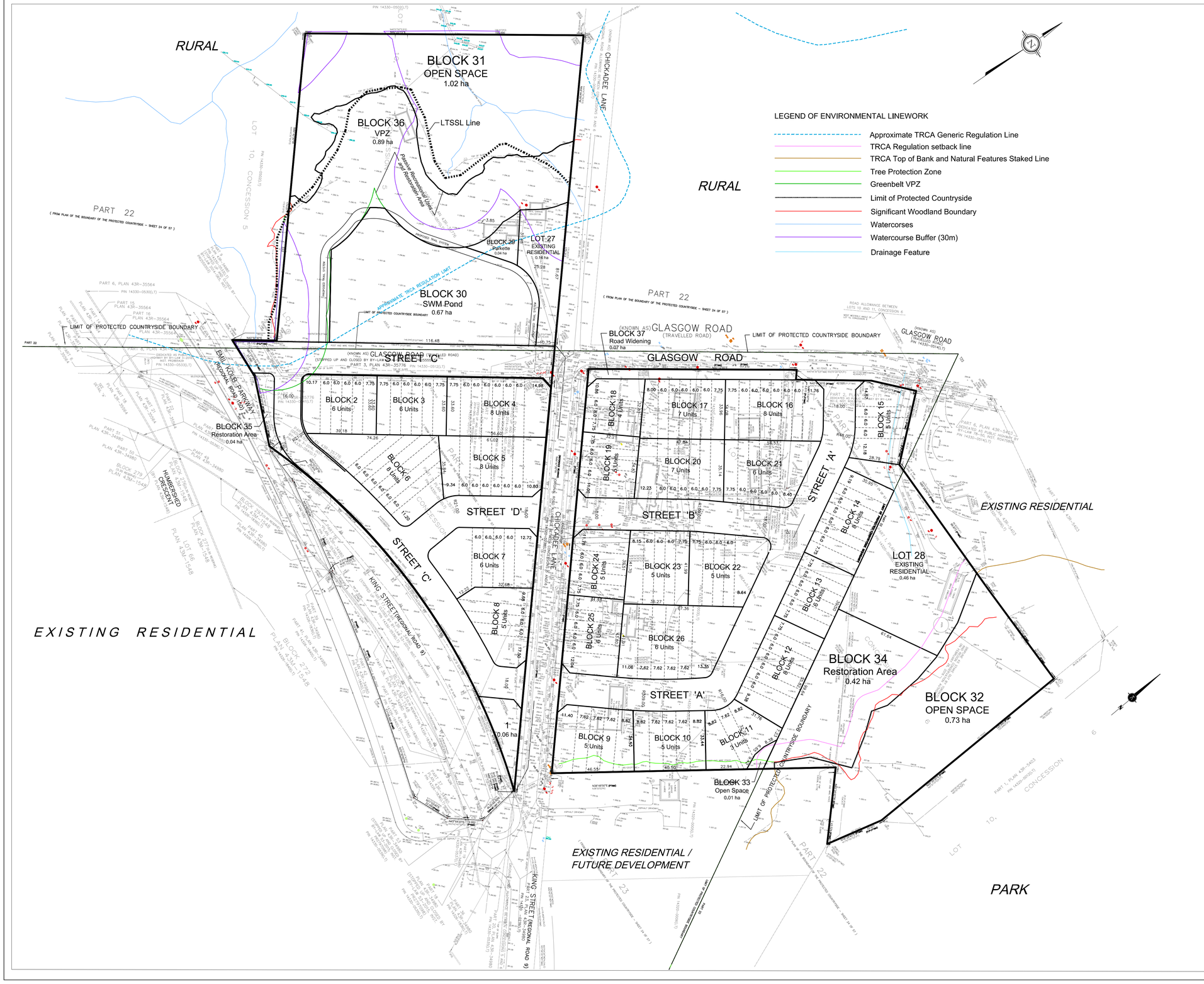


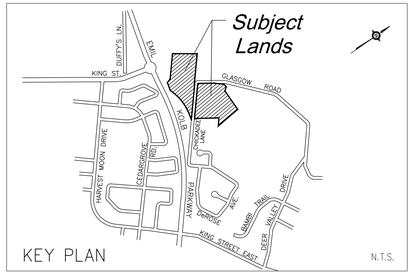
Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE
90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

Project Title: Slope Stability Assessment - Cross Section D-D			Load Case: 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

Appendix H

Draft Plan of Subdivision (HPG, 2021)





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

DEVELOPMENT STATISTICS:

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

OWNER'S CERTIFICATE:

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

Date: DECEMBER 28, 2020

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

SURVEYOR'S CERTIFICATE:

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

Date: DECEMBER 28, 2020

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

ADDITIONAL INFORMATION:

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

DRAFT PLAN OF SUBDIVISION

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

SCALE 1:1000

10 0 10 20 50 100m

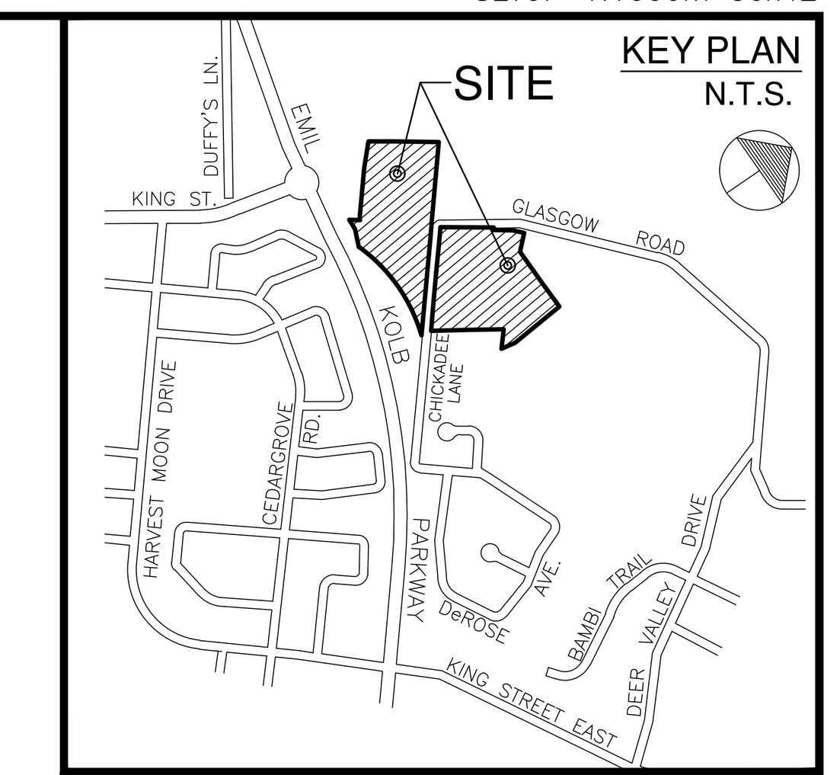
HUMPHRIES PLANNING GROUP INC.
216 CHRISLEA ROAD, SUITE 103, VAUGHAN, ONTARIO, L4L 8S5
TEL (905)264-7678, FAX (905)264-8073
www.humphriesplanning.com

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

Appendix I

Stormwater Management Plans (Candevcon, 2020)

SETUP 1:1000m 30x42



LEGEND:

