DILLON CONSULTING

## BURLINGTON MOBILITY HUB

# Scoped Environmental Impact Study

### Downtown Mobility Hub


February 2019 (revised October 2019) – 17-5015

# Table of Contents

## Figure



## Tables



## Appendices



## References

# 1.0 Introduction

Dillon Consulting Limited ("Dillon") was retained to complete a Scoped Environmental Impact Study ("EIS") for the City of Burlington (the "City") in support of future redevelopment and intensification in association with the City's four Mobility Hubs (i.e. Downtown, Burlington, Aldershot and Appleby). This Scoped EIS was prepared specifically for the Downtown Mobility Hub.

The Downtown Mobility Hub Planning Area (herein referred to as the "Study Area") is generally bounded by Fairview Street to the northwest, Guelph Line to the northeast, the Queen Elizabeth Way (QEW) to the southwest, and Lake Ontario to the southeast (**Figure 1**). Please note that the Study Area depicted on the Figures included herein illustrates the total Planning Area; however, assessments with respect to natural heritage features did not include the Lake Ontario shoreline or the adjacent park space. Rather, the Downtown Lakefront will be reviewed as part of a separate planning process.

The purpose of the Scoped EIS is to document existing conditions of the natural environment; determine the potential limits of development; evaluate the potential for environmental impacts associated with the proposed development; and recommend mitigation, restoration, and enhancement measures to preserve and/or restore natural features.

The Scoped EIS has been prepared in general accordance with the following environmental guidelines:

- Conservation Halton ("CH") Environmental Impact Statement Guidelines (November 2005);
- Halton Regions ("Halton") Environmental Impact Assessment Guidelines (2016);
- CH's Guidelines for Ecological Studies (March 2017);
- Regional Official Plan Amendment Number 38 ("ROPA 38", 2015);
- Regional Official Plan Policy 77(5) study requirements for an Area-Specific Plan (2015); and
- The Guidelines following the Terms of Reference ("TOR") established in consultation with the CH, Halton Region, the City, the City's consultants, and agreed to through correspondence on May 31, 2017 (**Appendix A**).


CITY OF Burlington

**DOWNTOWN**

BURLINGTON HUB MOBILITY STUDY

**STUDY AREA**

FIGURE 1

- Study Area
- Road
- Railway
- Watercourse
- Waterbody
- MNRF Wooded Area


0 50 100 200 Metres

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNRF

MAP CREATED BY: LK
MAP CHECKED BY: DL
MAP PROJECTION: NAD 1983 UTM Zone 17N

DILLON CONSULTING

PROJECT: 17-5015

STATUS: DRAFT

DATE: 2019-01-22

FILE LOCATION: G:\cad\GIS\175015\Mapping\EIS_Downtown\Fig1_StudyArea_Jan2019.mxd

# 2.0 Overview of Policy Framework

The Downtown Mobility Hub Area is subject to three levels of planning policies: Provincial, Regional, and Municipal. Recent updates to Provincial policies (effective July 1, 2017) will be reflected in upcoming updates to Regional and Municipal policies. For purposes of the following discussion, the most recent updated version of the applicable documents has been reviewed. The context provided relates to issues pertinent to the Study Area and does not represent the full spectrum of applicable planning related considerations contained within these governing plans. Refer to **Appendix B** for Schedules referenced within **Section 2.0**.

## 2.1 Provincial Framework

### 2.1.1 Provincial Policy Statement (2014)

The Provincial Policy Statement, 2014 ("PPS") provides overall policy direction on matters of provincial interest related to land use planning and development in Ontario. The PPS sets forth a vision for Ontario's land use planning system by managing and directing land use to achieve effective development and land use patterns, wise use and management of resources, and protecting public health and safety. This report deals specifically with Policy 2.1, Natural Heritage, and Policy 2.2, Water, which provides for the protection and management of natural heritage and water resources, which include the following:

- *significant wetlands;*
- *significant coastal wetlands;*
- *significant woodlands;*
- *significant valleylands;*
- *significant wildlife habitat;*
- *significant areas of natural and scientific interest (ANSIs);*
- *fish habitat;*
- *sensitive surface water features; and*
- *sensitive groundwater features.*

The PPS defines "significant" to mean:

- *in regard to wetlands, coastal wetlands and areas of natural and scientific interest, an area identified as provincially significant by the Ontario Ministry of Natural Resources using evaluation procedures established by the Province, as amended from time to time;*
- *in regard to woodlands, an area which is ecologically important in terms of features such as species composition, age of trees and stand history; functionally important due to its contribution to the broader landscape because of its location, size or due to the amount of forest cover in the planning area; or economically important due to site quality, species composition, or*

*past management history. These are to be identified using criteria established by the Ontario Ministry of Natural Resources; and*

- *in regard to other features and areas in Policy 2.1, ecologically important in terms of features, functions, representation or amount, and contributing to the quality and diversity of an identifiable geographic area or natural heritage system".*

The PPS defines "sensitive" to mean:

- *in regard to surface water features and groundwater features, means areas that are particularly susceptible to impacts from activities or events, including, but not limited to, water withdrawals, and additions of pollutants.*

The potential significance of natural heritage features may be evaluated based on size, age, the presence of rare or sensitive species, species diversity, and linkage functions, taking into consideration factors such as adjacent land use and degree of disturbance. Criteria for determining significance follow the guidance outlined in the Natural Heritage Reference Manual (MNRF, 2010) and the Significant Wildlife Habitat Technical Guide *Eco-Region 7E Criterion Schedules* (MNRF, 2015), where applicable.

### 2.1.2 Growth Plan for the Greater Golden Horseshoe (2017)

Pursuant to the Places to Grow Act, 2005, the Growth Plan for the Greater Golden Horseshoe, 2006 (Growth Plan) was approved on June 16, 2006. The Growth Plan has been amended three times since its release in 2006. The first amendment was released in January 2012 and contains policies, schedules and definitions that apply in the Simcoe Sub-area. The second amendment was released in June 2013 to update and extend the Growth Plan's population and employment forecasts. The third amendment took effect on July 1, 2017, which effectively replaced the 2006 Growth Plan.

The Growth Plan requires the identification of water resource systems and the protection of key hydrologic features and key hydrologic areas, similar to the level of protection provided in the Greenbelt (MMAH, 2017). This provides a consistent framework for water protection across the Greater Golden Horseshoe ("GGH") and builds on existing plans and policies. The Growth Plan also provides for the identification and protection of natural heritage systems in the GGH outside of the Greenbelt Area and settlement areas in order to provide consistent and long-term protection for natural heritage systems across the GGH (MMAH, 2017).

Schedule 2 of the Growth Plan recognizes a portion of the Study Area as being part of the *Downtown Burlington Urban Growth Centre*, as well as the *Built-Up Area – Conceptual.* Growth in the Study Area would, therefore, be prioritized, as per Policy 2.2.1 through 2.2.3 of the Growth Plan. With respect to the natural environment, the Policies under Section 4 of the Growth Plan, in addition to policies relating to natural heritage protection in other sections of the Plan, would apply. Section 4.2 of the Growth Plan provides direction for Municipalities in the protection of natural heritage assets. In support of the Growth Plan, in 2018 the Province released mapping for a Provincially-led Natural Heritage System along

with a document outlining the criteria, rationale, and methods for mapping the system. This Natural Heritage System is to be integrated with Municipal Official Plans.

### 2.1.3 Greenbelt Plan (2017)

The Study Area falls within the area designated as '*Settlement Areas outside the Greenbelt*', just outside of the Greenbelt lands (see Schedule 1 and detailed Map 104 of the Greenbelt Plan). As such, in accordance with Policy 1.3 of the Greenbelt Plan, this Plan does not apply to lands designated as being outside the Greenbelt. The Greenbelt Plan defers to municipal official plans for detailed delineation of settlement boundaries and to govern land use and manage development within non-Greenbelt areas.

## 2.2 Regional Framework

### 2.2.1 Region of Halton Official Plan

The Region of Halton Official Plan is based on The Regional Plan [1995], which was adopted by Council of the Corporation of the Regional Municipality of Halton on March 30, 1994, through By-law 49-94. There have been a number of revisions and amendments to the Plan in addition to subsequent appeals to the changes in the years since this original Official Plan was adopted. Most recently, Regional Official Plan Amendment No. 38 ("ROPA 38") to the Halton Region Official Plan was adopted by Regional Council on December 16, 2009, and modified and approved by the Minister of Municipal Affairs and Housing (MMAH) on November 24, 2011. An appeal of the Amendment was launched with the Ontario Municipal Board (OMB), and following a series of decisions, portions of ROPA 38 have since received OMB approval. The most up-to-date version of the Regional Official Plan ("ROP") reviewed in support of the Scoped EIS is the September 28, 2015, Interim Office Consolidation, published on January 13, 2016.

Policies within the ROP direct a significant portion of new growth to the Built-up Areas of the community through intensification, to preserve the surrounding protected countryside of the Greenbelt. The ROP structure includes provisions of applicable Provincial plans, namely the PPS, the Greenbelt Plan, and the Growth Plan. The Natural Heritage System designation includes both Regional Natural Heritage System and Greenbelt Natural Heritage System. The Regional Natural Heritage System is defined in the ROP as "a system of connected natural areas and open space to preserve and enhance the biological diversity". The Study Area lies inside of the Built Boundary identified in Map 1 of the ROP.

The Downtown Study Area contains the following designations, as shown on Map 1 of the ROP:

- *Urban Growth Centre*: The Urban Growth Centre designation is an overlay on top of the Urban Area, and the Study Area is therefore subject to policies relating to both designations. Policies 72 – 77(21) of the ROP address the Urban Area designation and contain provisions for environmental protection and undertaking environmental studies within the urban area. The Urban Growth Centre overlay identifies specific intensification policies (i.e. Policies 81.1 through 81.3) of the ROP.

- *Mobility Hub*: The Downtown Burlington Transit Terminal is shown as a Mobility Hub and is subject to intensification polices outlined in the ROP.

Additional policies relating to protection of environmental quality as a result of development are outlined in Policies 140 through 149 of the ROP. These policies also outline specific provisions for development occurring adjacent to an active rail network and have been considered as part of this EIS.

## 2.3 Municipal Framework

### 2.3.1 City of Burlington Official Plan

The City's Official Plan (OP) came into effect in 1994 through By-law No. 78-1994 and was subsequently approved by the Region of Halton with modifications in 1997. Since that time the OP has been systematically reviewed and amended in order to ensure it reflects changing community needs and dynamics, address external influences, and to respond to new Regional and Provincial planning policies and legislation. The Office Consolidated version of the Plan used for this review was published by the City in July 2015. On April 26, 2018, the City of Burlington Council adopted a new OP through By-law 24-2018*: Burlington's Official Plan'.* This new OP document is currently under review by the Region of Halton, and is therefore not yet in full effect. As the intent is for the Secondary Plans under development for the Burlington Mobility Hubs to be integrated into the new OP, the following sections provide a review of the current OP and the Adopted OP in turn.

#### 2.3.1.1 Current Official Plan (July 2015 Consolidation)

Sustainable environment policies described in Part II, Section 2 of the OP apply to all areas of the City unless otherwise noted. These policies also contain provisions for the protection of natural heritage features and assets.

The Study Area falls within the Urban Area Boundary as depicted on Schedule B of the OP. The land uses in the Study Area include:

- *Residential – Low Density, Residential – Medium Density*, and *Residential – High Density*: Policies relating to all Residential designations are described in Part III, Section 2 of the Official Plan.

- *Mixed Use Centre*, *Mixed Use Corridor – General* and *Mixed Use Corridor – Employment*: Policies pertaining to Mixed Use areas in the City are outlined in Part III, Section 5 of the Official Plan. General policies pertaining to all Mixed Use areas are outlined in Section 5.1 to Section 5.3.2. Policies specific to the *Mixed Use Corridor – Employment* designation outlined in Section 5.3.4, while policies specific to the *Mixed Use Centre* designation are provided in Section 5.4.

As the Study Area covers the Downtown Burlington area, policies relating to the Downtown Mixed Use Centre designation are applicable as outlined in Section 5.5 of the OP. Within the Downtown Mixed Use Centre Designation, a portion of the Study Area is indicated on Schedule E of the OP as belonging to the Urban Growth Centre designation. This area has been divided into precincts as identified on Schedule E

of the OP, with accompanying policies for each precinct provided in Section 5.5 of the OP.

Within the Downtown Mixed Use Centre, natural heritage features are addressed under Section 5.5.6 which describes provisions for the Waterfront West/Public Lands Precinct in the southern most portion of the Study Area, as well Section 5.5.7, pertaining to the Old Lakeshore Mixed Use Precinct.

- *Greenland:* The *Greenland* designation applies to the waterfront edge of the Study Area, but does not overlap with the *Mixed Use Centre* designated area. Greenland falls under the Natural Features and Open Space policy area outlined in Part III, Section 6 of the Official Plan. Policies specific to the Greenland designations, including those relating to environmental protection are described in Section 6.2 of the Official Plan.

The relevant policies pertaining to the Study Area as indicated in the City's OP were considered in the development of this Scoped EIS.

#### 2.3.1.2 Adopted Official Plan: Burlington's Official Plan (Adopted by City Council April 26, 2018)

Environment and Sustainability policies that apply to all areas of the City (unless otherwise noted) are described in Chapter 4 of the City's new OP, adopted by Burlington City Council on April 26, 2018 (the Adopted OP). Pursuant to the Growth Plan (2017), the City has identified a Natural Heritage System as part of its Natural Heritage System, Major Parks, and Open Space designation under the Urban Structure of the Adopted OP (Section 2.3.5).

Schedule A of the Adopted OP designates the Study Area as Urban Area, with a few small scattered parcels along with the southern boundary along Lake Ontario identified as Green System. A central portion of the Study Area falls within the Urban Growth Area Boundary identified on Schedule A-1 of the Adopted OP. The Study Area is designated on Schedule B as being a Mixed Use Intensification Area – Urban Centre and a Mobility Hub. Schedule B-1 further identifies the large majority of the Study Area that falls within the Urban Growth Area as a Primary Growth Area, with the balance of the Study Area designated as Established Neighbourhood Area, and the southern edge along Lake Ontario falling under the Natural Heritage System and Major Parks and Open Space layer.

Schedule C of the Adopted OP identifies the Study Area as the Downtown Urban Growth Centre, and the southern boundary as being under the City's Natural Heritage System. The land uses in this area are detailed on Schedule D, and are divided into Precincts, including:

- Downtown Parks and Promenades Precinct
- Downtown Public Service Precinct
- St. Luke's/Emerald Neighbourhood Precinct
- Bates Precinct
- Brant Main Street Precinct
- Downtown Mid-Rise Precinct
- Downtown Tall Residential Precinct
- Old Lakeshore Road Precinct
- Downtown Core Precinct
- The Cannery Precinct
- Upper Brant Precinct
- New Public Park

- Downtown Waterfront Hotel Planning Study
- Downtown Watercourse

The policies corresponding to the land uses are defined in Section 8.1.1(3) of the Adopted OP. For purposes of this review, the land uses related to Natural Heritage assets are focused on:

- *Downtown Parks and Promenades Precinct*: This segment of the Downtown Urban Centre follows the shore of Lake Ontario and extends north to small portions of the Study Area. The permitted land uses in this Precinct include existing uses, and include the Burlington Beach Regional Waterfront Park.
- *Downtown Watercourse:* This designation is to be included as part of the City's Natural Heritage System in accordance with the scoped re-examination of the Official Plan. The limits of this designation are not identified on Schedule D, and Section 8.1.1(3.15)(c) states that these limits will be determined by the City in conjunction with Conservation Halton at the time of a development application and/or through the scoped re-examination of the Official Plan. Once identified, the lands within this designation will be subject to the Natural Hazards and Watercourse policies contained in Subsection 4.4.2(3), and where applicable, the Natural Heritage System policies (Section 4.2) of the new OP.

Schedule M of the Adopted OP does not identify any Natural Heritage System components within the Study Area, aside from the Lake Ontario shoreline.

## 2.4 Endangered Species Act, 2007

In June 2008, the *Endangered Species Act*, 2007 (ESA) came into effect in Ontario. The purpose of the ESA is to identify Species at Risk (SAR) based on the best available scientific information; to protect SAR and their habitats, to promote the recovery of SAR; and to promote stewardship activities to assist in the protection and recovery of SAR in Ontario. There are two applicable regulations under the ESA; *Ontario Regulation 230/08* (the SARO List); and, *Ontario Regulation 242/08* (General). These regulations serve to identify which species and habitat receive protection and provide direction on the current implementation of the ESA. As of April 1, 2019 the responsibility of the ESA has transitioned from the Ministry of Natural Resources and Forestry (MNRF) to the Ministry of the Environment, Conservation and Parks (MECP).