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

NOTE
FOR STORMWATER MANAGEMENT POND DETAILS SEE DRAWING SWM-1

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

REVISIONS

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

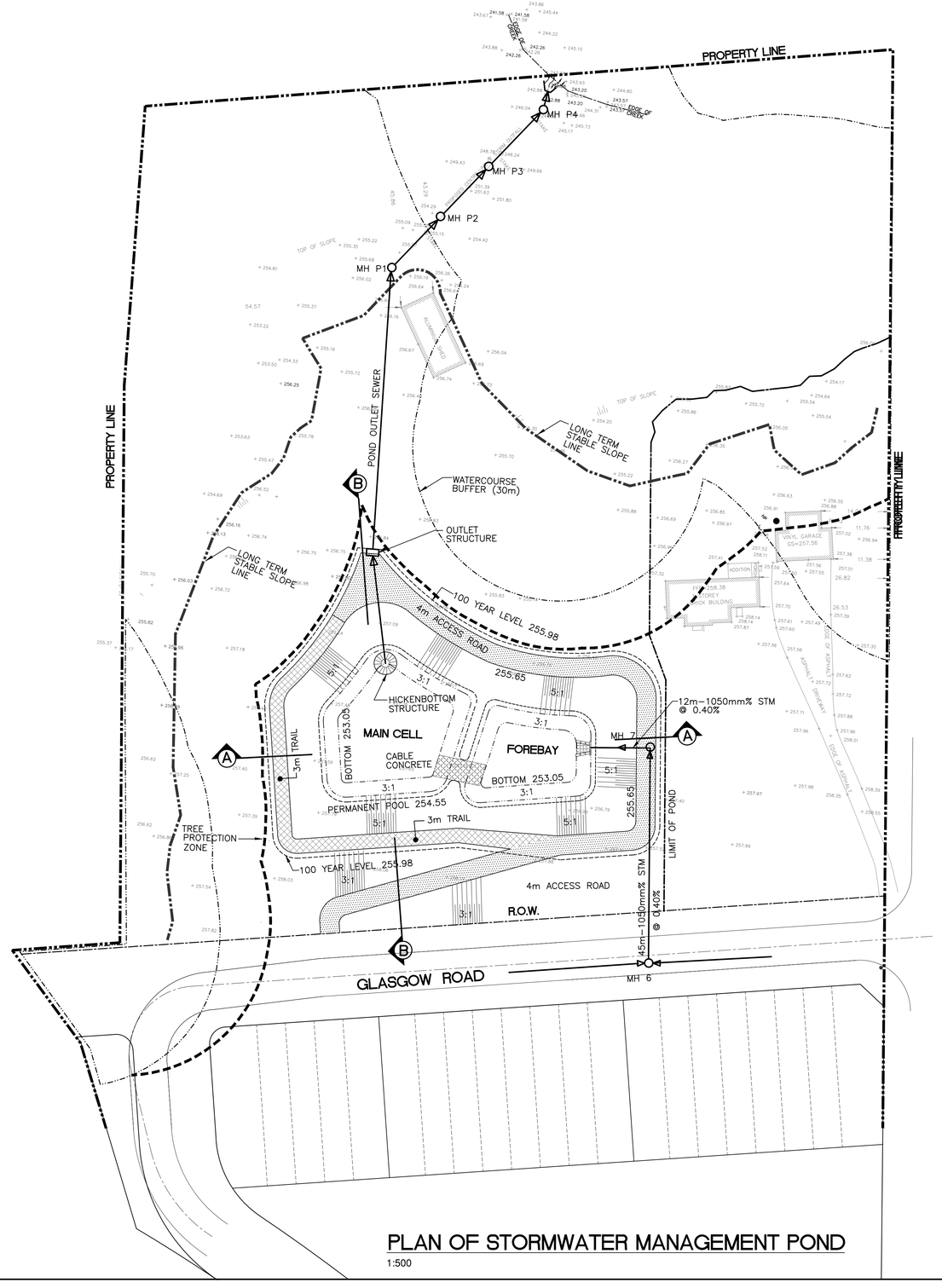
TOWN OF CALEDON

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

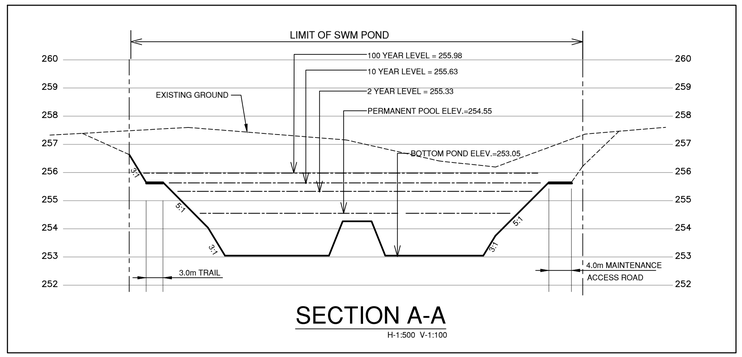
SHEET TITLE:
PRELIMINARY STORM DRAINAGE AREA PLAN

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



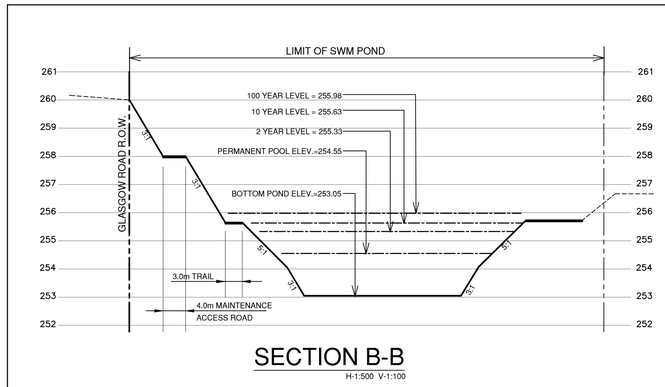
PLAN OF STORMWATER MANAGEMENT POND

1:500



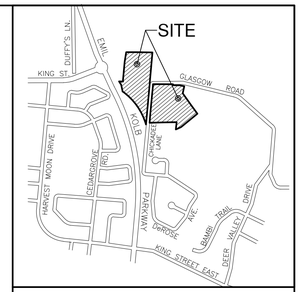
SECTION A-A

H-1:500 V-1:100



SECTION B-B

H-1:500 V-1:100



KEY PLAN
N.T.S.

NO.	DESCRIPTION	DATE	BY
	REVISIONS		

CANDEVCON LIMITED
CONSULTING ENGINEERS AND PLANNERS
9358 GOREWAY DRIVE BRAMPTON, ONTARIO L6P 0M7
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:
STORMWATER MANAGEMENT POND

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

Appendix J

Infiltration Trench Drawing (IT-1A) (Candevcon, 2020)

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

REVISIONS

CANDEVCON LIMITED
CONSULTING ENGINEERS AND PLANNERS
9358 GOREWAY DRIVE, BRAMPTON, ONTARIO L6P 0M7
TEL. (905) 794-0600 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: 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		

Appendix K

MNRF Correspondance (March 7, 2019)

Necessity of SAR/SWH surveys - Chickadee Lane Rounding Area B (PECG#170163) Inbox

Austin Adams <austin@pecg.ca> Thu, Feb 14, 3:19 PM
to esa.aurora, me

Hello,

Palmer (PECG) is currently completing CEISMP and EIS reporting for the Chickadee Lane Rounding Area B in Bolton, Ontario. Further to the SAR occurrence data received from Te July 5, 2018 and field studies completed for the study area, we submit this letter for review, advisement and/or direction. Due to the ecological character of the study area, studies alı completed and the planned avoidance and/or quality of potential habitats, it is felt that additional species-specific surveys may be avoided. PECG is seeking consultation from the M regard.

Please review the attached letter, which I believe provides sufficient context and rationale regarding SAR and SWH concerns in the study area. Should you have any questions, plea hesitate to contact me.

Regards,
Austin Adams, M.Sc., EP
Senior Terrestrial Ecologist

Palmer Environmental Consulting Group Inc.
74 Berkeley Street, Toronto, ON M5A 2W7
t 647 795 8153 ext 147 **c** 647 461 2372 **e** austin@pecg.ca
www.pecg.ca

MNRF Corresp_S…

ESA Aurora (MNRF) <ESA.Aurora@ontario.ca> Thu, Mar 7, 2:46 PM
to Austin, me

Hello Austin

Letter reviewed. Based on the proposed avoidance and mitigation approaches described, MNRF has no concerns with the proposed development.

Regards

Mark Heaton
OMRNF Aurora

Appendix L

Fluvial Geomorphology Existing Conditions Memo (Palmer, 2020)

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

Memorandum

Date: July 29, 2020

Project #: 1701603

To: Frank Filippo, Zancor Homes

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

cc: Jason Cole, M.Sc, P.Geo.

Re: Chickadee Lane Existing Conditions
Fluvial Geomorphological Assessment of Humber River Tributary

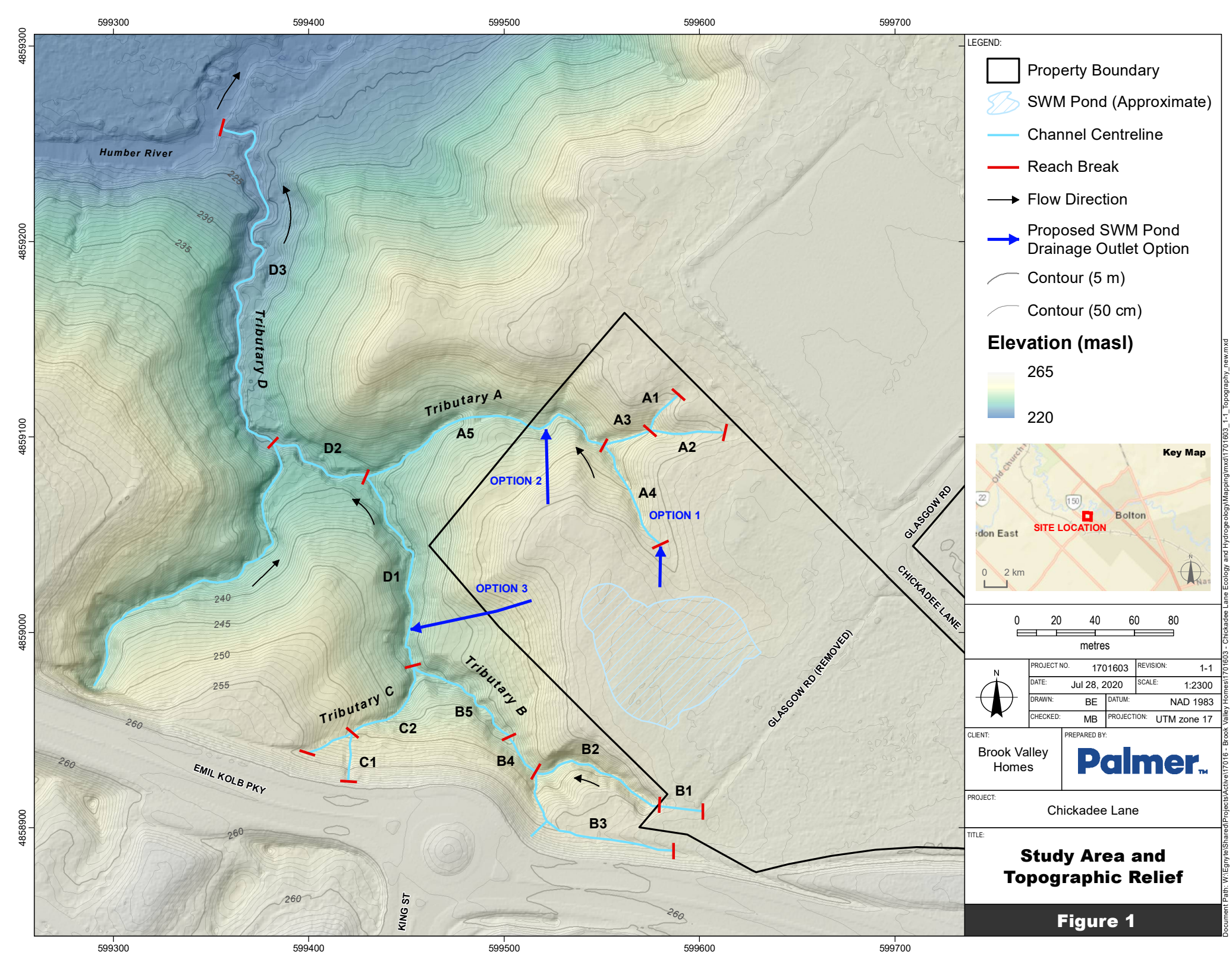
1. Introduction

Palmer is pleased to provide Brookvalley Project Management Inc. (Brookvalley), on behalf of Zancor Homes Inc. (Zancor), the results of our existing conditions assessment to document extensive bed degradation and valley wall instability along a network of headwater tributary gullies and channels of Humber River draining the northwest corner of the subject property at the intersection of Chickadee Lane and Glasgow Road, in Bolton. This technical memorandum provides detailed documentation of existing conditions along the reaches of each tributary gully and channel (**Figure 1**), which exhibit evidence of at least localized severe erosion as a result of uncontrolled stormwater runoff and anthropogenic alteration within the catchment. A photographic log is provided in **Appendix A.**

1.1 Background

Following submission of Palmer's (2019) *Chickadee Lane Rounding Out Area B Comprehensive Environmental Impact Study and Management Plan*, comments from Toronto and Region Conservation Authority (TRCA), received May 15, 2020, expressed concern that a thorough assessment of existing conditions of the tributary network was not previously completed. TRCA noted that an existing conditions assessment was required to inform proposed stormwater management (SWM) drainage options into the Humber River valley. After a site visit with Palmer's Senior Fluvial Geomorphologist, Candevcon Ltd. and Brookvalley on May 26, 2020, to discuss potential SWM Pond outlet alternatives, severe erosion was observed near potential outlet locations. It was determined that an expanded assessment of the existing tributary network would be required to ensure TRCA is aware of erosion issues prior to land development.

Palmer understands that the principal objective is to establish a baseline of the tributary network's contemporary form and function, along four of its five branches, to inform evaluation of SWM outfall options identified during the site meeting on May 26, 2020.


599300
599400
599500
599600
599700
4859300
4859200
4859100
4859000
4858900
Humber River
Tributary D
Tributary A
Tributary B
Tributary C
D1
D2
D3
A1
A2
A3
A4
A5
B1
B2
B3
B4
B5
C1
C2
OPTION 1
OPTION 2
OPTION 3
GLASGOW RD
GLASGOW RD (REMOVED)
CHICKADEE LANE
EMIL KOLB PKY
KING ST
225
230
235
240
245
250
255
260
265
220
LEGEND:
Property Boundary
SWM Pond (Approximate)
Channel Centreline
Reach Break
Flow Direction
Proposed SWM Pond Drainage Outlet Option
Contour (5 m)
Contour (50 cm)
Elevation (masl)
Key Map
SITE LOCATION
Bolton
0 2 km
0 20 40 60 80
metres
N
PROJECT NO. 1701603
REVISION: 1-1
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 Topographic Relief
Figure 1
Document Path: W:\Egnyte\Shared\Projects\Active\17016 - Brook Valley Homes\1701603 - Chickadee Lane Ecology and Hydrogeology\Mapping\mxd\1701603_1-1_Topography_new.mxd

2. Methods

The fluvial geomorphology of the tributary network draining the subject property was assessed through a combination of desktop analysis and field investigation. We reviewed a number of important sources for the study area including historical and recent aerial photography, LiDAR-derived elevation data purchased through First Base Solutions Ltd. and pertinent results from Palmer's *Chickadee Lane Rounding Out Area B Comprehensive Environmental Impact Study and Management Plan (CEISMP) Parts A, B, and C* (2019).

Initial field reconnaissance of the tributary network was completed by Palmer's Senior Geomorphologist on May 26, 2020. Palmer staff specializing in fluvial geomorphology and ecology completed a subsequent field investigation on June 22, 2020. Flow conditions were near baseflow with no antecedent precipitation prior to the field visit. The purpose of the visit was to thoroughly document existing conditions along four of five tributary catchments (**Figure 1**) draining the northwest corner of the subject property in accordance with applicable approaches from Harrelson et al. (1994). Spot checks of bankfull widths and depths were completed. A fifth tributary catchment located northwest of the subject property (**Figure 1**) was excluded from the existing conditions assessment. It was determined that the proposed development and SWM pond outlet locations would not directly or indirectly influence its channel morphology, and the tributary catchment would not contribute to erosion near proposed outlets. The tributary catchment was walked only to gain a general understanding of the channel's form and function. Attention was given to examining erosional patterns at, and downstream of, three proposed SWM pond outlet locations.

Reaches within the study area were preliminarily established based on interpretation of aerial photography, LiDAR-derived elevation data, surficial geology/soils mapping and surface drainage/stormwater mapping, in accordance with the protocols established by Harrelson et al. (1994). A total of 15 reaches were delineated (**Figure 1**). A reach length typically exhibits similar physical characteristics reflecting particular geomorphic controls – discharge (drainage area, tributary confluences), gradient (steepness, slope-breaks), substrates (geology, soils) and valley setting (confinement) – to which the channel has become or is becoming adjusted. Riparian vegetation, land use and anthropogenic influences represent modifying factors. The drainage network was subdivided into four tributary catchments: Tributary A, Tributary B, Tributary C and Tributary D. Reaches within each of the four tributary catchments were given an alphanumeric value (e.g. A1, B2, etc.).

3. Physical Setting and Historical Changes

The site is located within the South Slope physiographic region, characterized 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). 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 and shale. In the vicinity of the subject property, Humber River has incised through thick deposits of clay to silt-textured till. Borehole logs from drilling completed within the subject property generally indicate that a veneer of topsoil and earth fill overlies silty clay till and compact to very dense sandy silt till at greater depth (Soil Engineers Ltd., 2018). The presence of cohesive till along the floor and sidewalls of the tributary valleys was confirmed during field investigation on June 22, 2020. A discontinuous veneer of fill along the

west-facing valley wall of Reaches B2, B4 and B5 of the Tributary B catchment, paralleling the western property boundary, was observed (**Figure 1**).

The Tributary A and D catchments exhibit signs of anthropogenic modification; however, disturbances were not visible in historical aerial photographs. Wire fencing, a concrete spillway, culverted sections and concrete and brick rubble highlight past anthropogenic influence. Residential development, which has steadily increased since the mid-2000's to the west and south of the subject property, has changed the catchment size of the overall tributary network. Recent construction (2014 – 2017) of Emil Kold Parkway has had a direct influence on the gullies and channels comprising the Tributary B, C and D catchments, including new riprap-lined drainage swales that convey stormwater runoff to downstream reaches. Also, the Emil Kolb Parkway road embankment extends into Reach B4 enough to have modified the channel bed and banks.

4. Description of Channel Morphology

4.1 Overview

Uncontrolled runoff from Emil Kolb Parkway has increased peak flows above those to which channel morphology has adapted along the gullies and channels comprising the Tributary B, C and D catchments (**Figure 1**). Watershed urbanization to the west and south, combined with Emil Kolb Parkway construction, has led to irregular channel instability. In response to unnaturally deep and fast flows, channels have down-cut and incised through their original (pre-development) alluvial floodplain along the lower reaches of the tributary network (Tributary D) into underlying sandy silt till substrate. Channel incision has exacerbated toe erosion and valley wall instability, particularly in the upper reaches of the Tributary B and C catchments. Surface runoff and seepage along the valley wall, resulting from the presence of a perched water table (Palmer 2019), further contributes to instability. The Tributary A catchment is relatively stable in comparison to all three others.

The reaches comprising the Tributary A, B and C catchments function as gullies. The morphology of gullies differs from the morphology of channels formed predominantly by fluvial processes (Tributary D). Gullies tend to have steep sides, low width/depth ratios, and a stepped profile, characteristically having knickpoints from head-cutting (Knighton, 1998). They generally lack alluvial floodplains along their narrow bottoms. Gully initiation and development involve multiple episodes of channel erosion: downward scour, head-cutting, rapid enlargement, and stabilization. These erosional processes work as a positive feedback mechanism as the steep slope and low width/depth ratio lead to higher velocities and stream power, leading to enlargement of the gully (Gao, 2013). As a result, gullies are inherently erosive landforms that form where surface runoff concentrates down a slope.