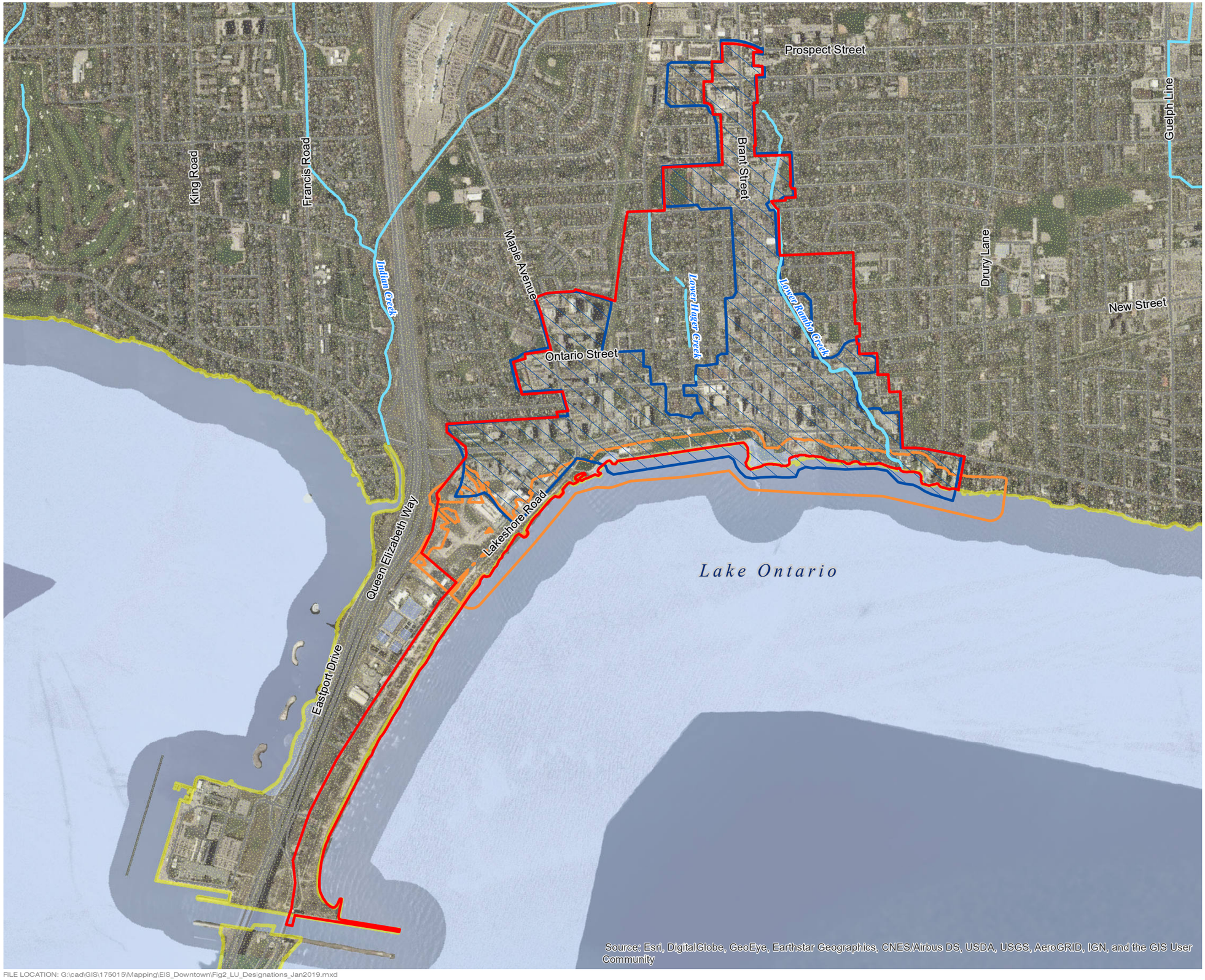
The potential for SAR and SAR habitat to be present within the Study Area is discussed further in **Section 3.4** and **Section 5.5** of this report.

## 2.5 Conservation Halton (Ontario Regulation 162/06)

In accordance with Section 28 of the Conservation Authorities Act, 1990, CH is authorized to implement and enforce the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation (*Ontario Regulation* 162/06). Section 2(1) of this Regulation lists areas within CH's jurisdiction where development is prohibited without proper permissions from CH. Such areas include, but are not limited to, rivers or stream valleys, hazardous lands, and wetlands.

In participating in the review of applications under the Planning Act and Environmental Assessment Act(s), CH ensures that applicants and approval authorities are aware of any Section 28 Regulation requirements under the Conservation Authorities Act, where applicable. Further, CH assists in the coordination of these applications to avoid ambiguity, conflict and unnecessary delay or duplication in the process.

Although the shoreline of the Study Area is located within a CH Regulated Area (**Figure 2**); the shoreline is outside of the scope of natural heritage investigations for the Downtown Burlington Mobility Hub. Therefore, no works are anticipated within the CH Regulated Area along Lake Ontario shoreline. Additionally, please note that the two watercourses within the Study Area, Rambo Creek and Lower Hager Creek, are not within a CH Regulated Area.




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

CITY OF Burlington

**DOWNTOWN**

BURLINGTON HUB MOBILITY STUDY

**PROVINCIAL AND AGENCY LAND USE DESIGNATIONS**

FIGURE 2

- Study Area
- Road
- Railway
- Watercourse
- Waterbody
- Conservation Halton Regulation Limit within Study Area (2012-05-14)
- Greater Golden Horseshoe Urban Growth Centre (2006)
- Built Boundary for the Growth Plan for the Greater Golden Horseshoe (2006)

0 50 100 200 Metres

N W E S

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNRF

MAP CREATED BY: LK
MAP CHECKED BY: DL
MAP PROJECTION: NAD 1983 UTM Zone 17N

DILLON CONSULTING

PROJECT: 17-5015
STATUS: DRAFT
DATE: 2019-01-22

FILE LOCATION: G:\cad\GIS\175015\Mapping\EIS_Downtown\Fig2_LU_Designations_Jan2019.mxd

# 3.0 Results of Background Review

The following sections provide a brief summary of the existing environmental conditions within the Study Area. This information provides the background information upon which the Scoped EIS was based.

## 3.1 Landforms, Soils, and Geology

The Study Area is located within the Iroquois (Sand) Plains physiographic region of southern Ontario, which is a lowland region bordering Lake Ontario. Lake Iroquois formed following the formation of Lake Peel, as the ice receded farther from the Lake Ontario Basin. Lake Iroquois occupied a larger area than the current Lake Ontario and had higher water levels. Shoreline cliffs, sandbars and beaches are located approximately three kilometres inland and mark the edge of the former lake. The physiographic region, known as the Iroquois Plains, extends around the shore of Lake Ontario from the Niagara River to the Trent River spanning a distance of approximately 300 km (Chapman and Putnam 1984). The plain is covered in layers of fine silty sands which formed the former lake bottom and beaches (Halton-Hamilton Source Protection, 2012).

The surficial bedrock east of the Niagara Escarpment is primarily the Queenston Formation. The Queenston Formation overlies the Georgian Bay Formation and comprises easily weathered, red shale with siltstone. The formation is approximately 150 m thick. The ice movement and water flow has eroded the shale over hundreds of thousands of years. This erosion has left an irregular bedrock surface and an unpredictable thickness of overlying soils (Halton-Hamilton Source Protection, 2012).

The old sandbars in this region are considered good aquifers that supply water to farms and villages. The gravel bars are quarried for road and building material, while the clays of the old lake bed have been used for the manufacture of bricks (Chapman and Putnam 1984). This narrow strip is the most densely inhabited area because of its proximity to Lake Ontario and its climatic influences, as well as its favourable soil conditions.

## 3.2 Aquatic Environment

### 3.2.1 Watershed Summary

The Study Area lies within the Urban Creeks watershed, which consists of fourteen small watersheds located along the north shore of Lake Ontario within urban areas. The Urban Creeks watershed all originate at or below the Niagara Escarpment and flow either into the north shore of Burlington Bay/Hamilton Harbour or directly into Lake Ontario. The drainage areas of the Urban Creeks are quite small, ranging in size from 2.7 - 20.9km$^2$, which are small in comparison to other watersheds within CH's jurisdiction (CH, 2013). Of the fourteen subwatersheds that make up Urban Creek Watershed, the Study Area lies within the Lower Rambo Creek subwatershed and Lower Hager Creek subwatershed. With most of the flows diverted from the upper portions of the watershed, the Lower Hager Creek and Lower

Rambo Creek watershed have limited drainage. The watersheds are mostly urbanized and are predominately enclosed except for small portions of open, altered channels. Storm sewer flows add significantly to the natural drainage within the watercourses. Both watersheds discharge directly into Lake Ontario (Halton-Hamilton Source Protection, 2015).

Urban Creeks Watershed in one of the watersheds involved in CH's Long-Term Environmental Monitoring Plan ("LEMP"). The LEMP was developed in 2005 to assess the long-term health of the CH's watershed. The results of the program will assist in verifying whether CH's mission to "help protect the natural environment from the lake to escarpment for the benefit and enjoyment of future generations" in being fulfilled (CH 2013). Reports issued in 2009 and 2013 document the monitoring progress and results of environmental assessments during the 2008 & 2012 assessment years (e.g. fish community sampling, benthic invertebrate sampling, channel morphology, ecological land classifications, marsh monitoring, etc.; CH, 2009 & 2013).

Urbanization has highly altered natural drainage patterns within Lower Rambo Creek and Lower Hager Creek watershed. Rambo and Hager Creek originally flowed to Lake Ontario through downtown Burlington. However, following the construction of the Hager-Rambo Diversion Channel in 1976, the upper portions of the watershed were diverted to Indian Creek (Halton-Hamilton Source Protection 2015; CH, 2006).

### 3.2.2 Fish Habitat

**LOWER RAMBO CREEK**

Rambo Creek has been significantly altered and consists of a series of naturalized, enclosed, concrete or altered channels (CH, 2006). Downstream of Highway 407, the Lower Rambo Creek remnant branches are fed by storm sewer drainage. The fish community in Rambo Creek is limited to remnant populations of creek chub (*Semotilus atromaculatus*) found in the lower reaches of the Rambo Creek tributaries (CH, 2006). The largest barrier to fish passage in Rambo Creek is the Hager-Rambo Diversion Channel as it is very difficult for fish to migrate through the concrete channel (CH, 2006). Studies completed for the North Shore Watershed Studies indicated that although cool water conditions prevail, the benthic communities indicate impaired conditions (CH, 2006). Rambo Creek was characterized as having poor aquatic ecosystem health (CH, 2006).

**LOWER HAGER CREEK**

Portions of Lower Hager Creek are enclosed beneath suburban portions of Burlington. Downstream of Highway QEW, the flows are diverted through the Hager-Rambo Diversion Channel to Indian Creek (CH, 2006). Studies completed for the North Shore Watershed Studies indicated that water quality within upper reaches of Hager Creek is moderately impaired with high nutrient loads and that cool water conditions prevail, though the benthic community indicate moderately impaired conditions; however, the fish community in Hager Creek is largely non-existent (CH, 2006). Hager Creek was characterized as having poor aquatic ecosystem health (CH, 2006).

Previous fish community sampling within Halton Region by CH has been performed. Conservation Halton provided Dillon with terrestrial and aquatic records for the watershed in support of the Scoped EIS. Information was filtered to fish observed within the Study Area as well as adjacent to the Study Area if the water feature supplied a watercourse within the Study Area (i.e. fish species records from Lake Ontario were included as Lower Rambo Creek is directly connected to Lake Ontario) are shown in **Table 1**.

**Table 1: Fish Species Identified throughout CH Assessments and Surveys**

| Scientific Name | Common Name | SARA[1] | ESA[2] | S-RANK[3] |
|---|---|---|---|---|
| **Within the Study Area** | | | | |
| *Cyprinus carpio* | Common Carp | --- | --- | SNA |
| *Notropis athernoides* | Emerald Shiner | --- | --- | S5 |
| *Aplodinotus grunniens* | Freshwater Drum | --- | --- | S5 |
| *Dorosoma cepedianum* | Gizzard Shad | --- | --- | S4 |
| *Osmerus mordax* | Rainbow Smelt | --- | --- | S5 |
| *Neogobius melanostomus* | Round Goby | --- | --- | SNA |
| *Moxostoma macrolepidotum* | Shorthead Redhorse | --- | --- | S5 |
| *Notropis hudsonius* | Spotfin Shiner | --- | --- | S5 |
| *Morone americana* | White Perch | --- | --- | SNA |
| *Catostomus commersoni* | White Sucker | --- | --- | S5 |
| **Associated with Lake Ontario** | | | | |
| *Alosa pseudoharengus* | Alewife | --- | --- | SNA |
| *Anguilla rostrata* | American Eel | --- | END | S1? |
| *Salmo trutta* | Brown Trout | --- | --- | SNA |
| *Oncorhynchus tshawytscha* | Chinook Salmon | --- | --- | SNA |
| *Cyprinus carpio* | Common Carp | --- | --- | SNA |
| *Notropis athernoides* | Emerald Shiner | --- | --- | S5 |
| *Dorosoma cepedianum* | Gizzard Shad | --- | --- | S4 |
| *Salvelinus namaycush* | Lake Trout | --- | --- | S5 |
| *Lepisosteus osseus* | Longnose Gar | --- | --- | S4 |
| *Osmerus mordax* | Rainbow Smelt | --- | --- | S5 |
| *Micropterus dolomieu* | Smallmouth Bass | --- | --- | S5 |
| *Notropis hudsonius* | Spotfin Shiner | --- | --- | S5 |
| *Percopsis omiscomaycus* | Trout-perch | --- | --- | S5 |
| *Morone americana* | White Perch | --- | --- | SNA |
| *Catostomus commersoni* | White Sucker | --- | --- | S5 |
| *Perca flavescens* | Yellow Perch | --- | --- | S5 |

[1]Federal Species at Risk Act (SARA); [2]Provincial Endangered Species Act (ESA); [1]S-Rank is an indicator of commonness in the Province of Ontario. A scale between 1 and 5, with 5 being very common and 1 being the least common; "---" denotes no information or not applicable.

### 3.2.3 Invertebrate Biotic Index

Invertebrate sampling stations do not exist within the Lower Hager and Rambo creek tributaries (CH, 2012).

## 3.3 Natural Heritage Features

As mentioned in **Section 2.1**, natural heritage features as defined under the PPS require consideration within the Scoped EIS, discussed in subsequent sections. Note that consideration of fish habitat and habitat for *endangered* and *threatened* species has been included in **Section 3.4**, **Section 4.5** and **Section 5.5**, respectively.

### 3.3.1 Wetlands

Wetlands provide habitat for fish and wildlife and have important hydrological functions. A variety of wetland habitat types, significant locally and provincially, exists primarily above the escarpment due to poor drainage.

No Provincial Significant Wetland (PSW), locally significant wetlands or Unevaluated Wetland units were identified within or adjacent to the Study Area.

### 3.3.2 Woodlands

The woodland cover is generally concentrated above the Niagara Escarpment with patches of forest cover below. This distribution reflects the agricultural history of the area. In the 1800s and early 1900s, the extent of forest cover in the Burlington Region declined considerably as people settled in the area (CH, 2006).

The Study Area occurs in the Urban Land Cover area of Halton Region. Land covers in the urban areas include impervious surfaces such as asphalt, concrete and rail tracks on transportation routes. It also includes buildings of various sizes and densities that are used for a variety of purposes. Pervious surfaces are primarily limited to parklands and lawns (CH, 2013).

No significant woodlands were specifically identified within or adjacent to the Study Area; however, there is an unevaluated woodland associated with the Lower Rambo Creek in the southeastern corner of the Study Area. Due to the size of this woodland and its association with Rambo Creek, this woodland likely meets the criteria for significance and is discussed further in **Section 5.4.2**.

### 3.3.3 Valleylands

No significant valleylands were identified within or adjacent to the Study Area.

### 3.3.4 Areas of Natural and Scientific Interest (ANSI)

No ANSIs were identified within or adjacent to the Study Area.

### 3.3.5 Significant Wildlife Habitat

The Significant Wildlife Habitat Technical Guide (MNRF 2000) defines Species of Conservation Concern as globally, nationally, provincially, regionally, or locally rare (S-Rank of S1 to S3) but does not include SAR (listed as *endangered* or *threatened* under the ESA). A review of the MNRF background data provided in support of the Scoped EIS does not suggest the presence of significant wildlife habitat in association with the woodland communities within the Study Area. However, several Species of Conservation Concern have the potential to occur within or adjacent to the Study Area (**Table 2**).

**Table 2: Species of Conservation Concern with the potential to occur within the Study Area**

| Scientific Name | Common Name | SARA[1] | ESA[2] | S-RANK[3] | Info Source[4] |
|---|---|---|---|---|---|
| **Vascular Plants** | | | | | |
| *Asplenium scolopendrium var. americanum* | Hart's-tongue Fern | SC | SC | S3 | MNRF SAR in Area |
| *Hieracium paniculatum* | Panicled Hawkweed | --- | --- | S2? | NHIC |
| *Lithospermum parviflorum* | Soft-hairy False Gromwell | --- | --- | S2 | NHIC |
| *Mertensia virginica* | Virginia Bluebells | --- | --- | S3 | NHIC |
| *Euonymus atropurpureus* | Eastern Burning Bush | --- | --- | S3 | NHIC |
| *Hypoxis hirsuta* | Yellow Stargrass | --- | --- | S3 | NHIC |
| *Uvularia perfoliata* | Perfoliate Bellwort | --- | --- | S1 | NHIC |
| *Nuphar advena* | Large Yellow Pond-lily | --- | --- | S3 | NHIC |
| *Aplectrum hyemale* | Puttyroot | --- | --- | S2 | NHIC |
| *Sphenopholis nitida* | Shiny Wedge Grass | --- | --- | S1 | NHIC |
| *Crataegus brainerdii* | Brainerd's Hawthorn | --- | --- | S2 | NHIC |
| *Crataegus pruinosa var. dissona* | Northern Hawthorn | --- | --- | S3 | NHIC |
| *Aureolaria pedicularia* | Fern-leaved Yellow False Foxglove | --- | --- | S2? | NHIC |
| *Aureolaria virginica* | Downy Yellow False Foxglove | --- | --- | S1 | NHIC |
| *Phegopteris hexagonoptera* | Broad Beech Fern | --- | SC | S3 | MNRF SAR in Area |
| **Birds** | | | | | |
| *Nycticorax nycticorax* | Black-crowned Night-heron | --- | --- | S3B,S3N | NHIC |
| *Falco peregrinus* | Peregrine Falcon | SC | SC | S3B | OBBA, MNRF SAR in Area |
| *Gavia stellata* | Red-throated Loon | --- | --- | S1N,S3B | OBBA |
| *Euphagus carolinus* | Rusty Blackbird | SC | --- | S4B | OBBA |
| *Larus minutus* | Little Gull | --- | --- | S1B | OBBA |
| *Vermivora chrysoptera* | Golden-winged Warbler | THR | SC | S4B | OBBA |
| *Melanerpes erythrocephalus* | Red-headed Woodpecker | THR | SC | S4B | OBBA |

| Scientific Name | Common Name | SARA[1] | ESA[2] | S-RANK[3] | Info Source[4] |
|---|---|---|---|---|---|
| *Podiceps grisegena* | Red-necked Grebe | --- | --- | S3B,S4N | OBBA |
| *Hylocichla mustelina* | Wood Thrush | --- | SC | S4B | OBBA |
| *Contopus virens* | Eastern Wood-pewee | --- | SC | S4B | OBBA |
| **Herpetozoa** | | | | | |
| *Chelydra serpentina* | Snapping Turtle | SC | SC | S3 | MNRF SAR in Area |
| *Thamnophis sauritus* | Eastern Ribbonsnake (Great Lakes population) | SC | SC | S3 | MNRF SAR in Area, OHA |
| *Graptemys geographica* | Northern Map Turtle | SC | SC | S3 | MNRF SAR in Area, OHA |
| *Sternotherus odoratus* | Eastern Musk Turtle | THR | SC | S3 | MNRF SAR in Area, OHA |
| **Lepidoptera** | | | | | |
| *Danaus plexippus* | Monarch | SC | SC | S2N,S4B | OBA |
| *Pieris virginiensis* | West Virginia White | --- | SC | S3 | OBA |
| **Odonata** | | | | | |
| *Cordulegaster obliqua* | Arrowhead Spiketail | --- | --- | S2 | NHIC |
| *Ophiogomphus rupinsulensis* | Rusty Snaketail | --- | --- | S4 | NHIC |
| **Mammals** | | | | | |
| *Microtus pinetorum* | Woodland Vole | SC | SC | S3? | MWH, MNRF SAR in Area |

[1]Federal Species at Risk Act (SARA); [2]Provincial Endangered Species Act (ESA); [1]S-Rank is an indicator of commonness in the Province of Ontario. A scale between 1 and 5, with 5 being very common and 1 being the least common; [4]Information sources include: MNRF = Ministry of Natural Resources and Forestry; OBBA = Ontario Breeding Bird Atlas; ON = Ontario Nature: Ontario Reptile and Amphibian Atlas; SARA = Species at Risk Act; TEA = Toronto Entomologists' Association; "---" denotes no information or not applicable.

The potential for significant wildlife habitat to be present within the Study Area is discussed further in **Section 4.4.3** and **Section 5.4.3**.

## 3.4 Species at Risk

### 3.4.1 Species at Risk and Species at Risk Habitat

A SAR information request was submitted to the MNRF Aurora District Office in order to obtain SAR records to help narrow our focus on potential SAR and/or SAR habitat within the Study Area. The MNRF identified the following *threatened* species with occurrence records within the Study Area:

- Chimney Swift (*Chaetura pelagica*) listed as *Threatened* under the ESA.

This species is discussed further in **Section 5.5**.

## 3.5 Incidental Wildlife

A review of aerial imagery and local knowledge suggests that there are several common wildlife species found within the general area with potential to occur in the Study Area.

Incidental wildlife occurrences are discussed further in **Section 4.6** and **Section 5.6**.

# 4.0 The Methodology of Biophysical Inventory

The results of the background review were used to assist in scoping the 2017 field program. Fieldwork conducted for the Scoped EIS occurred between May and August when weather conditions and timing were deemed suitable based on the survey protocols being implemented (**Table 3**). Fieldwork consisted of Ecological Land Classification (ELC) of vegetation communities, botanical surveys, aquatic surveys, and breeding bird surveys. The aforementioned surveys were completed in predetermined locations which were approved and confirmed in consultation with CH during the establishment of the TOR. Incidental wildlife observations made during the surveys were also documented. The following sub-sections outline the survey methodologies used in support of the Scoped EIS.

**Table 3: Dates and Times of Field Surveys**

| Date (2017) | Weather Conditions | Air Temp (°C) | Purpose of visit |
|---|---|---|---|
| May 23 | Mostly clear, light breeze, <1mm precipitation | 11 | Breeding Bird Survey #1 |
| June 22 | Overcast & heavy rain | 18 | Stream Assessment on Lower Rambo Creek |
| June 28 | Mostly clear, light breeze, no precipitation | 15 | Breeding Bird Survey #2, ELC Survey, Botanical |
| July 26 | Clear skies, breeze, no precipitation | 20 | Stream Assessment on Lower Hager Creek |

## 4.1 Ecological Land Classification

Vegetation communities were assessed using ELC as a first step to identify and assess potential natural heritage features within the Study Area. During the field investigations, vegetation was characterized using the ELC System for Southern Ontario (Lee et al., 1998) in order to classify and map ecological communities to the vegetation level. The ecological community boundaries were determined through the review of aerial imagery and then further refined during site visits. In addition to the vegetation survey, a basic soil assessment was conducted to identify the soil moisture class within the ecosystem.

The ELC protocol recommends that a vegetation community be a minimum of 0.50 ha in size before it is defined. Based on the composition of vegetation communities within the Study Area, patches of vegetation less than 0.5 ha or disturbed/planted vegetation were described, provided they clearly fit within an ELC vegetation type.

Results of the ELC survey are included in **Section 5.1**.

## 4.2 Vegetation Inventory

Summer botanical surveys were completed in conjunction with the detailed ELC survey in June. Surveys consisted of wandering transects and/or area searches to determine the presence, richness and abundance of floral species within the Study Area. Species nomenclature is based on the Ontario Plant List (Newmaster et al,. 1998).

Results of the botanical surveys are discussed in **Section 5.2**.

## 4.3 Aquatic Assessment

### 4.3.1 Stream Assessments

Stream assessments were conducted on June 22 and July 26 to investigate the Lower Rambo and Lower Hager Creeks mapped within the eastern and western portions of the Study Area, respectively. Information collected for the watercourses included (where applicable): channel form, presence/absence of flow, substrate type, channel dimensions (e.g. width and depth), and riparian vegetation. This information was then used to help determine the overall health and sensitivity of each branch of the watercourse.

The locations of stream assessments are shown on **Figure 3**, and results are discussed in **Section 5.3**.

### 4.3.2 Fluvial Geomorpholy Assessment

In addition to the aquatic stream assessments, a fluvial geomorphology assessment was completed within the Study Area by GeoProcess Research Associates (GeoProcess). Refer to **Appendix E** for detailed methods as they relate to the fluvial geomorphology assessment. A summary of the results as it pertains to the bank and stream stability, as well as aquatic/riparian habitat is summarized in **Section 5.3**.


CITY OF Burlington

**DOWNTOWN**

BURLINGTON HUB MOBILITY STUDY

## 2017 FIELD SURVEY LOCATIONS

FIGURE 3

- Study Area
- Conservation Halton Fish Records
- Breeding Bird Survey Location
- Stream Assessment Locations
- Road
- Railway
- Watercourse
- Waterbody

0 50 100 200 Metres

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNRF, CONSERVATION HALTON

MAP CREATED BY: LK
MAP CHECKED BY: DL
MAP PROJECTION: NAD 1983 UTM Zone 17N

DILLON CONSULTING

PROJECT: 17-5015
STATUS: DRAFT
DATE: 2019-01-22

FILE LOCATION: G:\cad\GIS\175015\Mapping\EIS_Downtown\Fig3_SurveyLocations_Jan2019.mxd

## 4.4 Natural Heritage Features

### 4.4.1 Wetlands

No PSW and/or unevaluated wetland units were identified within or adjacent to the Study Area.

### 4.4.2 Woodlands

Woodlands within the Study Area were investigated as part of the ELC and vegetation inventory.

Results of field studies relating to woodlands are discussed in **Section 5.4.2**.

### 4.4.3 Significant Wildlife Habitat

Based on the presence of the woodland within the Study Area, breeding bird surveys were conducted to establish baseline conditions, and to determine whether significant wildlife habitat for birds exists within the Study Area as defined in the *Eco-region 7E Criterion Schedules* (MNRF, 2015).

#### 4.4.3.1 Breeding Bird Survey

Diurnal breeding bird surveys conducted within the Study Area followed the methods outlined in the Ontario Breeding Bird Atlas Guide for Participants (Cadman et al 2007) and were completed in late-May and June (two surveys) in an effort to document both early-season and late-season breeders. Specifically, surveys consisted of point counts generally conducted between dawn and five hours after sunrise to establish quantitative estimates of bird abundance in suitable habitat types within the Study Area. During the surveys, evidence of breeding behaviour was recorded which generally includes, but is not limited to, males singing, nest building, egg incubation, territorial defence, carrying food, and feeding their young.

To supplement the surveys, area searches of the habitat were completed using binoculars to observe species presence and breeding activity. Area searches involved noting individual bird species observations and their corresponding breeding evidence while traversing the habitat on foot. Point count locations are displayed in **Figure 3**.

Results of breeding bird studies within the Study Area are included in **Section 5.4.3.1**.

## 4.5 Species at Risk

Surveys for Butternut were completed in conjunction with ELC surveys within the Study Area. With respect to birds, since no specific habitat for SAR birds identified by the MNRF is present within the Study Area, general surveys for Chimney Swift were completed in conjunction with diurnal breeding bird surveys outlined above.

Given that the woodland within the Study Area will be protected and no vegetation removal is anticipated in association with the woodland, specific snag/cavity trees density searches in support of bat habitat were not conducted.

Results relating to SAR within the Study Area are included in **Section 5.5**.

## 4.6 Incidental Wildlife

A general wildlife assessment was completed within the Study Area through incidental observations while on site. Incidental observations of wildlife were noted, as well as other wildlife evidence such as dens, tracks, and scat. For each observation, notes, and when possible, photos were taken. These observations helped to determine potential ecological functions, linkages, etc. within the Study Area.

Results relating to incidental wildlife within the Study Area have been included in **Section 5.6**.

# 5.0 Results of Biophysical Inventory

A biophysical inventory of natural features within the Study Area was completed in accordance with the methods detailed in **Section 4.0**. The analysis of data collected from secondary source information and during field studies in 2017, was used to evaluate the significance of natural heritage features within the Study Area.

## 5.1 Ecological Land Classification

A single natural vegetation community as well as a single green lands community were observed within the Study Area during the ELC survey. The location, type, and boundaries of the communities are delineated in **Figure 4.** The natural vegetation community surveyed within the Study Area is considered common in Ontario. **Table 4** outlines the communities documented during ELC surveys and summarizes the dominant vegetation cover. Reference photos of the natural vegetation community are provided in **Appendix C**.

The natural community within the Study Area has been disturbed due to anthropogenic uses (i.e., trails, dumping, etc.) and contained the presence of invasive species.

**Table 4: Ecological Land Classification**

| ELC Code | Classification | Area (ha) | Vegetation | Comments | Photo Appendix C |
|---|---|---|---|---|---|
| CGL | Greenlands | 0.24 ha | Manicured grass associated with an existing trail network. | N/A | N/A |
| FODM7-8 | Fresh – Moist Norway Maple Lowland Deciduous Forest Type | 0.72 ha | The canopy and sub-canopy consists of Norway Maple (*Acer platanoides*) as the dominant species with Eastern Black Walnut (*Juglans nigra*), Black Maple (*Acer nigrum*), American Elm (*Ulmus Americana*), Cottonwood (*Populus nigra*), Crack Willow (*Salix fragilis*) and White Mulberry (*Morus alba*) associates.<br><br>Understory species consist primarily of Norway Maple, Black Maple and Green Ash (*Fraxinus pensylvanica*).<br><br>Herbaceous species present consists of Japanese Knotweed (*Fallopia japonica*), Motherwort (*Leonrus cardiaca*), Goldenrod sp. (*Solidage spp*), Common Burdock (*Arctium minus*), Greater Celandine (*Chelidonium majus*), Garlic Mustard (*Alliaria petiolata*) and Kentucky Bluegrass (*Poa pratensis*). | This community is located on southeast side of the Study Area. This community is dominated with invasive species and moderate but localized rubbish dumping. This community also contains a moderate but localized amount of disease and death of trees. | Photo 1 |


CITY OF Burlington

**DOWNTOWN**

BURLINGTON HUB MOBILITY STUDY

**SITE INVESTIGATION RESULTS**

FIGURE 4

- Study Area
- Chimney Swift Points
- Road
- Railway
- Watercourse
- Waterbody

**Ecological Land Classification**

- FODM7-8: Fresh - Moist Norway Maple Lowland Deciduous Forest
- CGL: Green lands

0 50 100 200 Metres

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNRF, CONSERVATION HALTON

MAP CREATED BY: LK
MAP CHECKED BY: DL
MAP PROJECTION: NAD 1983 UTM Zone 17N

DILLON CONSULTING

PROJECT: 17-5015
STATUS: DRAFT
DATE: 2019-01-22

FILE LOCATION: G:\cad\GIS\175015\Mapping\EIS_Downtown\Fig4_ELC_Jan2019.mxd

## 5.2 Vegetation

A total of 17 botanical species were documented within FODM7-8 during 2017 field studies (**Figure 4**). Of the 17 species, eight are listed as native species and are considered common (SRank of S4) to very common (SRank of S5) in the province of Ontario. The remaining species are listed as introduced species; therefore, a status ranking is not applicable as the species is not a suitable target for conservation activities (SRank of SE or SNA).

The Co-efficient of Conservatism (CC) provides additional information on the nature of the vegetation communities within the Study Area. The CC values range from 0 to 10 and represent an estimated probability that a plant is likely to occur in a landscape that is relatively unaltered or is in a pre-settlement condition. For example, a CC of 0 is given to plants such as Manitoba Maple (*Acer negundo*) that demonstrate little fidelity to any remnant natural community (i.e. may be found almost anywhere). Similarly, a CC of 10 is applied to plants like Shrubby Cinquefoil (*Potentilla fructicosa*) that are almost always restricted to a pre-settlement remnant (i.e. a high-quality natural area). Introduced plants were not part of the pre-settlement flora, so no CC values have been applied to these species.

Of the 17 species identified in the Study Area, one has a CC value of 7 or greater; Black Maple (7). The mean CC value for the site was 4.33, indicating an altered landscape. This is typical of an urban environment as compared to naturally occurring environments. A full list of the vegetation species observed within the Study Area has been included in **Appendix D**.

Potential impacts related to vegetation within the Study Area are included in **Section 8.1.1**.

## 5.3 Aquatic Assessment

### 5.3.1 Stream Assessments

Daylighted portions of Lower Rambo Creek and Lower Hager Creek, subjected to aquatic field investigations, were confirmed with CH during the development of the ToR.

**LOWER RAMBO CREEK**

The section of Rambo Creek within the Study Area drains southeast from north of Caroline Street to its confluence with Lake Ontario, east of Martha Street. During the aquatic assessment, the Rambo Creek identified through background review was confirmed and assessed from northeast of Carloine Street to Lake Ontario (**Figure 3**).

Within the Study Area, Rambo Creek was characterized as a permanent creek, observed to be flowing on the day of the assessment and contained direct habitat for fish. The creek was linear with instances of meandering and partial braiding of the active channel (**Appendix C**; Photo 2). The morphology of the creek was dominated by run, riffle and glide habitat. Average wetted widths and depths ranged from 2.2 m wide and 0.2 m deep in the upper portion of the reach to approximately 7 m wide and 0.9 m deep

lower in the reach which was also observed to be subject to fluctuations in Lake Ontario's water level (**Appendix C**; Photo 3).

Eroded and unstable banks were observed throughout the majority of the reach despite a mature mixed deciduous forest riparian area (**Appendix C**; Photo 4). Substrates within the creek were dominated by coarse shale, cobble, gravel and sand in the upper portion of the reach with silt, sand and clay present in the lower end of the reach. No instream aquatic vegetation was observed within the area of assessment; however, the creek is channelized and underground from the upstream crossing of Caroline Street to the downstream crossing of James Street (**Appendix C**; Photo 5) which prevented assessment in this area. A seasonal barrier to fish migration in the form of a concrete footing with no low flow channel was observed upstream of the Caroline Street crossing (**Appendix C**; Photo 6) and likely deters small bodied, non-leaping fish from migrating further upstream during seasonal periods of low flow.

**LOWER HAGER CREEK**

The Lower Hagar Creek flows southerly within the study area from its northern boundary at the Baldwin Street crossing to its southern limit at the Elgin Street crossing. Within this reach, the watercourse was characterized as a permanent, channelized creek providing direct fish habitat. The creek was linear in form, with minor instances of meandering (**Appendix C**; Photo 7). The morphology was dominated by flat and glide habitat with occurrences of run habitat. The wetted width averaged approximately 0.9 m and the average depth within this reach was 0.07 m.