A better-defined watercourse (Tributary D) originates downstream of the confluence between the Tributary B and C catchments where the channel has down-cut and incised through the most upstream occurrence of an alluvial floodplain. A new corridor, with an active channel and a discontinuous low (active) floodplain, has begun to form approximately 1.5-2 m below the former floodplain and valley floor (now best described as a terrace). The Tributary D channel, which is confined by terrace scarps, exhibits reach-scale instability until its confluence with Humber River.

4.2 Reach Descriptions

4.2.1 Tributary A Catchment (Reaches A1, A2, A3, A4 and A5)

The Tributary A catchment consists of a well-defined network of gullies and channels that descends from the northeast corner of the subject property into the Humber River valley (**Figure 2**). A total of five reaches were delineated within the Tributary A catchment. Residential development has reduced and fragmented Tributary A's catchment, with overland flow captured by the drainage ditch along the south side of Glasgow Road and a driveway to the east that borders the property. SWM pond drainage alternative 1 is proposed to discharge into Reach A4. Alternative 2 discharges into Reach A5 (**Figure 1**). **Table 1** provides a detailed description of channel morphology along each reach. Representative photographs are provided in **Appendix A**.

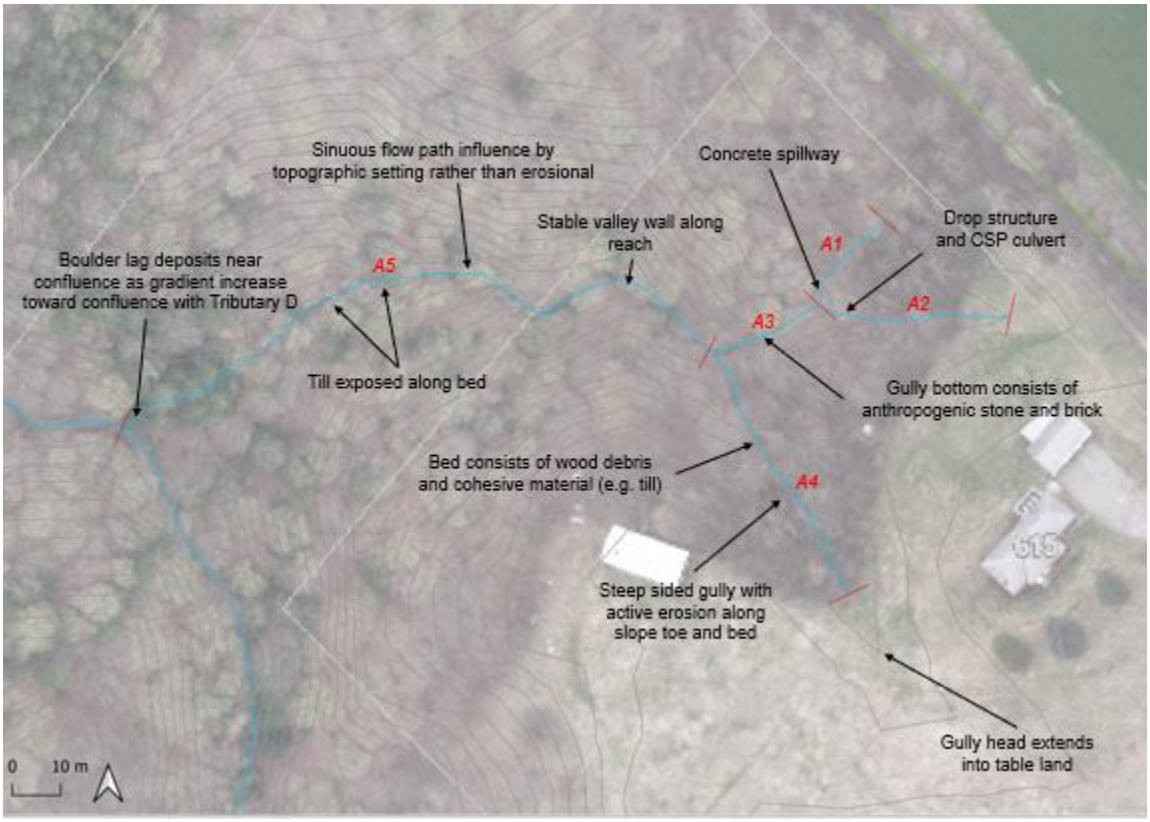


Figure 2. Tributary A catchment reach descriptions and channel morphology

Table 1. Tributary A Catchment Reach Descriptions

Reach	Description
A1	The gully has a swale-like appearance upstream of a concrete spillway located at its downstream extent. The concrete spillway acts as a grade control. The gully has gently sloping sidewalls and exhibits no signs of erosion or mass movement failures. No headward cut or seepage areas were observed. The gully has a high gradient (17%) and a smooth bed profile. The gully has a poorly defined U-shaped channel with an approximate width and depth of 3 m and 0.2 m, respectively.
A2	The gully has a swale-like appearance along its upstream extent before steepening near its confluence with A2. The gully has gently sloping sidewalls and exhibits no signs of erosion or mass movement failures. No headward cut or seepage areas were observed. The gully has a moderate-high gradient (10%) and a smooth bed profile. The gully has a poorly defined U-shaped channel with an approximate width and depth of 2.5 m and 0.2 m, respectively. The bed and bank materials consist of topsoil with anthropogenic stone and brick present. A grated drop structure, surrounded by cinderblocks, captures flow and conveys it through a CSP culvert at its downstream extent.
A3	The gully has gently sloping sidewalls and exhibits no signs of erosion or no mass movement failures. No headward cut or seepage areas were observed. The gully has a high gradient (13%) and a smooth bed profile. The gully bottom is lined with anthropogenic stone and brick, which overlies topsoil. Erosion mitigation along the gully bottom and truncated catchment inhibit scour along its length, creating a relatively stable reach. The gully has a poorly defined U-shaped channel with an approximate width and depth of 3 m and 0.2 m, respectively.
A4	The gully exhibits signs of active erosion along its sidewalls, influenced by scour along their toes. No mass movement failures, headward cut or seepage areas were observed. The gully has a high gradient (14%) and an irregular, stepped bed profile. The development of a stepped profile reflects local diversity in materials into which the gully has incised and how the channel moderates erosion to maintain stability. The banks are scoured and slightly undercut, exposing roots. All flows are confined to the V-shaped gully bottom without any floodplain. The gully-bottom cross-section is trapezoidal with a narrow bed (1 m) and shallow depth (0.2 m). Bed and bank materials consist of sandy silty-clay till, locally overlain by organic matter, sand, fine gravels, cobbles and anthropogenic debris (i.e. concrete rubble).
A5	The reach is transitional in its genesis and characteristics, exhibiting more influence from fluvial processes. The channel 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 (10%) and an irregular, stepped bed profile. The banks are scoured and slightly undercut, exposing roots and silty till. All flows are confined to the V-shaped gully bottom with no floodplain. The channel cross-section has a narrow bed (2 m) and shallow depth (0.2). Bed and bank materials consist of sandy silty-clay till, overlain by sand, cobbles and boulders. Woody debris and exposed tree roots impart structure and roughness along the bed. Coarsening of the bed moderates erosion and limited scour along the toe of the valley wall maintains stability along this reach.

4.2.2 Tributary B Catchment (Reaches B1, B2, B3, B4 and B5)

The Tributary B catchment consists of a well-defined network of gullies and channels that descends from the southwest corner of the subject property into the Humber River valley (**Figure 3**). The reaches within this catchment exhibit evidence of anthropogenic modification in association with the construction of Emil Kolb Parkway. Drainage swales constructed to convey stormwater into the natural gully reaches (B2, B4 and B5) have led to instability. High energy gradients and shear stresses along drainage swales have driven instability along the anthropogenic features and gully network. A total of five reaches were delineated within the Tributary B catchment. **Table 2** provides a detailed description of channel morphology along each reach. Representative photographs are provided in **Appendix A**.