Bank stability varied throughout this reach from areas of unstable and eroding banks to areas which have received erosion protection in the form of retaining walls (**Appendix C**; Photo 8). Riparian cover was present and was primarily comprised of mixed deciduous trees and shrubs with the surrounding land use dominated by residential development. As a result, areas of manicured lawn were also present with the riparian area. Substrates within the creek were dominated by sand with silt, muck, detritus, cobble and gravel present. No instream, aquatic vegetation was observed.

Potential impacts related to surface water within the Study Area are included in **Section 8.1.2**.

### 5.3.2 Fluvial Geomorphology Assessment

Both Lower Hager and Lower Rambo Creeks are considered geomorphically strained due to their channelized nature and urban stressors. A total of 19 storm sewer outfalls were documented during the field investigations.

Lower Rambo creek exhibits more signs of degradation with the entrenched valley, lack of floodplain access and existing instability which suggests fewer resiliencies to future hydrology, sediment supply or proximal infrastructure. The confined nature, lack of floodplain and existing bank hardening of Lower Hager Creek also suggest fewer resiliencies to future changes. Given that the streams have been adjusting to the new flow regime since the diversion was completed, landscape alterations may cause additional incisions that could compromise the bank erosion protection infrastructure. For detailed

results as they relate to the fluvial geomorphology assessment, refer to the Preliminary Fluvial Geomorphology Assessment Results Report prepared by GeoProcess in **Appendix E**. For additional information pertaining to storm sewer outfalls, refer to the Downtown Stormwater Quality Control Plan prepared by Wood Environment & Infrastructure Solutions (Wood, 2019) as part of a separate undertaking with the City.

## 5.4 Natural Heritage Features

### 5.4.1 Wetlands

No PSW or unevaluated wetland units were identified within or adjacent to the Study Area.

### 5.4.2 Woodlands

The woodland (FODM7-8) within the Study Area was investigated in association with ELC surveys. In accordance with the policies of the Halton Regional Official Plan (ROP) Amendment Number 38 (ROPA 38 Section 277):

> ***SIGNIFICANT WOODLAND*** *means a Woodland 0.5 ha or larger determined through a Watershed Plan, a Sub-watershed Study or a site-specific Environmental Impact Assessment to meet one or more of the four following criteria:*
>
> *(1) The Woodland contains forest patches over 99 years old;*
>
> *(2) The patch size of the Woodland is 2 ha or larger if it is located in the Urban Area, or 4 ha of larger if it is located outside of the Urban Area but below the Escarpment Brown, or 10 ha or larger if it is located outside the Urban Area but above the Escarpment Brow;*
>
> *(3) The Woodland has an interior core area of 4 ha or larger, measured 100 m from the edge; or*
>
> (4) *The Woodland is wholly or partially within 50 m of a major creek or certain headwater creek or within 150 m of the Escarpment Brow.*

The woodland assessed within the Study Area, though less than 2.0 ha (i.e. 0.96 ha) in an Urban Area, is within 50 m of a major creek given that the southern portion of the Lower Rambo Creek is within CH regulated limits (ROPA 28 Section 256.2). Therefore, the woodland meets the criteria for significance outlined in Halton's ROPA 38 Section 277 and forms part of the Regional Natural Heritage System in accordance with Halton's ROPA 38 Section 115.3. It is recommended that where appropriate, the significant woodland within the Study Area is protected through appropriate OP policies/Area-Specific Plans or studies related to development and/or site alteration applications in accordance with Section 118 and 139.12 of the 2009 ROP.

Potential impacts related to woodland within the Study Area are included in **Section 8.1.1** and **Section 8.1.3**.

### 5.4.3 Significant Wildlife Habitat

The results of the field surveys as they apply to wildlife habitat are detailed below. Based on the results of the 2017 field investigations, no Significant Wildlife Habitat (SWH) pertaining to Seasonal Concentration Areas of Animals, Rare Vegetation Communities, Specialized Habitat for Wildlife, Habitat for Species of Conservation Concern or Animal Movement Corridors were identified within the Study Area as defined in the *Eco-region 7E Criterion Schedules* (MNRF, 2015). Given that the 2017 field investigations were limited to ELC, botanical, breeding bird and aquatic surveys, it is recommended that the need to undertake additional surveys (e.g. amphibians, bats, etc.) be evaluated during the site specific development application process to confirm the presence/absence of amphibian and/or bat significant wildlife habitat (if required). Until the additional studies are completed, the woodland within the study area is considered candidate SWH for bat maternity colonies and amphibian breeding habitat. The aforementioned habitats are included in the Regional Natural Heritage System in accordance with Halton's ROPA 38 Section 115.3 (**Figure 5**).

#### 5.4.3.1 Breeding Bird Survey

A total of ten (10) bird species were observed during breeding bird surveys (**Table 5**). Of the 10 species observed, none are considered area sensitive and all are considered common and secure (SRank of S4) to very common (SRank of S5) in the province of Ontario based on the provincial conservation rankings assigned by the NHIC.

**Table 5: 2017 Breeding Bird Survey Results**

| Scientific Name | Common Name | GRank[1] | SRank[2] | SARA[3] | ESA[4] | Breeding Evidence[5] |
|---|---|---|---|---|---|---|
| *Anas platyrhynchos* | Mallard | G5 | S5 | --- | --- | FO/FY/H/P |
| *Cardinalis cardinalis* | Northern Cardinal | G5 | S5 | --- | --- | H/S |
| *Carduelis tristis* | American Goldfinch | G5 | S5B | --- | --- | S |
| *Page 28 Corvus brachyrhynchos* | American Crow | G5 | S5B | --- | --- | F/O |
| *Dumetella carolinensis* | Gray Catbird | G5 | S4B | --- | --- | A/H |
| *Larus delawarensis* | Ring-billed Gull | G5 | S5B,S4N | --- | --- | F/O |
| *Melospiza melodia* | Song Sparrow | G5 | S5B | --- | --- | S |
| *Poecile atricapillus* | Black-capped Chickadee | G5 | S5 | --- | --- | S |
| *Quiscalus quiscula* | Common Grackle | G5 | S5B | --- | --- | F/O |
| *Turdus migratorius* | American Robin | G5 | S5B | --- | --- | S |

[1]Glabl conservation status is an indicator of commonness across the species entire rang; [2]S-Rank is an indicator of commonness in the Province of Ontario. A scale between 1 and 5, with 5 being very common and 1 being the least common; [3]Federal Species at Risk Act (SARA); [4]Provincial Endangered Species Act (ESA); [5]Breeding Bird Codes from Breeding Bird Atlas of Ontario (Cadman *et al.* 2007) =

**Observed**

**X** Species observed in its breeding season (no breeding evidence)

**Possible**

**H** Species observed in its breeding season in suitable nesting habitat

**Confirmed**

**NB** Nest-building or excavation of nest hole by a species other than a wren or a woodpecker

**DD** Distraction display or injury feigning

**Probable**

**S** Singing male(s) present, or breeding calls heard, in suitable nesting habitat in breeding season

**P** Pair observed in suitable nesting habitat in nesting season
**T** Permanent territory presumed through registration of territorial song, or the occurrence of an adult bird, at the same place, in breeding habitat, on at least two days a week or more apart, during its breeding season.
**D** Courtship or display, including interaction between a male and a female or two males, including courtship feeding or copulation
**V** Visiting probable nest site
**A** Agitated behaviour or anxiety calls of an adult
**B** Brood Patch on adult female or cloacal protuberance on adult male
**N** Nest-building or excavation of nest hole, except by a wren or a woodpecker

**NU** Used nest or egg shells found (occupied or laid within the period of the survey)
**FY** Recently fledged young (nidicolous species) or downy young (nidifugous species), including incapable of sustained flight
**AE** Adult leaving or entering nest sites in circumstances indicating occupied nest
**FS** Adult carrying fecal sac
**CF** Adult carrying food for young
**NE** Nest containing eggs
**NY** Nest with young seen or heard
**FO** Fly over

## 5.5 Species at Risk

No SAR was identified within the Study Area during the 2017 field investigations. However, the woodland within the study area has the potential to support SAR bats. As a result, the woodland is included in the Regional Natural Heritage System in accordance with Halton's ROPA 38 Section 115.3 (**Figure 5**). In the event impacts to the woodland are anticipated in support of future development, additional surveys should be completed during the site specific development application process to confirm whether the woodland provides SAR bat habitat.

Although Chimney Swift individuals were not observed, CH provided the anthropogenic structure locations of known/historical Chimney Swift roosting locations within the Study Area (**Figure 4**). No additional Chimney Swift habitat was observed within the Study Area during the 2017 field investigations beyond those identified in **Figure 4**.

## 5.6 Incidental Wildlife

During field investigations, no incidental wildlife species were observed within the Study Area.

# 6.0 Ecological Function

Natural features within and adjacent to the Study Area were analyzed to determine their ecological function. At the larger landscape scale, the Study Area exists in an Urban Growth Area and is associated with Lake Ontario. As the majority of the Study Area is comprised of urban, recreational and educational land uses, the potential ecological functions within the Study Area are minimal.

The significant woodland and Lower Rambo Creek corridor in the southeastern portion of the Study Area is one of only a few natural areas within the highly urbanized Burlington Downtown with a high percentage of tree cover. This area provides a limited ecological function; though the woodland's association with the Lower Rambo Creek has a positive influence on the feature's ecological function as it provides a connection for species with a high mobility to the larger Lake Ontario system to the south. This woodland feature provides limited cover, foraging, refuge, and nesting habitat for terrestrial wildlife. Due to the surrounding urbanized area and the disturbed nature of the Study Area, the creek corridor (including the woodland) provides limited habitat function for urban tolerant flora and fauna.

The portion Lower Rambo Creek within the Study Area provides some ecological and hydrological function given its connectivity to Lake Ontario, and provides habitat to a number of native plant and wildlife species. General ecological functions of significant woodland and other natural features within the Study Area include prevention of erosion and runoff, facilitating hydrological and nutrient cycling, and improving localized soil, water and air quality. As previously mentioned, Lower Hager Creek has been characterized as having poor aquatic ecosystem health with non-existent fish communities. In addition, given that portions of the creek are enclosed beneath suburban portions of Burlington, there appear to be none, to very limited, ecological function associated with Lower Hager Creek.

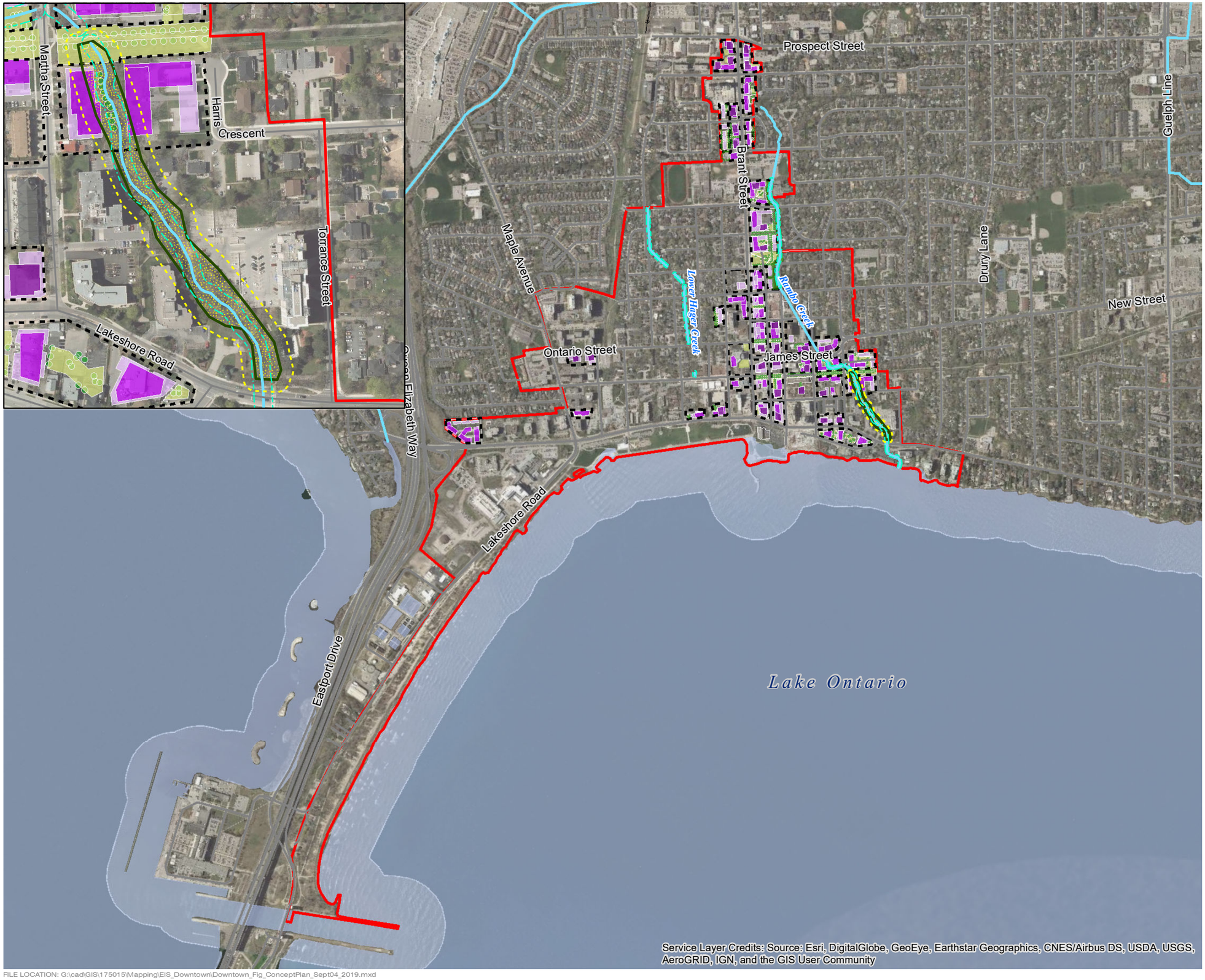
# 7.0 Description of Area Specific Plans

The City is embarking on an ambitious program to complete a comprehensive intensification planning framework. Conceptualizing OP policies/Area Specific Plans for the Downtown Mobility Hub is an important step to ensure the City continues to grow sustainably in the face of increasing development pressures. The goal is to promote intensification in a number of strategic locations, providing opportunities for mixed-use redevelopment, employment growth, reinvigorating community infrastructure and improved transportation networks to support growth. The near built-out status of the City's urban area was a central factor for the conceptualized OP policies/Area Specific Plans and was required in order to manage future growth within strategic existing urban areas through infill and intensification. It should also be noted that a focus of the plans is to accommodate long-term population and employment growth within the Downtown to support the downtown's long-term success. The City's Downtown Mobility Hub will serve as a primary growth area within the City's long-term growth framework.

The Conceptualized Plan for the Downtown Mobility Hub is illustrated in **Figure 5;** along with the assessed natural heritage features with their associated recommended buffers. The Downtown Burlington Mobility Hub will continue to develop as an Urban Growth Centre and the City's primary cultural/civic destination. Low, mid-rise and tall mixed use buildings will be designed to create vital, pedestrian-supportive streetscapes while maintaining pedestrian connections/linkages to the Lake front. Key considerations implemented in the Downtown Hub Conceptualized Plan are:

- *Allowing for height and density permissions that will support and enhance the city-wide, regional and Provincial significance of the Downtown Mobility Hub and its role as a major transit centre;*
- *Providing for development that can achieve heights and densities that will create a population and employment base to attract new businesses, services and amenities to the Downtown Mobility Hub;*
- *Where possible, establishing maximum building heights which are consistent with existing development precedent;*
- *Ensuring that the tallest developments are in areas of the Downtown Mobility Hub which have the greatest pedestrian access to higher order transit (Burlington GO);*
- *Concentrating the tallest developments in areas away from Lake Ontario to increase affordability and attract a wider range of demographics and income levels to the Downtown Mobility Hub;*
- *Establishing effective transitions from tall building locations to established residential areas both within and adjacent to the study boundary;*
- *Conserving areas with concentrated heritage and/or character defining elements significant to the Downtown Mobility Hub and the City;*
- *Protecting significant public view corridors to Lake Ontario;*
- *Achieving new and enhanced public green/open spaces;*

- *Mitigating future traffic congestion associated with growth through a variety of measures including development specific transportation demand management measures, enhanced pedestrian and cycling amenities and networks and the strategic concentrations of height and density within walking distance of major transit stations; and*
- *Ensuring the Downtown Mobility Hub has adequate lands to accommodate future community and government public services required to serve existing and future residents and employees.*




CITY OF Burlington

**DOWNTOWN**

BURLINGTON HUB MOBILITY STUDY

**CONCEPTUALIZED PLAN & IMPACT ASSESSMENT**

FIGURE 5

- Study Area
- Railway
- Road

**Regional Natural Hertiage System**

- Woodland — Candidate SWH - Amphibian Breeding Habitat; - Bat Maternity Colony; Potential SAR Bat Habitat

**Assessed Natural Heritage Features**

- Watercourse
- Waterbody
- 7.5 m Setback from Daylight Watercourse
- Woodland
- 10m Setback from Woodland

**Concept Plan Features**

- Concept Plan
- Block Boundaries
- Tall Building
- Mid-rise
- Low-rise
- Park / Open Space / POPS
- Proposed Trees

0 50 100 200 Metres

N W E S

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNRF

MAP CREATED BY: LK
MAP CHECKED BY: DB
MAP PROJECTION: NAD 1983 UTM Zone 17N

DILLON CONSULTING

PROJECT: 17-5015
STATUS: DRAFT
DATE: 2019-10-08

FILE LOCATION: G:\cad\GIS\175015\Mapping\EIS_Downtown\Downtown_Fig_ConceptPlan_Sept04_2019.mxd

# 8.0 Impact Assessment

## 8.1 Direct Impacts

Direct impacts are those that are immediately evident as a result of development. Typically, the adverse effects of direct impacts are most evident during the site preparation and construction phase of a development. Potential direct impacts of the proposed intensification of redevelopment within the Downtown Mobility Hub may include the following:

- Tree and vegetation removal;
- Diversion of surface water flows;
- Erosion and sedimentation into natural features (woodland, Lower Rambo Creek and potentially Lower Hager Creek); and
- Loss of/ disturbance to wildlife and general wildlife habitat.

The majority of intensification of redevelopment activities are proposed outside of the recommended 10 m woodland buffer. Potential direct impacts would generally be limited to pre-existing disturbed areas which currently consist of residential, business and asphalt parking lots (**Figure 5**).

The Conceptualized Plan for intensification of redevelopment and its associated potential environmental impacts are shown in **Figure 5**.

### 8.1.1 Tree and Vegetation Removal

Potential tree and ground vegetation removal would be limited to the intensification and redevelopment area as shown on the Conceptualized Plan on **Figure 5** to facilitate grading and construction of infrastructure.

Potential tree removal may result in a reduction in tree cover, marginal wildlife habitat loss, and alteration of soil conditions. On a site level, the impacts of tree and vegetation removal may include:

- Direct loss of trees;
- Decreased floral species richness and abundance;
- Negative edge effects, including altered soil conditions and water availability;
- Alteration of microclimate;
- Loss of native seed banks; and
- Physical injury, root damage, and compaction of trees not intended for removal that may result from construction operations.

As previously stated in this report, the proposed intensification of redevelopment area provides minimal ecological function and thus, the potential removal of select isolated trees and other vegetation (with

exception to the woodland) may result in minimal habitat loss, minimal reduction of natural cover in the area, and minimal reduction in ecological function.

Refer to **Section 9** for mitigation and enhancement opportunities.

### 8.1.2 Diversion of Surface Water Flows

The open watercourse corridors within the Study Area contribute as "natural" conveyance infrastructure (i.e. drainage system), riparian habitat (though limited), and socially by preserving and enhancing open space. In order to preserve these functions for the long term, the current ecological function has been determined, and mitigation and enhancement (**Section 9.0**) in the context of future intensification of redevelopment have been proposed.

**Riverine Flooding Hazard**

The Downtown Mobility Hub includes drainage from two riverine systems: Lower Hager Creek and Lower Rambo Creek. These watercourses are remnant features; upstream drainage was eliminated through the previous implementation of the Hager-Rambo Diversion Channel. Portions of the watercourses are also enclosed along their length, particularly Lower Rambo Creek between Caroline Street and James Street.

With respect to Lower Hager Creek, the floodplain is largely contained to the channel area, with no impacts to identified re-development areas. The exception would be in the identified westerly spill between Birch Avenue and Caroline Street. This spill would likely be directed to the sag point on Burlington Avenue, between Caroline Street and Ontario Street.

With respect to Lower Rambo Creek, the floodplain is affected by whether or not spill flows from the Hager-Rambo Diversion channel (Burlington GO Mobility Hub area) are included or not. Spill flows have been assessed using 2D hydraulic modelling, which indicates that the majority of the spill would be directed along Brant Street and ultimately be returned to the Lower Rambo Creek. A total of five (5) parcels identified for potential re-development have been identified as partially impacted by the simulated Regional Floodplain; they include:

- Brant Street and Baldwin Street (northeast corner)
- James Street between Pearl Street and Martha Street (south side)
- Martha Street at James Street (east side)
- Martha Street at Pine Street (east side)
- Lakeshore Road at Old Lakeshore Road (west side)

With the addition of spill flows, an additional two (2) properties are impacted, for a total of seven (7) properties; they include:

- Brant Street and Ghent Avenue (southeast corner)

- Elizabeth Street/Emerald Crescent at Caroline Street (northwest corner)

**Urban Flooding Hazard**

In addition to urban flood impacts due to spills from riverine systems (Hager-Rambo Diversion channel – primarily impacts Brant Street area between Fairview Street and Blairholm Avenue), urban (overland) flooding hazards have also been noted along roadway systems within the Downtown Mobility Hub. Overland flow depths in excess of 0.15 m and 0.30 m in some areas, respectively, have been noted for both the 100-year storm and Regional Storm Event. With respect to the expected areas of re-development within the Downtown Mobility Hub, the primary areas of concern include:

- Baldwin Street (east of Brant Street)
- James Street (at Pearl Street)
- Martha Street (at James Street)
- Lakeshore Road (at Old Lakeshore Road)

The aforementioned locations each indicate simulated 100-year surface depths in excess of 0.30 m and generally correlate with the areas of identified riverine flooding. With respect to storm sewer capacity and potential surcharging, based on hydraulic modelling the trunk storm sewer along Brant Street (south of Caroline Street) is indicated as being unsurcharged along its entire length, as are storm sewers in close proximity to Lake Ontario, including along Lakeshore Road (west of Lower Rambo Creek). The remaining sections area indicated as surcharged, with a few sections indicated as flooded. Flooded sections tend to be located at the upstream limits of the simulated storm sewer extents, including Caroline Street and Ghent Avenue.

During aquatic assessments, reaches of Lower Rambo and Lower Hager creek were observed to contain areas of reinforced or unstable banks with persistent erosion. An increase of stormwater drainage associated with proposed redevelopment has the potential to cause a negative impact on the ecological form and function of the creeks and aquatic habitat downstream. The confined nature and lack of floodplain decrease the stream's resiliency to future changes, especially in instances where existing bank hardening is already being compromised.

Refer to **Section 9.3** and **Section 9.6** for mitigation measures related to surface flows. For detailed results as they relate to diversion of surface water flows, refer to the February 25, 2019 Flood Hazard and Scoped Stormwater Management Assessment Report prepared by Wood, for the Burlington GO and Downtown Mobility Hubs.

### *8.1.3* Erosion and Sedimentation of Natural Features

Due to the anticipated reduction in infiltration rates post intensification of redevelopment, there is the potential for the woodland and watercourses to be impacted as a result of the redevelopment if construction best management practices are not implemented. Potential impacts to the aforementioned features may include, but are not limited to:

- Reduced water quality and degradation of downstream aquatic habitat (e.g. surface water flow into Lake Ontario from Lower Rambo Creek downstream of the Study Area); and
- Disturbance to or loss of, additional vegetation due to the deposition of dust and/or overland mobilization of soil.

Refer to **Section 9** for mitigation measures related to erosion and sedimentation within the Study Area.

### 8.1.4 Loss of and/or Disturbance to Wildlife

Marginal habitat for flora and fauna may be impacted due to potential vegetation clearing within the proposed intensification of redevelopment areas. Habitat for flora and fauna may be impacted by construction in the following ways:

- Displacement, injury, or death resulting from contact with heavy equipment during clearing and grading activities;
- Disturbance to wildlife as a result of noise associated with construction activities, particularly during breeding periods; and
- Loss of general wildlife habitat.

Accordingly, wildlife impact mitigation measures have been recommended for the development area and are included in **Section 9.5**.

The development of buildings upwards and outwards in close proximity to Lake Ontario increases the number of hazards found in cities and may result in bird strikes day or night due to the confusing effects of glass and light pollution. This is particularly harmful to nocturnal and migratory animals in flight. Avian building strikes are the results of confusing optical illusions for birds. Light inevitably attracts avian species to urban environments where the subsequently get trapped, which is commonly known as “fatal light attraction”. Glass poses a danger as birds cannot perceive glass as a solid object, and will strike clear glass while attempting to reach the reflected habitat and sky.

## 8.2 Indirect Impacts

Indirect impacts are those that do not always manifest in the core development area, but in the lands adjacent to the development. Indirect impacts can begin in the construction phase; however, they can continue post-construction. Potential indirect impacts of the proposed intensification of redevelopment include anthropogenic disturbance and colonization of non-native and/or invasive species.

### 8.2.1 Anthropogenic disturbance

Disturbance to local wildlife communities due to potential indirect impacts on the lands adjacent to the proposed intensification of redevelopment could result if left unmitigated. Noise, light, vibration and human presence are indirect impacts that can adversely influence the population size and breeding success of local wildlife. These effects are more pronounced when new development is introduced in

non-urban areas. Lands within the development area are already disturbed by adjacent recreational areas. Therefore, the proposed intensification of redevelopment is not anticipated to cause a negative impact on surrounding natural areas.

### 8.2.2 Colonization of Non-native and/or Invasive Species

Physical site disturbance may increase the likelihood that non-native and/or invasive flora species will be introduced to the surrounding vegetation communities. Invasive flora can establish in disturbed sites more efficiently than native flora. This type of colonization is currently occurring within the woodland, creek corridors and greenland area as shown on **Figure 4**. Site visits determined that the herbaceous layer was dominated by invasive species such as Japanese Knotweed, Common Buckthorn and Garlic Mustard. In order to maximize ecological function within the Study Area, removal of invasive species paired with planting of native tree and shrub species is recommended.

Mitigation measures related to control of invasive species are addressed in **Section 9.2**.

# 9.0 Mitigation and Opportunities for Enhancement

Mitigation involves the avoidance or minimization of developmental impacts through good design, construction practices and/or restoration and enhancement activities. The feasibility of mitigation options has been evaluated based on the natural features within and adjacent to the Study Area. The impact assessment highlighted four potential direct impacts, which include potential tree and vegetation removal, diversion of surface water flows, potential loss of wildlife and wildlife habitat, and erosion and sedimentation of natural features.

A variety of mitigation techniques can be used to minimize or eliminate the above-mentioned impacts. These measures include enhancement of the buffer area through a Landscaping and Planting Plan, a Stormwater Management Plan, Wildlife Impact Mitigation Plan, Erosion and Sediment Control Plan and an Environmental Monitoring Plan; each of which is introduced below. Appropriate policies will be incorporated into the OP as a mechanism to guide further review of the proposed mitigation measures as part of the preliminary and site specific development application.

## 9.1 Natural Heritage Feature Buffers

Recommended buffers are illustrated in the Conceptualized Plan for the Downtown Mobility Hub (**Figure 5**). As discussed in **Section 5.4.2**, the woodland (FODM7-8) identified in the Study Area met the criteria to be considered significant under Section 277 of the ROPA 38. As a result, and in consideration of the existing development adjacent to the woodland and Lower Rambo Creek corridor, we have applied a recommended 10 m buffer to the woodland. As illustrated in **Figure 5**, there are pre-existing disturbances such as residential housing, parking lots and buildings within this recommended buffer. As such, the buffer applies to areas without pre-existing disturbance in order to prevent potential adverse effects to habitat and ecological function (though limited) that the woodland and creek corridor provides in the urban setting.

The buffer recommendation can be further assessed at the site specific development application stage to observe their extent is sufficient so they can perform their intended function in light of the potential negative impacts associated with the adjacent development or site alternations. Additionally, other measures such as vegetated buffers or permanent fencing to mitigate potential negative impacts should also be determined at the site specific development application stage.

With respect to the Lower Hager Creek and Lower Rambo Creeks, they are under the jurisdiction of the City and are not subject to the CH regulation. New development adjacent to watercourses will be subject to a setback from the stable top of bank, the flooding hazard and/or meanderbelt allowance (whichever is greater) associated with the watercourse. The location of the stable top of bank, flooding hazard and/or meanderbelt allowance width shall be determined by the City in conjunction with CH at the

site specific development application stage. For the delineation of flooding hazards, refer to the February 25, 2019 Flood Hazard and Scoped Stormwater Management Assessment prepared by Wood, for the Burlington GO and Downtown Mobility Hubs.

The recommended buffer applies to areas without pre-existing disturbances or restoration and enhancement areas identified during the site specific development stage in order to prevent potential adverse effects to natureal features and their ecological function (though limited). It is recommended that the proposed buffers be further assessed at the site specific development application stage to observe their extent is sufficient.

In their current state, the buffer areas consist of low-quality habitat and contain invasive species as a result of pre-existing disturbances within the Study Area. Enhancement activities within the buffer areas will generally have the effect of increasing the amount of available habitat and overall wildlife corridor, while reducing the erosion potential associated with the Lower Rambo and Hager creeks. In addition, this naturalized, vegetated buffer will provide protection to adjacent natural features through filtration of overland flows for both watercourses, and protection from edge effects to the woodland. As the proposed buffer enhancements will not only increase the overall quality of available habitat within the buffer, but also the quality and protection of both aquatic and terrestrial habitat within the adjacent natural features, the intensification of redevelopment limit as shown, with minimal encroachment into the buffer areas, should not result in negative impacts to the adjacent natural features.

Buffer enhancement plantings are to be detailed in the preliminary Landscaping and Planting Plan, described below.

To improve the aquatic function of the watercourse within the Study Area, the following enhancements with associated ecological benefit should be considered during the site specific development stage:

- Native Riparian Plants:
    - Improves corridor function and linkage between existing areas of natural cover;
    - Improves natural cover for wildlife movement and plant dispersal;
    - Contribution of resources to stream biota (i.e. nutrients and shade);
    - Moderation of water temperatures and flow;
    - Sediment load buffering;
    - Bank stabilizations; and
    - Removal of invasive species.

- Implement habitat structures such as basking logs, brush piles, raptor poles etc.:
    - Promotes wildlife diversity by implementing several habitat elements; and,
    - Maximizes potential for wildlife passage, forage, residency, hibernation, and breeding habitat.

## 9.2 Landscaping and Planting Plan

The proposed intensification of redevelopment plan may require the potential removal of select trees, shrubs, wildflowers and wild grasses and are limited to the Conceptualized Plan illustrated on **Figure 5**.

As a result, a Landscaping and Planting Plan is required to off-set proposed vegetation removal as a mechanism to enhancement and mitigate potential impacts to natural areas, where possible. Compensation plantings of trees are generally based on the number of removals required to facilitate construction of the development. The exact number of compensation plantings and locations is generally determined at the site specific development application stage. It was identified by the City that, given the densities and urban nature of the development on many downtown sites, it may be difficult to achieve compensation plantings on site for many developments. The Landscaping and Planting Plans should include, but is not limited to:

- Identifying strategic areas on publicly owned lands and recommended approaches to improving overall tree canopy in urban areas;
- A mix of native deciduous and coniferous trees and shrubs throughout the redevelopment and buffer areas;
- Sodding within the residential portions of the redevelopment areas; and
- A native seed mix recommended by suppliers for enhancement within buffer areas and publicly owned lands.

The following monitoring and maintenance measures may also be recommended for both the buffer and enhancement areas:

- Removal of invasive tree and shrubs (i.e., buckthorn, garlic muster, Japanese knotweed), where applicable;
- Watering and weeding of newly planted areas as required for proper establishment of plantings; and
- Replacement of dead material from previous year's planting.

## 9.3 Integrated Stormwater Management Plan and Low Impact Design

Effective stormwater management (SWM) measures are required for all Environmental Impact Studies within the City. For detailed results as they relate to the Integrated Stormwater Management Plan and Low Impact Design (LID), refer to the February 25, 2019 Flood Hazard and Scoped Stormwater Management Assessment prepared by Wood, for the Burlington GO and Downtown Mobility Hubs. A summary of the aforementioned as it relates to the Integrated Stormwater Management Plan and LID is provided below.

The Lower Hager and Lower Rambo creek systems have not been historically regulated by CH from an operational perspective. Likewise, spill impacts have not historically been considered as regulated areas, but will be further evaluated through the Flood Hazard Study. As such, development within the

identified hazard limits could still potentially proceed; notwithstanding, flood management measures should be implemented for proposed developments within these hazard areas (both riverine, spill, urban/overland flood hazard zones). Building flood-proofing measures (both passive and active) should be implemented accordingly in these areas while opportunities for flood storage and diversions should also be considered, if feasible. Similarly, opportunities to revise roadway grading or provide additional outlet capacity should be considered at identified sag points.

In addition to the preceding, it is expected that developments that involve an increase in impervious coverage would incorporate on site quantity controls to observe that there is no increase in peak flows to downstream receivers. Opportunities for shared or communal quantity control features would need to be reviewed in conjunction with proposed area plans. This includes the implementation of LID Best Management Practices (BMPs) for roadway reconstructions, consistent with the "Green Streets" approach. LID BMPs can be implemented as part of the overall streetscaping design, including surface features (bioswales and bioretention areas, soil retention cells/tree planters) and sub-surface features (exfiltration pipes and storage chambers). These measures would benefit both water quantity, quality and water budget/infiltration/erosion.