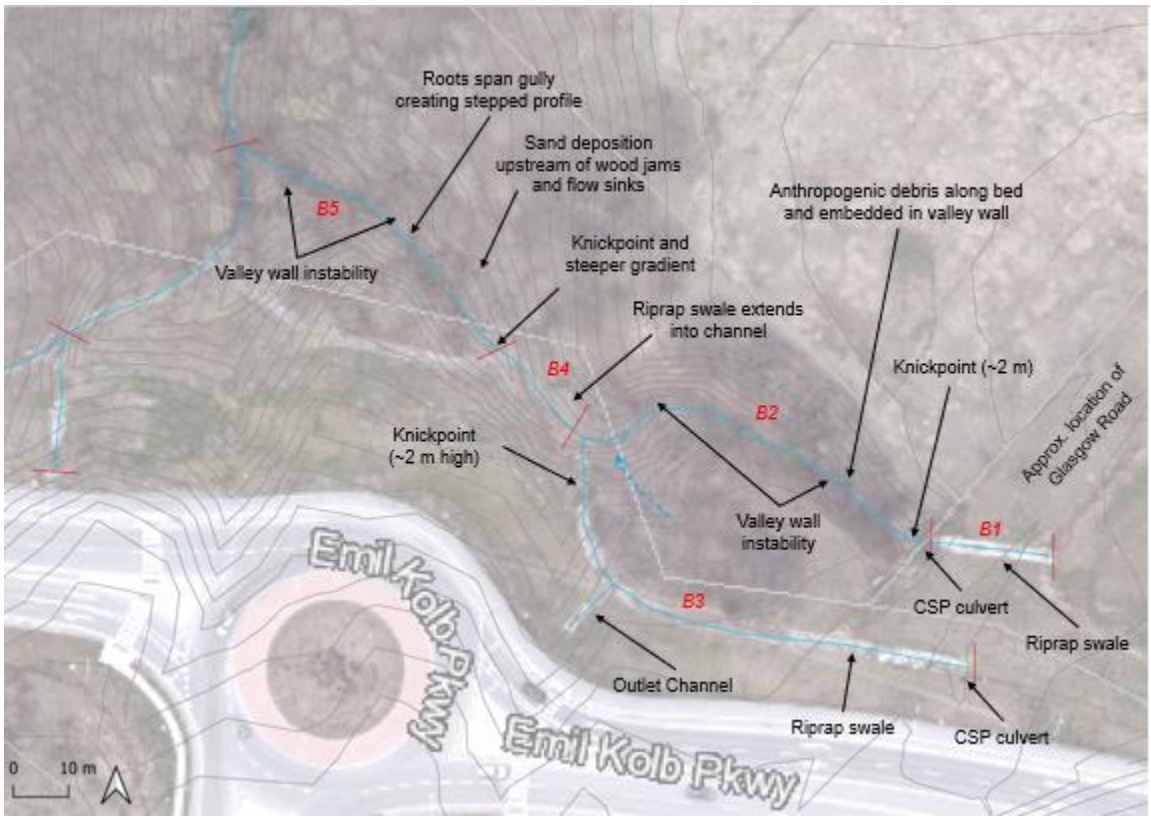


Figure 3. Tributary B catchment reach descriptions and channel morphology

Table 2. Tributary B Catchment Reach Descriptions

Reach	Description
B1	The reach essentially functions as a drainage swale that inhibits gully head (Reach B2) migration toward tableland. The relatively short (22 m) riprap-lined swale has a low-moderate gradient (4.5%) and drains a truncated catchment consisting of a small agricultural field between Chickadee Lane and Emil Kolb Parkway. The majority of surface runoff now enters Reach B3. The swale is stable along its upstream extent with minor displacement of riprap near the reach break. The swale is approximately 2.5 m wide and 0.25 deep.
B2	The gully exhibits signs of active erosion along sidewalls with mass movement failures. Seepage areas were observed along both valley walls. Head cut has been mitigated by placement of riprap along the bed of the gully. The gully has a high gradient (15%) and an irregular, stepped bed profile. The development of a stepped profile reflects local diversity in materials into which the gully has incised and sediment input from valley wall mass wasting events. The banks are scoured and slightly undercut, exposing roots and anthropogenic debris (e.g. glass bottles and rusted metal). The valley wall may consist of a discontinuous veneer of anthropogenic fill based on the presence of embedded debris and levelled tableland. All flows are confined to the V-shaped gully bottom with no floodplain. The gully-bottom cross-section is trapezoidal with a narrow bed (1 m) and shallow depth (0.5 m). The bed and bank material consist of sandy silty-clay till, locally overlain by organic matter, sand, fine gravels with cobbles and anthropogenic debris (i.e. concrete rubble). Also, woody debris and exposed tree roots impart structure and roughness along the bed.
B3	The reach essentially functions as a roadside ditch, which conveys stormwater from Emil Kolb Parkway. The construction of Emil Kolb Parkway has expanded the swale's catchment area, increasing the volume of uncontrolled stormwater entering the tributary. Three culverts outlet into the reach. The swale has an averaged width and depth of 2.5 m and 0.25, respectively. The riprap-lined swale flows across table land before descending steeply into the valley. The rapid gradient change (9 m) over a short 30 m section of swale has increased velocity and shear stress of stormwater flow, resulting in deep incision into the valley wall. Gully head formation has created a 2 m (approx.) knickpoint where riprap was outflanked and undermined. The gully has incised into silty-clay till with some gravels and riprap deposited on the bed. All flows are now confined within a narrow V-shaped gully with no floodplain available to attenuate peak flows. Without mitigation, the gully will continue to widen and head-cut toward Emil Kolb Parkway.
B4	The relatively short reach (23 m) exhibits signs of anthropogenic modification, as a riprap-lined drainage swale constructed along the road embankment's toe extends into and along the channel's bed. Riprap placed along the bed acts as a grade control and decreased its gradient (4%). Riprap placement has created a knickpoint at its downstream extent and impounds low flows. Fine sands and gravel have deposited on the bed. The channel has an average width and depth of 2.5 m and 0.25 m, respectively. A mass wasting event (rotational failure) leaving a small erosional hollow along the base of the road embankment is located at the mid-way point of the reach.
B5	The gully exhibits signs of active erosion along sidewalls with mass movement failures. Seepage areas were observed along both valley walls. Head cut has been mitigated by placement of riprap at the upstream knickpoint. The gully has a moderate-high gradient (10%) and an irregular, stepped bed profile. Steps, formed by gully-spanning trees and their roots, are separated by short 'pool-like' sections with a 'blown-out' cross-sectional shape. No defined 'channel' was observed and widths range from 0.25 m to 2 m. All flows are confined to the V-shaped gully bottom with no floodplain. The banks are scoured and slightly undercut, exposing roots and silty till. The observed bed material consisted of cohesionless material along the gully bottom, including fines and sands deposited in 'pool' sections.

4.2.3 Tributary C Catchment (Reaches C1, and C2)

The Tributary C catchment consists of a modified headwater tributary culverted beneath Emil Kolb Parkway and stormwater drainage outlet that descends into the Humber River valley (**Figure 4**). The reaches exhibit evidence of anthropogenic modification (e.g. realignment and riprap placement along bed) in association with the construction of Emil Kolb Parkway. Increased stormwater, a high gradient and abrupt elevation changes as the channels descend into the valley have driven instability along these anthropogenic features. A total of two reaches were delineated along Tributary C. **Table 2** provides a detailed description of channel morphology along each reach. Representative photographs are provided in **Appendix A**.

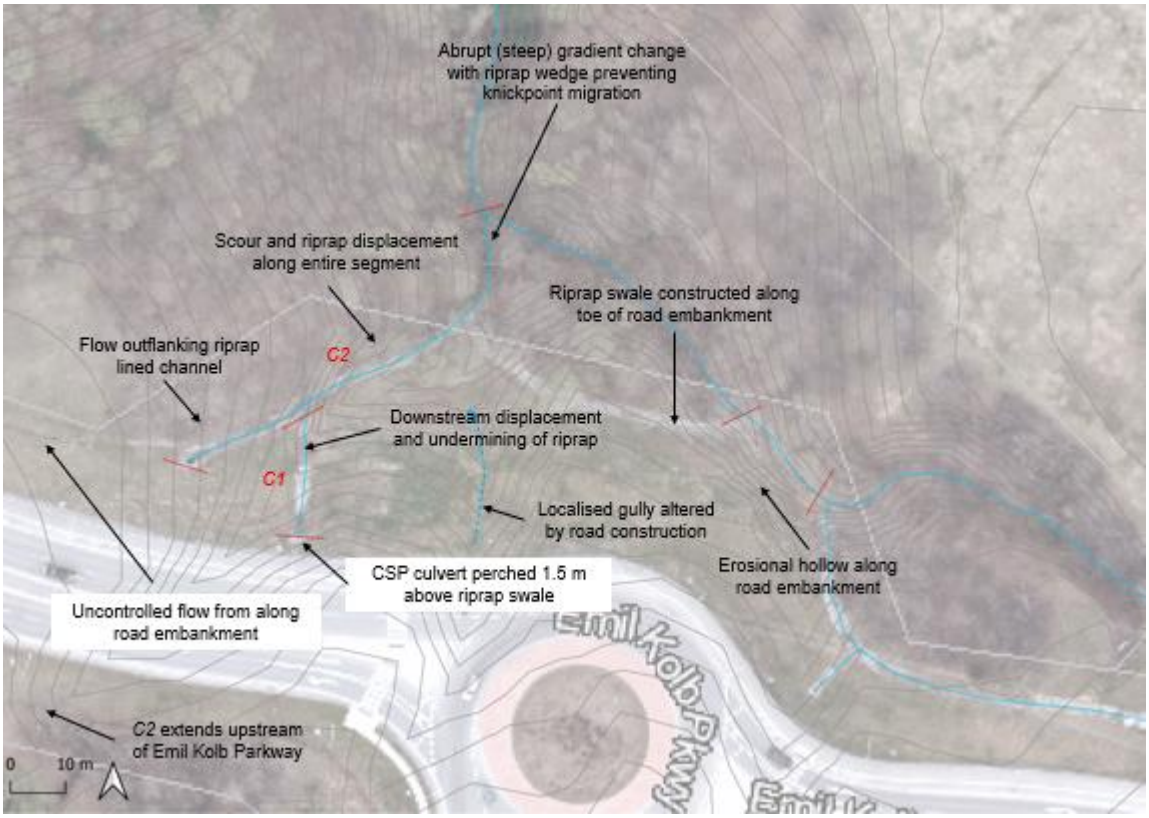


Figure 4. Tributary C catchment reach descriptions and channel morphology

Table 3. Tributary C Catchment Reach Descriptions

Reach	Description
C1	The riprap-lined drainage swale was constructed to convey stormwater from Emil Kolb Parkway into the headwater tributary via a culvert. The culvert is perched approx. 1.5 m above the drainage swale. The short (25 m) swale cascades down the road embankment with rapid elevation change of 4 m. The high gradient (16%) reach has increased velocity and shear stress of stormwater flow, resulting in the displacement of riprap along its entire length. The swale is approximately 2.5 m wide and 0.15 deep.
C2	The reach naturally originates west of Emil Kolb Parkway. Construction of Emil Kolb Parkway has increased its catchment area and the amount of uncontrolled stormwater runoff entering the tributary. The channel has a high gradient of 20%. Its steepness and increased discharge have amplified shear stresses, resulting in scour and displacement of riprap along its entire length. A large knickpoint has formed at its confluence with Reach B5. Headward migration of the knickpoint has been inhibited by riprap accumulation. The average width and depth of the channel is 2.5 m and 0.25, respectively.

4.2.4 Tributary D (Reaches D1, D2, and D3)

Tributary D consists of a well-defined, sinuous channel, which has rapidly down-cut and incised through its pre-development alluvial floodplain in response to unnaturally deep and fast flows from uncontrolled stormwater in association with watershed urbanization (**Figure 5**). The channel is now confined by terrace scarps and high valley walls, which exhibit localized instability in the form of slope failures. Tributary D is located northwest of the subject property and will receive stormwater discharge from the proposed development. A total of three reaches were delineated along Tributary D. SWM pond drainage alternative 3 is to discharge into Reach D1 (**Figure 1**). **Table 2** provides a detailed description of channel morphology along each reach. Representative photographs are provided in **Appendix A**.

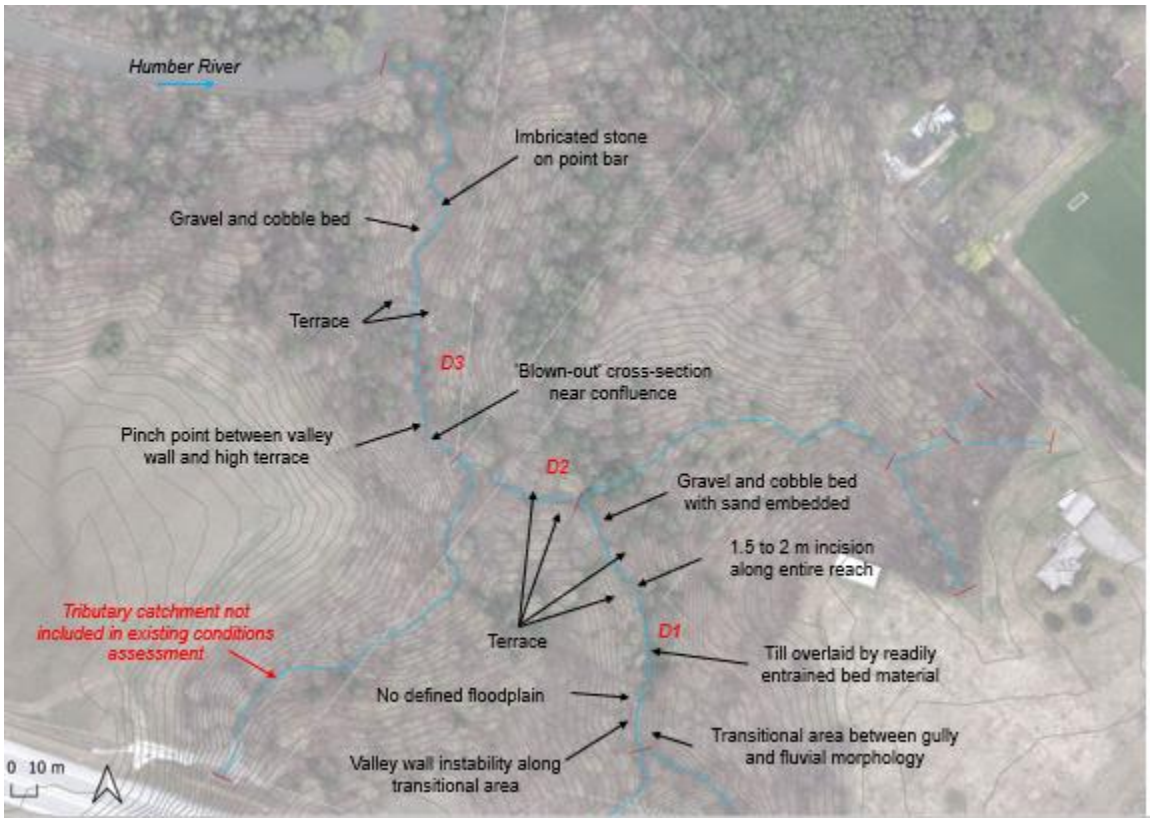


Figure 5. Tributary D catchment reach description and channel morphology

Table 4. Tributary D Catchment Reach Descriptions

Reach	Description
D1	The sinuous channel is confined on both sides by prominent valley walls along its upstream extent and a high terrace near its confluence with Tributary A. The channel has incised below its floodplain and become entrenched. Entrenchment has concentrated shear stress along the channel boundary, which in turn has led to further degradation, instability, and channel enlargement. The channel cross-section is rectangular with an average width and bankfull depth of 2 m and 1 m, respectively. 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 sand. Bed material is likely easily entrained due to the high energy gradient along the reach. Till is exposed locally along the bed, mostly along the thalweg, and extensively along the lower banks.
D2	The sinuous channel is confined on both sides by terraces (1.5-2 m high) and prominent valley walls with no accessible floodplain. The channel has down-cut and incised through alluvial floodplain into underlying till. Increased peak flows have also begun to enlarge the channel. The channel cross-section is rectangular with an average width and bankfull depth of 3 m and 1 m, respectively. The average bed gradient along the reach is 4%. Bed morphology is poorly defined due to active degradation. Bed materials are dominated by gravels and cobbles overlain by sand. Bed material is likely easily entrained due to the high energy gradient along the reach. Till is exposed locally along the bed, mostly along the thalweg, and extensively along the lower banks.
D3	The sinuous channel is confined on both sides by terraces (1.5-2 m high) and prominent valley walls with no accessible floodplain. Signs of active erosion with mass movement failures and seepage areas are present along the valley wall. The channel has down-cut and incised through its original alluvial floodplain into underlying till. The channel cross-section has begun to enlarge as a new corridor has started to form. The channel cross-section is rectangular with an average width and bankfull depth of 2 m and 0.6 m, respectively. The average bed gradient along the reach is 5%. Bed morphology is poorly defined due to active degradation and numerous woody debris jams. The woody debris accumulations are causing local storage of bed sediment and have led to variability in cross-sectional shape. Bed materials are dominated by gravels and cobbles overlain by sand. Bed material is easily entrained due to the high energy gradient along the reach. Till is exposed locally along the bed, mostly along the thalweg, and extensively along the lower banks.

5. Key Findings and Implications

A number of important findings and implications of our field reconnaissance and desktop assessment warrant acknowledgment:

- Almost all of 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 locally severe erosion.
- Gullies are inherently erosive landforms that form where surface runoff concentrates down a slope, complicating their use for controlled stormwater outlet areas.
- The steep energy gradients (4 to 20%), limited floodplain access, and unstable nature of the channels should be considered when determining suitable stormwater outlet areas.
- Reaches within the Tributary A catchment are relatively stable, with the exception of Reach A4.
- Reaches within the Tributary B catchment exhibit severe erosion and valley wall instability along their entire lengths. Instability is driven by anthropogenic modification and uncontrolled stormwater entering the watercourse.

- Reaches within the Tributary C catchment exhibit evidence of extensive anthropogenic modification and displacement of riprap along their entire lengths.
- 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.

Positioning a SWM pond outlet along the bottom of steep gullies and narrow-bottomed valleys without exacerbating erosion will be challenging without at least localized mitigative measures along the channel. Of all investigated reaches, those comprising the gully/channel network within the Tributary A catchment exhibit 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.

6. Certification

This report 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, Geomorphologist

References

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

Gao, P., 2013. Rill and Gully Development Processes. In Treatise on Geomorphology (Vol. 7, pp. 122-131). Elsevier Inc.

Harrelson, C.C., C. Rawlins, and J. Potyondy, 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Techniques. USDA Forest Service Rocky Mountain Forest and Range Experiment Station General Technical Report RM-245, 67 p.

Knighton, D., 1998. Fluvial Forms & Processes. A New Perspective. Arnold, London.

Palmer, 2019. Chickadee Lane Rounding Out Area B Comprehensive Environmental Impact Study and Management Plan, Part A, B and C.