The following recommendations for stormwater management quantity and quality control are to be considered during the site specific development application stage:

- Post to pre peak flow control (2-year through 100-year) for areas discharging directly to creek systems;
- Over-control (100-year post to 5-year pre) of peak flows for areas connecting to storm sewers or where major system is constrained. Additional over-control may be warranted where the current modeling results indicate storm sewer capacity is less than 5-year storm event standard;
- Utilize existing hydrologic/hydraulic modelling tools to verify effectiveness of site quantity control strategies;
- Implement standard erosion control measures (24-hour extended detention of 4-hour 25 mm storm event), potentially in combination with LID BMPs for the overall SWM strategy. Best efforts are to be considered where it can be demonstrated that the above cannot be reasonably achieved.
- Enhanced (80% average annual TSS for all impervious areas; and,
- Review opportunities for synergies with other studies (Stormwater Quality Control Plan for Downtown) and road reconstruction projects in particular ("Green Streets").

It is also recognized that the City is currently in the process of reviewing and updating its Stormwater Management Design Policies and Guidelines. As a result, additional stormwater management requirements, particularly with respect to climate change, erosion control, and water balance/infiltration should be considered for future developments.

## 9.4 Wildlife Impact Mitigation Plan

Strategies to mitigate impacts to general wildlife prior to and during construction are proposed. These may include (but are not limited to):

- Clearing trees and vegetation outside the breeding bird season (April 1 to August 31). Should any clearing be required during the breeding bird season, nest searches conducted by a qualified person should be completed 48 hours prior to clearing activities. If nests are found, work within 10 m of the nest should cease until the nest has fledged. If no nests are present, clearing may occur. This is in accordance with the federal *Migratory Birds Convention Act*;
- Schedule vegetation clearing and grading activities to avoid disturbance to sensitive wildlife species where possible;
- Where possible, maximize the distance of construction equipment used from the woodland edge to avoid disturbing wildlife;
- Limit the use of lighting where possible. Avoid light effects entering the woodland (eliminate light trespass) where possible;
- Installation of wildlife exclusion fencing and escape routes, which direct wildlife away from the construction area and to more suitable habitat;
- Visual monitoring for wildlife species and avoidance where encountered if possible;
- If necessary, have a qualified biologist monitor construction in the areas of potential wildlife habitat. If wildlife is found within the construction area they will be relocated to an area outside of the development into an area of appropriate habitat, as necessary;
- Construction crews working on site should be educated on local wildlife and take appropriate measures for avoiding wildlife; and
- Should an animal be injured or found injured during construction they should be transported to an appropriate wildlife rehabilitation centre.

Following the construction of buildings, mitigation measures that can be incorporated into the design of a proposed building in an attempt to reduce potential bird strikes have been identified in the City of Toronto's Bird-friendly Development Guidelines. Examples of such measures recommended for incorporation into the design of the proposed building which render glass more visible to avian wildlife include:

- Applying firms or decals on glass;
- Installing internal screens in windows;
- Voiding the use of internal lights when commercial operations are not active;
- Directing external lights downwards and turning them off when not in use (except for security and safety purposes); and
- Using motion sensors on the safety and security lighting.

While collisions cannot be avoided entirely, it is not anticipated that bird strikes will significantly impact bird populations in the area. Through the implementation of measures such as those listed above, the potential for bird strikes can be reduced through building design and operational control measures. The City of Burlington is currently developing Bird Friendly Guideline to require that buildings are designed to incorporate bird friendly design options versus this being a post construction requirement. In keeping with the MNRF EcoRegion Criteria Schedule 7E, the City's guidelines will also require buildings within five (5) kilometres (km) of the Lake Ontario Shoreline to implement bird friendly designs in order to protect migratory birds (MNRF 2015).

Some of the many enhancements options to bird habitat to be considered during the site specific development application stage are:

- Providing habitat to support life processes (e.g. nest boxes, perches, etc.); or
- Provide an Organic Growers Supply (OGS) approved seed mix for pollinators to enhance and support life processes which, in turn, will serve as a mechanism to create habitat for other taxon (i.e. Odonata).

Enhancements can be designed and discussed in consultation with the City during the site specific development application stage.

## 9.5 Erosion and Sediment Control Plan

Construction activity, especially operations involving the handling of earthen material, dramatically increases the availability of sediment for erosion and transport by surface drainage. In order to mitigate the adverse environmental impacts caused by the release of sediment-laden runoff into receiving watercourses, measures for erosion and sediment control are required for construction sites. This is an extremely important component of land development that plays a large role in the protection of watercourses and aquatic habitat.

Control measures that are appropriate for the erosion potential of the site should be selected. These control measures should also be implemented and modified on a staged basis to reflect the site activities. Furthermore, their effectiveness decreases with sediment loading and therefore, inspection and maintenance are recommended.

In addition, an Erosion and Sediment Control Plan should be developed as part of the site specific development application for the proposed redevelopments. The plan may include, but is not limited to, installation of geotextile silt fences, rock check dams, ditch checks, mud mats, temporary sediment ponds, designated topsoil stockpile areas, and cut-off swales and ditches to divert surface flows to the appropriate sediment control area; with provisions for re-vegetating the area as soon as construction is completed. More specifically, the plan may include the following measures:

- Standard duty silt fencing (OPSD 219.110) and/ or other equivalent erosion and sediment controls should be installed around the perimeter of the work area to clearly demarcate the development area and prevent erosion and sedimentation into adjacent habitats. Erosion and sediment control measures should be monitored regularly to ensure they are functioning properly and if issues are identified they should be dealt with promptly;
- Stockpiling of excavated material should not occur outside the delineated work area. If stockpiling is to occur outside of this area, silt fencing should be used to contain any spoil piles to prevent sedimentation into adjacent areas. Further, stockpiling of excavated materials will not occur within 30 m of watercourses; and
- A spill response plan should be developed and implemented as required.

## 9.6 Environmental Monitoring Plan

The Environmental Monitoring Plan (EMP) should be carried out through the duration of construction activities on-site to ensure that the erosion and sediment control measures operate effectively and to monitor the potential impact, if any, upon the natural environment. The duration of construction is defined as the period of time from the beginning of earthworks until the site is stabilized. Site stabilization is defined as the point in time when the roads have been paved, buildings have been built, lawns have been sodded and restoration plantings have been completed.

The EMP should consist of monitoring the erosion and sediment measures and the restoration/compensation plantings. Erosion and sediment control measures should be regularly monitored and may require periodic cleaning (e.g. removal of accumulated silt), maintenance and/or reconstruction. Inspections of the erosion and sediment controls on the construction site should be undertaken by a certified sediment and erosion control monitor. If control measures are damaged and/or not functioning as originally intended they should be repaired and/or replaced promptly. Site inspection staff and construction managers should refer to the *Erosion and Sediment Control Inspection Guide* (2008) prepared by the Greater Golden Horseshoe Area Conservation Authorities. This guide provides information related to the inspection reporting, problem response and proper installation techniques.

The EMP should be implemented during active construction periods in the redevelopment areas with the following frequency:

- On a bi-weekly basis; and/or
- After every 10 mm or greater rainfall event.

Restoration planting and protected vegetation areas will require periodic monitoring to observe that they are not impacted by adjacent development. Should impacts be observed, necessary steps should be taken to observe that the impacted vegetation is either restored or replaced.

Vegetation communities should be monitored for vegetation compositions and spatial boundaries. This monitoring data will be useful in detecting changes resulting from natural succession, maintenance, restoration & enhancement activities, as well as impacts from development activities.

The ELC system is a standardized vegetation classification system for monitoring vegetation community composition, spatial boundaries and impacts from humans. This approach to mapping vegetation communities should form part of the EMP and can be completed through field surveys and/or aerial imagery interpretation, with the purpose of documenting:

- NHS-Urban Interface Integrity;
- Ecosite Description;
- Boundary Integrity;
- Canopy Health;
- Native Communities & Species Diversity; and
- Invasive Plant Species.

Wildlife monitoring is also recommended and would be conducted concurrently with vegetation monitoring activities. As a result, it is recommended that the EMP include, at a minimum, a commitment to undertake breeding bird and amphibian call surveys (where appropriate). These two wildlife groups are easily monitored and sensitive to human disturbances and changes in habitat.

The purpose of the recommended vegetation and wildlife monitoring is to detect potential changes in habitats, plants and wildlife species compositions over time. Acknowledging a natural system is dynamic, and will vary over time, the monitoring program should seek to document a range of changes in the system; including:

- Existing natural habitat maintenance requirements (e.g. invasive species removal, etc.);
- Successional changes in habitat composition; and,
- The success of restoration and enhancement activities.

The City of Burlington is also currently in the process of completing a Stormwater Quality Control Plan for the Downtown Area, which overlaps with a portion of the Downtown Mobility Hub Study Area. The recommendations and proposed measures from that study should be considered as part of the overall quality control strategy for new developments in the Downtown Mobility Hub and incorporated in the EMP.

As part of the site specific development application stage, it is recommended that the applicant work with the City (and other agencies as determined by the City) to develop an approved site specific EMP.

# 10.0 Summary

This Scoped EIS was prepared in support of future redevelopment and intensification in association with the City's Downtown Mobility Hub. The TOR for this Scoped EIS was developed in consultation with CH, the Region and the City. The findings of the biophysical inventory, which consisted of secondary source reviews and comprehensive field studies, are presented in this Scoped EIS.

The majority of the Study Area consists of pre-existing developed land uses. As a result, the 2017 natural heritage inventories were limited to the Lower Rambo Creek and its associated woodland as well as the Lower Hager Creek. The woodland associated with the Lower Rambo Creek was assessed as significant under the ROPA 38 (Section 277), as well as candidate SWH for amphibian breeding habitat and bat maternity colonies with the potential to support SAR bats. As a result, the woodland as well as the aforementioned habitats, were included in the Regional Natural Heritage System in accordance with ROPA 38 (Section 115.3). A total of 10 common bird species were observed during field studies, each of which are considered *Secure* or *Apparently Secure* in Ontario. A total of 17 botanical species were observed, eight of which are native and considered *Secure* of *Apparently Secure* in Ontario. In addition, no significant wildlife habitat was observed within the Study Area. The Lower Rambo and Hager creeks each exhibit signs of degradation. As a result, if left unmitigated, landscape alterations have the potential to compromise the existing creek banks, including the existing bank erosion protection infrastructure.

Based on the proposed redevelopment areas associated with the Downtown Mobility Hub, potential impacts of development may include tree and vegetation removal, diversion of surface water flows, sedimentation, and loss of potential wildlife habitat. These potential impacts can be avoided or minimized by implementing the mitigation, enhancements, restoration, and management measures described in this report.

# Appendix A

## *Terms of Reference*

March 6, 2017 (Updated April 25, 2017)
Our File: TPB178008-04

City of Burlington
426 Brant Street
Burlington, ON L7R 3Z6

Attention: Phillip Caldwell, MCIP RPP, Senior Planner

Dear Sir:

**Re: Scoped Environmental Impact Studies Work Plan, Mobility Hubs Planning**

Brook McIlroy Inc.'s (BMI) proposal for Consulting Services for the City of Burlington Mobility Hub Planning (December 12, 2016) outlined a Work Plan that included departures from the Terms of Reference (TOR) agreed to between the City and Conservation Halton and Region of Halton and outlined in RFP-239-16 (November 17, 2016). The changes to the TOR were proposed by Amec Foster Wheeler and Dillon Consulting in order to provide cost efficiencies to accommodate the City's project budget, and related specifically to the *Scoped Environmental Impact Studies* as defined in Appendix G *Environmental Impact Study Preliminary Guidance For Study Components and Technical Requirements* in the RFP. The intent of this letter is to more clearly communicate the changes to the TOR for the Environmental Impact Study presented in BMI's December 12, 2016 proposal. It is intended that this letter and attachments are read in conjunction with BMI's December 12, 2016 proposal.

On February 14, 2017 staff from the City of Burlington, Conservation Halton, Amec Foster Wheeler and Dillon Consulting met to discuss the Work Plan for the Scoped Environmental Impact Study. The discussion focused on identifying the changes proposed to the TOR and the objective was to obtain agreement between the City, Conservation Halton and the BMI Team on the proposed Work Plan such that there was a consensus moving forward. In an effort to clearly and concisely summarize the proposed changes to the TOR, the original TOR have been modified and changes have been tracked. The changes proposed by Amec Foster Wheeler to *Section 6.0 Stormwater Management and Riverine Hazards* and by Dillon Consulting to *Section 5.0 Environmental Studies and Analysis* and *Section 7.0 Supplementary Information* have been integrated in Attachment A. As noted above, it is intended that this letter and Attachment A are read in conjunction with BMI's December 12, 2016 proposal. Further, Attachment A is intended to clarify our original proposal, not replace it – if the City perceives an inconsistency between the December 12, 2016 proposal and Attachment A, please bring it to the attention of the BMI Team.

Five (5) key study gaps related to *Stormwater Management and Riverine Hazards* have been identified and are summarized below. The proposed gap-filling approaches and study-risks related to potential out-of-scope work are discussed in Attachment A to this letter.

3215 North Service Road
Burlington, Ontario L7N 3G2
Tel +1 905 335 2353
Fax +1 905 335-1414
amecfw.com

Amec Foster Wheeler Environment & Infrastructure
Registered office: 2020 Winston Park Drive, Suite 700, Oakville, Ontario L6H 6X7
Registered in Canada No. 773289-9; GST: 899879050 RT0008; DUNS: 25-362-6642

1. Uncertainties remain on policy perspectives related to Regulatory flood control and specifically the Hager-Rambo Flood Control System. Conservation Halton agreed to review this matter further and advise on how the Authority will seek to apply policy. Background related to this issue is discussed in Section 6.3 a) x).

2. Flood risk in the Burlington and Downtown Mobility Hubs related to a potential breach of the Freeman Pond and/or West Hager Pond, two of the three flood control facilities that are part of the Hager-Rambo Flood Control System, is a potential gap. Amec Foster Wheeler has outlined preliminary assessments that are proposed and is expected to determine if additional study is required as part of the Mobility Hub Planning.

3. Flood spills have been identified in several locations along the Hager-Rambo Diversion Channel however the associated spill path(s) through the Burlington and Downtown Mobility Hubs and the potential impact on future development is a gap. Amec Foster Wheeler has outlined preliminary assessments that are proposed to be completed and are expected to provide 'high-level' guidance on the flood hazard associated with the spill(s). The level of flood risk prescription that can be obtained within the existing Work Plan scope is uncertain and additional study will be required. The limitations of the assessment are discussed in Section 6.3 a) x).

4. The Work Plan proposes a high-level risk assessment for erosion potential related to future development in the Mobility Hubs. Where erosion potential is determined to be 'low' and the Technical Advisory Committee (TAC) agrees that no further study is required, the proposed Work Plan will meet study objectives. If erosion potential cannot be satisfactorily screened by proposed Work Plan, study gaps may exist. Gaps relate to the potential need to establish erosion thresholds downstream of the Mobility Hubs, and the potential need to undertake continuous hydrologic simulations to complete an erosion duration analysis in support of establishing the criteria for future erosion control requirements. Section 6.2 e) (2) provides additional detail on the proposed approach.

5. Conservation Halton staff have noted they will consider regulating Lower Hager and Lower Rambo Creeks; staff to advise. No implications to the Work Plan are expected.

Additional comments from Conservation Halton (received via e-mail March 23, 2017, secondary comments received via e-mail April 20, 2017) have also been updated into the current revised work plan. To summarize the changes resulting from this additional round of comments:

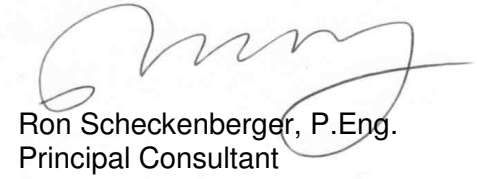
1. Page 6 of PDF (5.0 - Table A) – Aldershot has been revised to a "Yes*", based on the qualifiers and conditions outlined under the "*".
2. Page 10 of PDF (5.0 – Water Quality/Benthic Invertebrates) – Asteriks added for Burlington and Appleby Line.
3. Page 11 of PDF (5.0 – Stream/Drainage Corridor and Storm Sewer Outfall Assessment) Falcon Creek and Glen Wood Creek have not been included in the Table. Falcon Creek is not located within the Aldershot Mobility hub area, and Glenwood Creek has only a minor amount within the area. Qualifying wording has been added to the text that an assessment may be required if it is determined that there is any expected hydrologic impact to these features; if necessary this work would be beyond the current scope. Table B within Section 6.0 (Hydrologic Modelling Requirements) has been similarly updated.

4. Page 17 of PDF (6.2 e) 3) – Proposed Hydrology/Stormwater Management) – Revised wording to include assessment of *preliminary potential* flood mitigation controls in the event of spill. Any detailed measures or assessments would be beyond the scope of the current study and are therefore not included.
5. Page 22 of PDF (6.3 a) x) – Hager-Rambo Diversion Channel & Flood Control System) – wording has been revised to clarify that the system to be assessed will include the channels between the ponds and the diversion channel (although spills will only be assessed at a high level, as noted in the revised terms of reference). This also assumes that the hydraulic models are readily available for these reaches in a usable state. Reference has also been included to the East Rambo Pond (it has been assumed that this is what was being referred to, rather than the East Hager Pond, as no such feature is known to exist beyond the QEW/North Service Road drop structure, which has no storage or attenuation function).

We trust the foregoing is consistent with our discussion on February 14, 2017 and provides an adequate basis upon which to advance the Work Plan for the Scoped Environmental Impact Studies.