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

Appendix A

Photo Log

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

1. Tributary A Catchment

1.1 Reach A1

Photo #:	Date.
1	6/30/2020
Direction Photo Taken	E

Description

Looking upstream at topographical low near gully head

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
1	6/30/2020
Direction Photo Taken	W

Description

Looking downstream along swale near gully head

Photo #:	Date.
3	6/30/2020
Direction Photo Taken	W

Description

Looking downstream toward concrete spillway where swale descends into a defined gully (Reach A3)

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
4	6/30/2020
Direction Photo Taken	S

Description

Concrete spillway located at gully head

1.2 Reach A2

Photo #:	Date.
5	6/30/2020
Direction Photo Taken	E

Description

Looking upstream where the gully head transitions from a field to a treed valley

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
6	6/30/2020
Direction Photo Taken	W

Description

Looking downstream along stable gully

Photo #:	Date.
7	6/30/2020
Direction Photo Taken	S

Description

Looking downstream at confluence with Reach A1

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
8	6/30/2020
Direction Photo Taken	N

Description

Overview of grate and drop structure used to convey flow to confluence and limit erosion

1.3 Reach A3

Photo #:	Date.
9	6/30/2020
Direction Photo Taken	E

Description

Looking upstream at gully confluence (Reaches A1(left) and A2 (Right))

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
10	6/30/2020

Direction Photo Taken	W

Description

Looking downstream along stable gully Reach A3 at its mid-way point. The bed is lined with anthropogenic debris (e.g. red brick)

Photo #:	Date.
11	6/30/2020

Direction Photo Taken	W

Description

Looking downstream toward gully confluence with Reach A4. The bed is lined with anthropogenic debris (e.g. red brick)

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
12	6/30/2020
Direction Photo Taken	E

Description

Looking upstream Toward Reaches A1 and A2. The bed is lined with anthropogenic debris (e.g. red brick)

1.4 Reach A4

Photo #:	Date.
13	6/30/2020
Direction Photo Taken	N

Description

Looking north toward the topographical depression where Reach A4 originates south of the treed valley

Photograph Log

Palmer™

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
14	6/30/2020

Direction Photo Taken	N

Description

Looking downstream from the gully head where bed is lined with anthropogenic brick and stone.

Photo #:	Date.
15	6/30/2020

Direction Photo Taken	N

Description

Looking north from the downstream extent of anthropogenic debris along the gully bottom, with leaning trees in the background.

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
16	6/30/2020

Direction Photo Taken	S

Description

Looking upstream at gully bottom incision exposing root mat spanning channel.

Photo #:	Date.
17	6/30/2020

Direction Photo Taken	S

Description

Looking upstream with vertical scour evident along gully bottom and drainage pipes located along the side wall.

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

1.5 Reach A5

Photo #:	Date.
18	6/30/2020
Direction Photo Taken	E

Description

Looking upstream at the confluence between Reaches A3 and A4.

Photo #:	Date.
19	6/30/2020
Direction Photo Taken	W

Description

Looking downstream from upstream extent with lateral and vertical scour evident

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
20	Click here to enter a date.

Direction Photo Taken	S

Description

Looking upstream along gully with stable valley wall

Photo #:	Date.
31	6/30/2020

Direction Photo Taken	S

Description

Looking south across relatively stable section of gully with boulder and wood debris along the bed

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
42	6/30/2020
Direction Photo Taken	E

Description

Looking upstream at silt till knickpoint at prominent change in bottom slope

Photo #:	Date.
53	6/30/2020
Direction Photo Taken	E

Description

Looking upstream near Tributary D confluence with cobble and boulder bed and stable valley walls

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

2. Tributary B Catchment

2.1 Reach B1

Photo #:	Date.
64	6/30/2020
Direction Photo Taken	S

Description

Looking south toward headwaters of Tributary B catchment

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
75	6/30/2020

Direction Photo Taken	N

Description

Looking downstream along riprap swale which drains into the gully head (Reach B2)

Photo #:	Date.
86	6/30/2020

Direction Photo Taken	S

Description

Overview of riprap descending into gully. Displacement of riprap has exposed native bed material at knickpoint.

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
97	6/30/2020
Direction Photo Taken	N

Description

Looking downstream along riprap swale at steep gully head (Reach B2).

2.2 Reach B2

Photo #:	Date.
108	6/30/2020
Direction Photo Taken	S

Description

Looking upstream along gully bottom with scour evident along toe of fill slope

Photograph Log

Palmer

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
119	6/30/2020

Direction Photo Taken	N

Description

Downstream view across fill slope. Note trees exhibit similar age

Photo #:	Date.
30	6/30/2020

Direction Photo Taken	N

Description

Looking downstream along steep V-shaped gully with erosional hollow along west valley wall

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
31	6/30/2020

Direction Photo Taken	EWNS

Description

Overview of scour along the toe of the east side slope.

Photo #:	Date.
312	6/30/2020

Direction Photo Taken	N

Description

Downstream view of valley wall instability near downstream extent of Reach B2

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
33	6/30/2020
Direction Photo Taken	N

Description

Downstream view of confluence with Reach B3. Low flow is backwatered resulting from riprap extending into and along the channel bed.

2.3 Reach B3

Photo #:	Date.
34	6/30/2020
Direction Photo Taken	S

Description

Upstream view of roadside ditch draining into Reach B3.

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
35	6/30/2020

Direction Photo Taken	W

Description

Culvert at upstream extent of Reach B3 conveys stormwater flow from Emil Kolb Parkway

Photo #:	Date.
36	6/30/2020

Direction Photo Taken	N

Description

Downstream view of stable riprap swale constructed in association with Emil Kolb Parkway

Photo #:	Date.

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

37 6/30/2020

Direction Photo Taken	N

Description

Looking north along Emil Kolb Parkway road embankment. Note stormwater drainage culvert in background

Photo #:	Date.
38	6/30/2020

Direction Photo Taken	W

Description

Upstream view of scour outflanking the riprap swale along the left bank

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
39	6/30/2020

Direction Photo Taken	E

Description

Downstream view of cavernous gully eroded approx. 2 m below riprap swale.

Photo #:	Date.
40	6/30/2020

Direction Photo Taken	N

Description

Approx. 2 m incision has exposed silty till along bed and bank of the newly formed gully

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
41	6/30/2020
Direction Photo Taken	S

Description

Upstream view of the confluence of Reaches B2 (Left) and B3 (Right) with large erosional hollow where Reach B3 has incised.

2.4 Reach B4

Photo #:	Date.
42	6/30/2020
Direction Photo Taken	N

Description

Downstream view from the upstream extent of Reach B4.

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
43	6/30/2020

Direction Photo Taken	S

Description

Upstream view near downstream extent of reach. Note wider channel cross-section between fill slope and toe of road embankment.

Photo #:	Date.
44	6/30/2020

Direction Photo Taken	E

Description

Looking east across channel from road embankment. Riprap placed along bed of channel

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
45	6/30/2020
Direction Photo Taken	S

Description

Upstream view of riprap swale (constructed along toe of road embankment) that extends into the channel, impounding low flows.

Photo #:	Date.
46	6/30/2020
Direction Photo Taken	N

Description

Downstream view of riprap knickpoint at the downstream extent of Reach B4.

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

2.5 Reach B5

Photo #:	Date.
47	6/30/2020

Direction Photo Taken	W

Description

Upstream view at reach break with erosional gully along the right bank

Photo #:	Date.
48	6/30/2020

Direction Photo Taken	S

Description

Upstream view of V-shaped gully with steep sided walls and scour along entire length

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
49	6/30/2020

Direction Photo Taken	N

Description

Downstream view of gully incised into valley with no defined channel. Deposition from incision upstream. Flow sinks beneath exposed tree roots.

Photo #:	Date.
50	6/30/2020

Direction Photo Taken	S

Description

Upstream view of forced stepped profile. Pool 'blow-out' sections are present upstream of steps from gully-spanning tree roots.

Photograph Log

Palmer

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
51	6/30/2020
Direction Photo Taken	N

Description

Downstream view of gully with valley wall instability (erosional hollows) present along both 'banks'

Photo #:	Date.
513	6/30/2020
Direction Photo Taken	N

Description

Downstream view toward confluence with Reach C2.

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

3. Tributary C Catchment

3.1 Reach C1

Photo #:	Date.
53	6/30/2020
Direction Photo Taken	E

Description

Downstream view of stormwater riprap swale.

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
54	6/30/2020

Direction Photo Taken	W

Description

Looking upstream at culvert perched approx. 1.5 m above riprap swale.

Photo #:	Date.
55	6/30/2020

Direction Photo Taken	E

Description

Downstream view of riprap swale. Note instability along its entire length

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

3.2 Reach C2

Photo #:	Date.
56	6/30/2020
Direction Photo Taken	N

Description

Upstream view of steep roadside ditch draining Emil Kolb Parkway

Photo #:	Date.
57	6/30/2020
Direction Photo Taken	W

Description

Looking at culvert outlet at upstream extent of reach. Reach drains residential area west of Emil Kolb Parkway

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
58	6/30/2020

Direction Photo Taken	E

Description

Downstream view of outflanking of riprap-lined channel

Photo #:	Date.
59	6/30/2020

Direction Photo Taken	W

Description

Upstream view of riprap knickpoint at confluence of Reaches C2 and D1.

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

4. Tributary D

4.1 Reach D1

Photo #:	Date.
60	6/30/2020
Direction Photo Taken	S

Description

Upstream view toward confluence of Reaches B4 (Left) and C2 (right).

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
61	6/30/2020

Direction Photo Taken	N

Description

Upstream view of transitional area between gully and fluvial morphology.

Photo #:	Date.
62	6/30/2020

Direction Photo Taken	N

Description

Looking downstream along transitional area with scour evident along its entire length.

Photo #:	Date.

Photograph Log

Palmer

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

63 6/30/2020

Direction Photo Taken	N

Description

Downstream view of severely incised channel with terrace along right bank.

Photo #: 64 Date. 6/30/2020

Direction Photo Taken	E

Description

Overview of till exposed along the bed and toe of bank.

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
65	6/30/2020

Direction Photo Taken	N

Description

Downstream view along mid-way point of reach. Note high terrace with no active floodplain present.

Photo #:	Date.
66	6/30/2020

Direction Photo Taken	N

Description

Downstream view of sinuous low flow channel. Note incision into previously deposited bed material.

Photograph Log

Palmer

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
67	6/30/2020
Direction Photo Taken	N

Description

Downstream view toward confluence with Tributary A

Photo #:	Date.
68	6/30/2020
Direction Photo Taken	S

Description

Upstream view of sinuous channel with scour along toes of valley walls.

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

4.2 Reach D2

Photo #:	Date.
69	7/1/2020
Direction Photo Taken	S

Description

Upstream view of incised channel toward confluence with Tributary A.

Photo #:	Date.
70	6/30/2020
Direction Photo Taken	N

Description

Downstream view of incised channel (approx. 1.5 m) below terrace

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
71	6/30/2020

Direction Photo Taken	N

Description

Downstream view of incised channel with high terrace along both banks.

Photo #:	Date.
72	6/30/2020

Direction Photo Taken	N

Description

Overview of bed material.

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
73	6/30/2020

Direction Photo Taken	S

Description

Upstream view of incised channel. Note low (active) floodplain in foreground

Photo #:	Date.
74	6/30/2020

Direction Photo Taken	N

Description

Downstream view of incised channel with low (active) floodplain along inner bank of meander.

Photo #:	Date.

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

75	6/30/2020
Direction Photo Taken	S

Description

Upstream view toward Tributary D confluence with peculiar erosional remnant of earth developed immediately downstream.

4.3 Reach D3

Photo #:	Date.
76	6/30/2020
Direction Photo Taken	E

Description

Downstream view at pinch point between valley wall and high terrace.

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
77	7/1/2020

Direction Photo Taken	E

Description

Downstream view of a large erosional hollow along toe of valley wall.

Photo #:	Date.
78	6/30/2020

Direction Photo Taken	W

Description

Upstream view of incised channel below high terrace on both banks.

Photo #:	Date.

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
79	6/30/2020

Direction Photo Taken	S

Description

Overview of exposed till along bed and toe of bank.

Photo #:	Date.
80	6/30/2020

Direction Photo Taken	E

Description

Downstream view of large bar with imbricated stone at a 'blown-out' channel cross-section.

Photograph Log

Client Name:	Project No.	Site Location:
Brookvalley Project Management Inc.	1701603	Chickadee Lane, Bolton ON

Photo #:	Date.
81	6/30/2020

Direction Photo Taken	E

Description

Downstream view of straight channel with low (active) floodplain along right bank confined by high terrace.

Photo #:	Date.
814	6/30/2020

Direction Photo Taken	E

Description

Looking downstream toward confluence with Humber River.

Appendix M

Fluvial Geomorphology SWM Outfall Comparison Memo (Palmer, 2020)

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

Memorandum

Date: December 14, 2020
Project #: 1701603

To: Frank Filippo, Zancor Homes
From: Michael Brierley, M.Sc., and Robin McKillop, M.Sc., P.Geo., CAN-CISEC
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. 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 locally 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.

2.2 Alternative 2

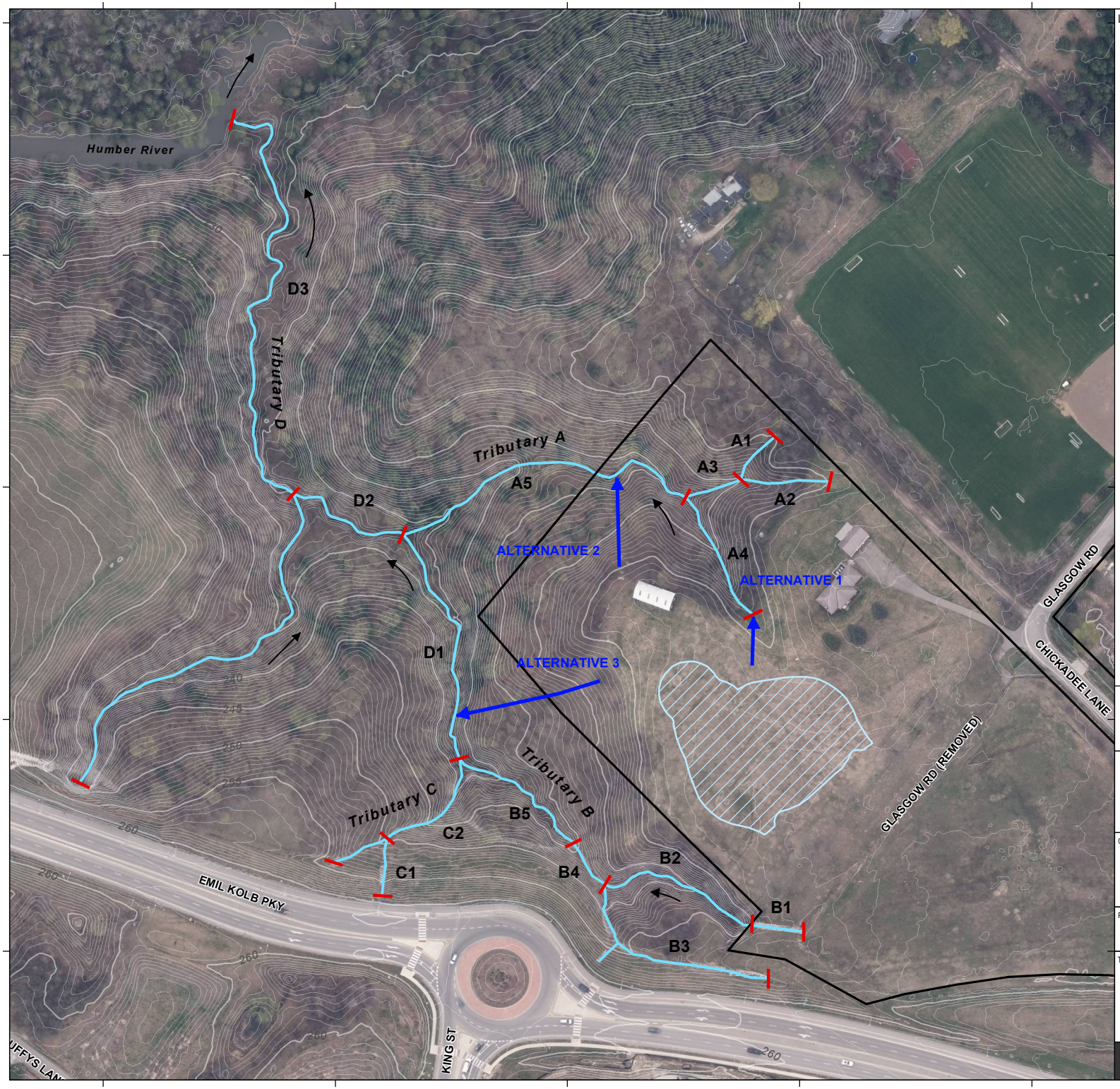
Drainage alternative 2 would be piped from the proposed SWM pond[1] and discharge into Reach A5. The proposed alignment of the pond outlet sewer is located along a naturally cleared corridor along the forested valley wall. The wall at this location has a gentler gradient relative to slopes 50 m to the 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

[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.*

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.



LEGEND:

- Property Boundary
- SWM Pond (Approximate)
- Channel Centreline
- Reach Break
- Flow Direction
- Proposed SWM Pond Drainage Outlet Alternative
- 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:	Jul 28, 2020	SCALE:	1:2300
DRAWN:	BE	DATUM:	NAD 1983
CHECKED:	MB	PROJECTION:	UTM zone 17

CLIENT: Brook Valley Homes

PREPARED BY: [redacted]

PROJECT: Chickadee Lane

TITLE:

Study Area and Proposed Drainage Routes

Figure 1

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

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. 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.	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. 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
Score	**3**	**3**	**3**
Terrestrial Ecology	The area provides a potentially suitable habitat for bats and salamanders. Large, tall deciduous trees provide canopy cover. The woodlands also provide confirmed habitat for Wood Thrush and Eastern Wood-pewee, both Species at Risk birds in Ontario.	The area provides a potentially suitable habitat for bats and salamanders. Large, tall deciduous trees provide canopy cover. The woodlands also provide confirmed habitat for Wood Thrush and Eastern Wood-pewee, both Species at Risk birds in Ontario.	This area would cause the least ecological impact. This section is primarily dominated by European Buckthorn (highly invasive, non-native), and Ash populations here have already declined with few live trees left. Clearing of this area would not fragment the forest due to its position at the woodland edge.
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	**1**	**1**	**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	**13**	**17**	**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.

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.