Sincerely,

Amec Foster Wheeler Environment & Infrastructure
a Division of Amec Foster Wheeler Americas Limited



Per: Ron Scheckenberger, P.Eng.
Principal Consultant

Per: Matt Senior, M.A.Sc., P.Eng.
Project Engineer

AB/ls/MJS/RBS

c.c. David Sajecki, Brook McIlroy Inc.
Daniel Bourassa, Dillon Consulting
Allen Benson, Dillon Consulting
Justine Giancola, Dillon Consulting
Jeff Hirvonen, GeoProcess

# APPENDIX G

# ENVIRONMENTAL IMPACT STUDY
# PRELIMINARY GUIDANCE FOR STUDY COMPONENTS AND TECHNICAL REQUIREMENTS

**DISCLAIMER**

**Please note that information contained in this Appendix has been provided by partner agencies to the City of Burlington. Given the urban context of the Mobility Hub study areas, additional scoping/elimination of study requirements identified within this Appendix will be explored with the chosen project consultant to ensure study's focus is less on characterization of existing features and more on restoration and enhancement opportunities.**

**The chosen project consultant will be required to submit a work plan for the Environmental Impact Studies upon awarding of the project contract which will identify an environmental scope of work reflective of the existing urban context of the Mobility Hub study areas and based on the consultant's own past experience as well as other best practices for similar studies. The project consultant's proposed work plan will be evaluated by the City of Burlington and partner agencies through a technical advisory committee (TAC)**

---

## 1.0 STUDY PURPOSE

The purpose of Environmental Impact Studies in each Mobility Hub area is generally to:

- Inventory, characterize, and assess existing environmental conditions including natural hazards, natural heritage and water resource features and areas;
- Provide recommendations for the protection, restoration, and enhancement, where feasible, of natural heritage, and water resource features and areas;
- Provide recommendations for management and mitigation of natural hazard and other constraints, where feasible;
- Provide sufficient detail to support the designation of the Natural Heritage System (NHS), through refinement of the Regional Natural Heritage System (RNHS), as well as identifying areas for future development;
- Refinement of the Regional Natural Heritage System for the Study Area and development of a Natural Heritage System Restoration and Enhancement Plan to be implemented through redevelopment and private and public land stewardship as part of an innovative Environmental Management Strategy for each study area;
- Conformity with applicable Provincial, Regional, and City land use planning policies, including Section 145(9) of the Regional Official Plan, and applicable Conservation Halton Policies;

- Establish procedures for monitoring water quality and quantity before, during and after development; and
- Other objectives and goals as proposed by the project consultant in their final work plan.

## 2.0 STUDY PROCESS/PHASING

The Environmental Impact Studies should be broken into the following phases to allow for feedback from relevant technical reviewers/agencies:

- Phase 1 – Background Review and Characterization
- Phase 2 – Analysis
- Phase 3 – Management Strategy Development
- Phase 4 – Implementation and Monitoring

The Environmental Impact Studies will both inform and be informed by the land use scenarios developed as part of the Area Specific Planning process. As a result, study phases should be prioritized based on the information required to inform the delivery of stage 1 and stage 2 project deliverables as established in the Terms of Reference and may include the undertaking certain phases concurrently.

The final Environmental Impact Studies should be completed prior to the approval of Area Specific Plans.

## 3.0 ADVISORY COMMITTEES/MEETINGS

Work undertaken as part of the Environmental Impact Studies will be reviewed by a technical advisory committee (tac) with representation from the project consultant, the City of Burlington, Region of Halton and Conservation Halton.

## 4.0 STUDY CONSIDERATIONS

**Urban Context –** Environmental Impact Studies/Sub-Watershed Studies such as those required within each Mobility Hub area are typically conducted in undeveloped greenfield settings. The existing urban nature of all four Mobility Hub study areas should be considered when undertaking the Environmental Impact Studies.

**Innovative Implementation Strategy –** Given the urban nature of the Mobility Hub study areas, the Environmental Management Strategy prepared at the conclusion of the Environmental Impact Studies should consider innovative implementation tools not typically considered in relation to Area Specific/Secondary Plans in greenfield areas. As greenfield development will not be the primary mechanism relied on for implementation, policies targeted primarily at guiding future development will not be the best way to fulfill the majority of the recommendations. Redevelopment, public land stewardship, public works relating to natural hazard mitigation and stormwater infrastructure "greening", targeted ecological restoration projects and community education and stewardship may be

more relevant tools in these studies. As a result, the studies should explore utilizing a broadened set of implementation tools to reflect the urban context of these areas.

## 5.0 ENVIRONMENTAL STUDIES AND ANALYSIS

**Table A Environmental Studies and Analysis**

| Required Environmental Studies/Analysis | Aldershot | Burlington | Downtown | Appleby |
|---|---|---|---|---|
| Hydrogeologic Assessment following CH Requirements for Completion of hydrogeological studies to facilitate Conservation Halton's reviews http://www.conservationhalton.ca/policies-and-guidelines | Yes* | No* | No* | No* |
| Identification of the extent of Hazard lands within the hub study area in accordance with MNRF guidelines and Conservation Halton policy and guidelines http://www.conservationhalton.ca/policies-and-guidelines. | Yes* | Yes* | Yes* | Yes* |
| Flooding Hazard Assessment | Yes | Yes | Yes | Yes |
| Erosion Hazard Assessment | Yes | Yes | Yes | Yes |
| Coastal hazard assessment | | | Yes | |
| Natural Heritage Studies/ System (see Table D in 7.0) | Yes* | Yes* | Yes* | Yes* |
| Species at Risk Consultation with the Ministry of Natural Resources and Forestry (MNRF) | Yes | Yes | Yes | Yes |
| Hydrologic/hydrogeologic evaluation and water balance for the wetlands | Yes* | | | |
| Stream classification, fish community inventory and fish habitat assessment | Yes | Yes | Yes | Yes |
| Water quality evaluation (including water chemistry and benthic invertebrates) | Yes | Yes | Yes | Yes |
| Stormwater management mitigation plans | Yes | Yes | Yes | Yes |

Please note that where **Yes*** is indicated please refer to the proceeding Notes section below.

**Table A** Notes:

- Hydrogeologic Assessment: For the Burlington Mobility Hub, Downtown Mobility Hub and Appleby Mobility Hub the hydrogeologic assessment will rely on available borehole information to screen for the feasibility and provide future design guideance (where

proposed) for subsurface green infrastructure (LID's). The basic information collected from existing available borehole data would include groundwater levels, soils types, infiltration rates, etc. For the Aldershot Mobility Hub, the following is included in the Work Plan:

- Review CH information including regulations mapping
- Review 1200 King Road data (spring and summer)
- Conduct a field reconnaissance to observe any changes and possible points of water discharge (either surface and / or groundwater)
- Establish micro-topography to define surface water catchment zone
- Develop details of a future monitoring assessment program

With regard to the foregoing, it is expected that following the execution of this scoped investigation there would be a better understanding of the composition and function of the wetland including its possible zone of influence on surface water contribution. This understanding will then inform the potential extent of the constraint, while providing direction on water management strategies and also the form of future studies.

- Identification of Natural Hazard lands: To determine the hazard limit associated with valleys (defined and undefined), both the flooding and erosion hazards are to be considered. The hazard limit is set by the greater of the flood or erosion hazard, plus the applicable development setback based on the appropriate policy and regulatory requirements. It should be noted that additional buffers and/or corridor widths may be needed in consideration of other factors introduced by the study assessment including, but not limited to, the protection of ecological and hydrologic functions such as critical function zones and impacts to adjacent lands.

- Natural Heritage Studies/ System: Natural heritage studies are completed in order to identify and further delineate the existing Regional Natural Heritage System (RNHS). Natural heritage investigations/studies will be conducted while using the guiding policy framework of the RNHS within the Regional Official Plan Amendment No. 38 (ROPA 38). They will provide an appropriate level of detail for the planning analyses such that the components of the RNHS (Key Features; Enhancement Areas and Linkages) can be identified and associated functions characterized. Once the RNHS and its key features are identified and delineated potential impacts of the proposed Secondary Plan and restoration or enhancement opportunities can be presented. Standard field studies include, but are not limited to, Ecological Land Classification (ELC), wetland delineation (using ELC), vegetation surveys, breeding bird surveys, and amphibian breeding surveys. It is noted that for the next stage of study OWES will be required.

Understanding the urban nature of the Mobility Hub study areas and the importance of interconnecting the core areas and key features of the RNHS, there will be a focus on identifying opportunities to use a combination of ecological restoration, natural hazard mitigation (excluding structural technicques), stormwater infrastructure, parks, etc. to establish both active and passive City of Burlington - Mobility Hub Planning Brook McIlroy/ connections with the natural environment. Where this may not be possible, other options such as community education and stewardship programs will be proposed, to establish this connection between residents and the environment.

A Natural Heritage study for the Aldershot GO Train Station lands as well as those lands immediately adjacent has recently been initated. Therefore, the study requirements for those portions of the study area with the Aldershot Mobility Hub area may already be underway and could inform/suppliment additional environmental work required in the study area. Please note that there are additional natural areas within the study area that will need to be assessed using the same criteria.

Based on consultation with CH Planning Ecologists, the following terrestrial field studies will be required for each of the Mobility Hubs. The table below should be read concurrently with ***Attachment A***, Figures 1 through 4, which illustrate the portions within each of the Mobility Hub study areas where field studies will occur.

| Terrestrial Field Studies | Aldershot | Burlington | Downtown | Appleby |
|---|---|---|---|---|
| Ecological Land Classification | ✓ | ✓ | ✓ | ✓ |
| Wetland Delineation | ✓* | | | ✓* |
| Vegetation Inventory | ✓ | ✓ | ✓ | ✓ |
| Breeding Bird Surveys | ✓ | ✓ | ✓ | ✓ |

**Presence of wetlands to be confirmed through ELC.*

A more fulsome list of the terrestrial and aquatic natural heritage studies that may be considered has been included in Section 7.0, Table D of this Appendix.

- Species at Risk: Species at Risk (SAR) listed as Endangered or Threatened under *Ontario Regulation 242/08* are afforded both species and habitat protection under the Ontario *Endangered Species Act* (ESA), 2007. The MNRF will be consulted to request relevant SAR occurrence records pertaining to each of the four Mobility Hub study areas. This information will be used to help identify potential SAR and SAR habitat within each of the study areas. Although incidental observations of SAR and/or potential SAR habitat will be noted during field surveys, it is important to note that this work plan does not include any work that may be required under the ESA (i.e., additional surveys, permitting, etc.).

Should species-specific surveys or permitting be required by the MNRF, Dillon has qualified staff (e.g., qualified Butternut Health Assessors, etc.) that can provide the City with these services, as required (Note: SAR mapping will not be on any publicly available mapping).

- Stream Classification: For each of the four Mobility Hub study areas, stream classification of existing watercourses will be established to determine either the required and/or appropriate setbacks for protection from proposed development. Required setbacks are established by CH through a number of policies differentiating between major and minor valley systems. Appropriate setbacks are established by using all available information including sensitivity of features, background reports (i.e., Sustainable Halton reports, etc.), experience in similar situations and potential impacts of proposed adjacent land uses in order to protect the form and function of the watercourse features (Note: the greater of the required or appropriated setback will be identified as a development constraint). Potential restoration and enhancement opportunities will also be considered wherever possible. Stream classification will rely on existing information (e.g., fish community sampling etc.) where available to determine stream type (permanent, intermittent, ephemeral), thermal regime, and whether streams provide suitable fish habitat. Other parameters to consider when determining suitability for fish habitat include riparian and in-stream cover, stream morphology, nutrient inputs etc. Where no information is available site visits may be required to collect information on stream characteristics, fish community sampling, thermal regime, etc. TAC to be included on site walks involving consideration of classification of watercourses.

- Water Quality/Benthic Invertebrates: In two (2) recent/ongoing Secondary Plans (Halton Hills/Mississauga), Amec Foster Wheeler consultatively worked with CH and the area municipality to defer the water quality (chemistry) and benthic invertebrates investigations. The rationale, which was ultimately supported by CH, was based on the perspective that the information collected rarely, if ever, influences land use decisions. Stormwater Management practices need to (most often) meet the highest standards, therefore water chemistry/benthic invertebrates also does not drive the level of protection for the receiving systems (watercourses or Lake). On this basis, the main utility of these data comes forward during the monitoring phase following development. In order to determine the efficacy of the various management practices in mitigating the impacts of development, baseline monitoring (water chemistry/benthic invertebrates) is considered useful and important. Notwithstanding these data are most appropriately collected closer towards the period of planned land use change. Therefore, based on the foregoing, as part of this task, it is proposed to develop the scope of an appropriate water

quality and benthics sampling program for each Mobility Hub to be executed as part of a future investigation.

Based on consultation with CH Planning Ecologists, the following aquatic field studies will be required for each of the Mobility Hubs. The table below should be read concurrently with ***Attachment A***, Figures 1 through 4 which illustrate the portions within each of the Mobility Hub study areas where aquatic studies will occur.

| **Aquatic Field Studies** | **Aldershot** | **Burlington** | **Downtown** | **Appleby** |
|---|---|---|---|---|
| Stream Classification | ✓ | ✓* | ✓* | ✓* |

**Daylighted portions of the Lower Rambo Creek, north of the Centennial Pathway and isolated portions in the Burlington and Appleby Hubs to be included in assessment. Locations of daylighted portions to be confirmed by CH.*

- <u>Stream/Drainage Corridor and Storm Sewer Outfall Assessment:</u> The various open watercourse corridors in the respective study areas provide important functions for the natural environment, as "natural" conveyance infrastructure (drainage system), riparian habitat and socially by preserving and enhancing open space. In order to continue these functions in the long term, it is important to determine current functionality and from this establish means for enhancement/restoration in the context of future development concepts. The primary corridors proposed to be assessed as part of this study include:

| | |
|---|---|
| Aldershot * | Grindstone Tributary, West Aldershot Creek, LaSalle Creek, Forest Glen Creek, Teal Creek |
| Burlington | East/ West Rambo Creek and Roseland Creek |
| Appleby | Appleby Creek, West Sheldon Creeks, and Shoreacres Creek |
| Downtown | Lower Hager and Rambo Creeks |

* *Additional assessments <u>may</u> be required for Falcon Creek and Glenwood Creek if it is determined* that these receivers *will experience hydrologic change due to the proposed Mobility Hubs development. This additional work would be determined pending discussions through the Technical Advisory Committee and review of the sewershed mapping.*

The scope of this review will include field reconnaissance by a Drainage Engineer, Aquatic Ecologist and a Fluvial Geomorphologist. Based on the visual review, the following will be identified and mapped:

- Bank treatment/areas for stabilization
- Aquatic/riparian habitat
- Stream stability

- Vegetation
- Storm outfalls and neighbouring land uses.

The foregoing approximate mapping exercise will then be used as a base for developing a framework for a restoration/rehabilitation plan for each system. Each watercourse will also be investigated for mitigation or rehabilitation opportunities, with the objective of maximizing the remaining natural potential of the watercourse's form and function (where feasible). This will include a rapid investigation of reach-wide channel stability and identification of causes of instability, where present. For areas where opportunities for mitigation or improvement exist, high level recommendations will be proposed to address key imbalances between the conveyance of flow and sediment. In development of these recommendations the Study Team Fluvial Geomorphologists will work closely with the Study Team Water Resources Engineers to ensure conceptual plans are feasible and sustainable in the long term.

In addition, one of the considerations cited in the TOR relates to potential "day lighting" of enclosed watercourses. These opportunities and their implications on area infrastructure will be reviewed at a high-level as part of this task.

# 6.0 STORM WATER MANAGEMENT AND RIVERENE HAZARDS

The following sections are intended to provide an overview of select components that are to be assessed as part of the Environmental Impact Studies. It is also to identify the minimum requirements for the study. The project consultant will be required to prepare a final work plan to further detail and refine the information set out in the Request for Proposal and associated appendices. The background and characterization, analysis and reporting work must be completed to the satisfaction of the advisory committee.

It should be noted that although each study component has been discussed separately, all components are to be looked at comprehensively and in an integrated manner. This will also help to ensure that the objectives that have been established for the study area have been met. All of the work described below is to be completed by a licensed professional (Engineer and/or Geoscientist as appropriate. All final reports and maps are to be signed and sealed.

### 6.1 Existing Hydrology

The project consultant will be required to:

a) Undertake a review of previous subwatershed and stormwater management studies, aerial photos, topographic base maps, flow records, high water marks, precipitation records, and existing "Permits To Take Water" within and upstream of the study areas;

b) Develop and verify physical feature mapping of the subwatersheds, including subwatershed boundaries, upstream catchment areas, watercourses, drainage swales, wetland features, undrained depressions, other drainage improvements, land use, levels of directly and indirectly connected imperviousness, existing stormwater management features, etc. and ensure these are represented in the models;

c) Refine or develop (where required) hydrologic models to be used for each subwatershed area. Refer to Table 1.1 provided below, which summarizes the status of available modelling. The models should be deterministic hydrologic models, capable of continuous simulation (if required, see (i).) with strong physical representation of surface runoff and infiltration, channel storage, base flows, and for the Aldershot mobility hub, a more detailed understanding of the surface/groundwater interaction;

    i) Continuous simulation has not been included in the proposed Work Plan. See Section 6.2 e) (2) for implications to the erosion assessment.

d) Document and justify hydrologic modeling parameters;

e) Determine sub-basins to establish nodes at points of interest;

f) Model selection, parameterization, and extent are to be approved by the advisory committee;

i) The Work Plan assumes the existing models identified in Table B are approved. Model parameterization will be reviewed to ensure previous assumptions are supportable. Adjustments to model discretization/parameterization are expected within Mobility Hub study areas, however watershed wide re-parametrization of existing models has not been included, nor is it expected to be required.

g) Calculate unitary discharge rates at each key node, complete comparisons to the previously calculated flows (where available) to validate modelled flow values;

h) Present the findings to the TAC and based on mutual discussions and agreements proceed to the next stage.

**Table B Hydrologic Modeling Requirements**

| Mobility Hub | Hydrologic Modeling Required | Available Information |
|---|---|---|
| Aldershot Mobility Hub* | Grindstone Creek (refinement of 1995 GAWSER model, with expansion of 2007 Waterdown Road interchange SWMHYMO model) | Grindstone Creek Subwatershed Study (Cosburn Patterson Wardman Ltd, 1995)<br><br>Indian Creek Grade Separation Design (<br>AMEC 2013)<br><br>Falcon Creek Hydrology and Hydraulics Study (Valdor, 2012) |
| | Creek West of LaSalle Park Road (Create new model) | Unavailable. New PCSWMM model proposed |
| | Teal Creek, Forest Glen Creek, LaSalle Creek, (refinement of PCSWMM model) | Class EA for Aldershot Community Stormwater Master Plan (AMEC, 2013) |

| | | |
|---|---|---|
| Burlington Mobility Hub | West Rambo Creek and Diversion (OTTHYMO refinement) | Technical Summary Updated Hydrology: Indian Creek, Hager-Rambo System, Roseland Creek (Phillips, 1997) |
| | East Rambo Creek (OTTHYMO refinement) | Technical Summary Updated Hydrology: Indian Creek, Hager-Rambo System, Roseland Creek (Phillips, 1997) |
| | Roseland Creek (refinement of SWMHYMO) | TRoseland Creek Flood Control Class EA (Philips Engineering Ltd, 2009) |
| Downtown Mobility Hub | Lower Rambo Creek (create model) | Unavailable. New PCSWMM model proposed |
| | Lower Hager Creek (create model) | Unavailable. New PCSWMM model proposed |
| Appleby Mobility Hub | Appleby Creek (GAWSER refinement) | Appleby Creek Floodline Mapping Update (EWRG 1997) |
| | Shoreacres Creek (refinement of GAWSER) | Shoreacres Creek Floodplain Mapping Update (EWRG 1997) |
| | Sheldon Creek (refinement of HSPF model) | Sheldon Creek Hydrologic and Hydraulic Study (DRAFT, AMEC Foster Wheeler, 2016) |

* *Additional hydrologic modelling <u>may</u> be required for Falcon Creek and Glenwood Creek if it is determined* that these receivers *will experience hydrologic change due to the proposed Mobility Hubs development. This additional work would be determined pending discussions through the Technical Advisory Committee and review of the sewershed mapping. An existing PCSWMM model is available for Glenwood Creek (Aldershot Community Stormwater Master Plan, AMEC 2013), while an existing GAWSER model is available for Falcon Creek (Falcon Creek Hydrology and Hydraulic Study, Valdor 2012).*

### 6.2 Proposed Hydrology / Stormwater Management

a) Develop model parameterization for the proposed condition hydrologic model based on the three land use scenarios. Obtain approval for model parameterization by the TAC.

b) Model future uncontrolled conditions for each of the three land use scenarios.

c) Identify downstream constrictions within the major and minor system drainage routes and assess the impact of the proposed development. See also Section 6.3 below.

d) Develop watercourse specific stormwater management strategies that achieve the following goals and objectives:

(1) To ensure new development does not increase the frequency and intensity of flooding, the rate of natural stream erosion or increase slope instability;

(i) See Section 6.2 e) (2) for considerations related to erosion control

(2) To ensure natural heritage features and areas, including their ecological and hydrologic functions, are protected from potential adverse impacts of development;

(3) To prevent accelerated enrichment and contamination of surface and groundwater resources from development activities;

(4) To maintain linkages and related hydrologic and hydrogeologic functions among groundwater features, and surface water features, where required as determined through the scoped hydrologic and hydrogeologic study; and

(5) To ensure that riparian rights of downstream landowners, specific to the use and enjoyment of water across their property is respected.

e) The effectiveness of stormwater management mitigation plans must be confirmed through model simulation results for peak flow control and erosion mitigation performance. The preferred plan must be tested relative to the municipal design storms and Hurricane Hazel Regional Storm Event, and two climate change hydrologic scenarios (as established in the Draft City-Wode Flood Vulnerability, Prioritization and Mitigation Study, Amec Foster Wheeler, November 2016), and the August 4$^{th}$, 2014 flood event. The following tasks shall be included:

(1) Utilize the results of the pre-development modeling to set targets and unitary discharge rates (paired storage and discharge values presented per impervious ha) at key locations. Provide preliminary sizing for stormwater management facilities;

(2) Determine whether erosion controls are required and provide technical justification for the selected level of control, in consultation with the TAC;

a) The Work Plan includes a preliminary assessment to identify the impacts on erosion potential related to the proposed land-use changes within the Mobility Hubs. 'Risk' will be established by:

(i) Completing a runoff volume impact assessment for the future land use scenarios based on the 25 mm Chicago 3 hour design event. Existing and future condition peak flows and channel velocities will also be considered.

(ii) Input from the fluvial geomorphologic assessment which will provide preliminary insight into the sensitivity of watercourse reaches within and

downstream of the Mobility Hubs. (e.g. highly armoured reaches represent a 'low' risk receiver)

b) Where erosion risk is considered 'low' by the TAC, no additional study will be required. Erosion control requirements for these areas will be approved by the TAC and may include: no erosion control, LID BMPs, extended detention based on current requirements outlined in the Stormwater Management Planning and Design Manual, MOE, 2003. Any emerging guidance will also be considered in consultation with the TAC.

c) Where erosion risk is not 'low' and the TAC determines a more rigorous assessment will be required to establish erosion controls; the scope for this work will be established by the TAC. Key scope gaps to complete a more detailed erosion assessment are considered to be 1. Establishing critical erosion threshold shear/flow; 2. Continuous simulation. Detailed erosion assessment is not included in the Work Plan.

(3) Determine whether post to pre-quantity control should be required for the Regional storm. The SWS must investigate and evaluate the potential risks and determine what level of control will be required. The analysis shall include the increase in risk to life (see qualifiers below) as well as the potential for flood risk to private, Municipal, Regional, Provincial and Federal property under Regional Storm conditions;

a) Risk to life will not be characterized through a detailed evaluation of depth and velocity. Flood impacts will be characterized by changes in water surface elevations, extents of flooding and hydraulic structure performance (i.e. overtopping frequency and depth). In the instance that the extents of flooding are predicted to meaningfully change, the impact and preliminary required mitigation controls will be identified for consideration by TAC as part of this study. Detailed measures or assessments are beyond the scope of the current study.

(4) Hydrologic model parameterization for impervious coverage to apply maximum potential impervious coverage based on proposed and existing zoning, and as established through the land use planning process. Planning policies will be required to ensure future development does not exceed the assumed maximum zoning imperviousness

(5) Assess the impact of the stormwater management strategies relative to creek peak flows and flow duration based on a design storm methodology. Present the hydrologic impacts of the proposed stormwater management strategies.

(6) Present the recommended stormwater management strategy. The conceptual design for the stormwater management facilities should include storage rating curves, facility locations, and outlets.

f) Identify opportunities to utilize Low Impact Development methods (LIDs), assess/quantify their feasibility and demonstrate compliance with the forthcoming MOECC Guidelines (anticipated to be released in Winter 2016/2017). Storm runoff should be treated via a multi-barrier approach, incorporating onsite, conveyance, end of pipe controls and LIDs to acceptable standards as determined in the MOECC's Stormwater Management Planning and Design Manual (2003) or more recent standard.

i) The Work Plan does not include any specific analysis/assessment to meet the anticipated update to the MOECC SWM Guidelines where the analysis/assessment is beyond that described by other tasks outlined in the Work Plan. The updated MOECC guidelines will be reviewed once available to determine if there is any impact to the Work Plan.

g) Hydrologic analyses shall be conducted for existing and future development conditions to determine pre and post-development flows and investigate the impact of post-development conditions on: flows, volumes, flood levels, channel erosion [see i) below] and base flows [see ii) below]. The subwatershed plans shall recommend an array of runoff control measures to be carried out in Secondary Plan and Subdivision Plan level studies to ensure that downstream peak flows are not increased, downstream channel erosion is not increased and that stormwater runoff is appropriately treated to meet water quality targets. The recommendations must be defined in sufficient detail to support completion of the subsequent secondary planning level studies.

i) Section 6.2 e) (2) for description of the erosion assessment included in the Work Plan

ii) Continuous simulation is not included in the Work Plan and as such, post-development impacts to baseflow will not be determined.

**6.3 Natural Hazards**

The study shall identify the extent of flooding and the limits of the erosion hazard lands within the study areas, in accordance with the Ministry of Natural Resources and Forestry (MNRF)'s Provincial Technical Guidelines and Conservation Authority direction.

To determine the hazard limit associated with valleys (confined and unconfined), both the flooding and erosion hazards are to be considered. The hazard limit is set by the greater of the flood or erosion hazard, plus the applicable development setback based on policy and regulatory requirements. Additional buffers and/or corridor widths maybe needed for

ecological and hydrologic purposes. The minimum setback is 15 metres from major valley systems such as Grindstone Creek, and 7.5 meters from minor valley systems.

a) Flood Hazards

Floodplain mapping refinements and/or generation (where watershed scale mapping and modeling is not available – as per the table below) are to be completed in accordance with MNRF recommendations based on the applicable Provincial Technical Guidelines (i.e., "Technical Guide – River & Stream Systems: Flooding Hazard Limit", Ministry of Natural Resources & Watershed Science Centre, 2002, "Technical Guide – Great Lakes, St. Lawrence River Shorelines, Flooding, Erosion and Dynamic Beaches", or updated current standard). Flood plain mapping must be refined/generated for the Mobility Hub study areas and for riverine flooding, a sufficient distance up and downstream to clearly characterize all hydraulic interactions and identify any future hydraulic impacts associated with development. The models should be detailed and flexible enough to evaluate modifications to the existing floodplains including realignment or changes to the corridor widths and profiles. The U.S. Army Corps of Engineers HEC RAS model is an acceptable tool for the hydraulic analyses.

Note: Provincial Technical Guidelines (i.e., "Technical Guide – River & Stream Systems: Flooding Hazard Limit", Ministry of Natural Resources & Watershed Science Centre, 2002 requirements/recommendations will be met with the following exceptions:

- Model calibration (Section F8 of the Technical Guide) will not be completed
- Testing and sensitivity analysis (Section F9 of the Technical Guide) will only be undertaken on the basis of peak flows where the Regulatory floodplain is not confined to a valley feature, or where the Regulatory floodplain is close to breaching a valley feature under future land use conditions

To establish/refine the existing riverine floodplain constraints to support a planning level study, the following steps must be completed:

i) Survey major watercourse crossing structures within the Mobility Hub study areas and a hydraulically relevant distance up and downstream, where existing data are not available or are not considered to be of a satisfactory level of accuracy, as approved by the TAC. A complete detailed survey of the low flow and bankfull channels (sufficient for floodplain mapping purposes) within municipal creek blocks along Appleby Creek is included in the Work Plan; opportunities to re-allocated the effort associated with this task will be considered by TAC on a priority basis. DEM data (0.5 m resolution) will be provided and may be applied to the floodplain throughout the remainder of the study areas where public access is unavailable. The project consultant is to ensure that the DEM and field survey data are properly integrated.

ii) As part of the refinement of the models, verify the hydrologic information, cross section locations and hydraulic parameters included in the hydraulic analyses and update as appropriate. Document the sources of information utilized within the hydraulic models. Alternatively, create and document a new hydraulic model where required. Hydraulic parameters utilized within the model are to be determined in consultation with the TAC.

iii) Establish reach boundary conditions based on the best available information, but ensure sufficient cross sections between the boundary conditions and study areas of interest to achieve model stability. Where Lake Ontario represents the starting water level, the mean monthly water level associated with Lake Ontario should be used as the boundary condition,

iv) The Lake Ontario's flood hazard limit (100 year high water level) must also be considered as it may govern in the establishment of the hazard within the Downtown Hub.

v) As part of the hydraulic modeling for the Aldershot mobility hub, the Floodplain delineation for Grindstone Creek must consider spill from the adjacent Falcon Creek. The spill values will be provided by the TAC.

vi) Validate the refined existing conditions models through comparison with original models (where available).

vii) Where the regulatory storm is defined by a 1:100 year design storm as opposed to Hurricane Hazel Regional storm event, climate change implications are to be assessed (three projected scenarios will be provided by the TAC) through modeling efforts and presented in a tabular form to inform the potential level of risk associated with anticipated climate change scenarios.

viii) Evaluate the extent of the future floodplains based on proposed hydrologic and hydraulic conditions as envisioned through the secondary planning process.

ix) Prepare full size copies of floodplain mapping (existing and proposed conditions) for the regulatory storm (greater of the 1:100 year or Regional Storm Event). The mapping shall be presented on a topographic contour base, overlain with property boundaries, structures, watercourse locations, and labeled hydraulic cross sections. Cross sections are to be labelled with cross section ID, the associated Regional and 1:100 year water levels, and the 'start' and 'end' of the modeled segments of the cross sections. Submit digital and hard copies of the mapping.

x) Hager-Rambo Diversion Channel & Flood Control System –

(1) The diversion channel is estimated to have capacity for the 50 year design storm based on the original design criteria and subsequent analyses. For larger design events (100 year and Regional Storm), the channel is expected to spill at several locations. A preliminary understanding of existing hydraulic conditions is available from Conservation Halton's draft HEC-RAS model for the channel. Spill paths are not known at this time, however spills are expected to impact the south end of the Burlington Mobility Hub and the Downtown Mobility Hub and may impact the location/nature of future development in these hubs. The magnitude of spill flow is also not known for any design event at this time.

(2) The Hager-Rambo flood control system consists of three (3) facilities including the Freeman Pond (QEW-Highway 403 interchange), West Hager Pond (North Service Road, west of Brant Street) and the East Rambo Pond (North Service Road, west of Guelph Line). The facilities were required to provide flood control (peak flow attenuation) for stormwater diversions related to the Highway 407 corridor (East/West Rambo Creek & East Hager Creek), and also accommodate a diversion from Roseland Creek. The flood control system was design and approved by the City of Burlington, Conservation Halton and the Province of Ontario to provide peak flow control for all events up to and including the Regional Storm.

    Current Provincial policy (ref. MNR, 2002) does not allow modification of Regulatory peak flows through stormwater management in establishing the downstream Regulatory flood hazard. Current policy also does not allow implementation of flood control measures for the purpose of facilitating development downstream. These policies are key considerations for the Mobility Hub Study as development proposed within the Burlington and Downtown Mobility hubs is expected to be affected by a flood flows in excess of the capacity of the Hager-Rambo Diversion Channel including spills. The associated flood risk will significantly increase if the Hager-Rambo flood control system is not credited for reducing Regulatory peak flows. It has not been determined how current policy affects previous Provincial approvals granted to the Hager-Rambo flood control system. However, it has been identified that a Hager-Rambo flood risk assessment is required and must consider peak flows with and without the flood control system in-place. The spill assessment will involve use of simplified techniques and will not involve 2D modelling.

(3) The Freeman Pond and the West Hager Pond detain runoff using an engineered barrier above ground (i.e. berms and/or weirs) which may classify them as dams under the Lakes and Rivers Improvement Act. Current Provincial criteria requires that dam breach assessments be undertaken to inform the design process and

establish flood risk downstream related to a flood wave. A dam breach assessment has not been undertaken to date. Given that the influence the two flood control facilities is integral to the Hager-Rambo system, a preliminary review of dam breach, including spill paths is considered required to understand the potential for an increase to Regulatory peak flows in the system (between the ponds and the diversion channel), and potential increase in flood hazard risk downstream.

(4) Based on the foregoing, the following assessments can be accommodated within the existing Work Plan:

(a) Hydraulic modelling to estimate the order of magnitude of the spills from for the Hager-Rambo Diversion channel, as well as upstream connecting channels, under attenuated and unattenuated Regulatory peak flow based on a steady-state flow methodology. Other simplified estimation techniques will be considered. The preceding assumes that hydraulic models of the channels between the ponds and the diversion channel are readily available from Conservation Halton in a usable state.

(b) Review of potential Freeman Pond, West Hager Pond, and East Rambo Pond breach spill paths to the extent that a preliminary understanding of the potential for the breach to affect the Burlington or Downtown Mobility Hubs. Given that the facilities are generally west of the Hubs (with the exception of the East Rambo Pond which is a depressed feature and thus considered to be lower risk), direct impacts are expected to be limited. Calculation of breach (i.e. Dam Break) peak flows cannot be accommodated in the current Work Plan.

(c) Review of topographic mapping to identify potential Diversion channel spill paths through the Burlington and Downtown Mobility Hubs. The spill path, local topography and the estimated spill magnitude will be considered together to coarsely estimate the potential extents of flood impact within the Burlington and Downtown Mobility Hubs.

(d) DISCLAIMER. To generate a level of accuracy that can be reasonably relied upon to guide development and establish related policies, including garnering the necessary approvals from Conservation Halton and the Province would require detailed hydraulic modelling including unsteady state flow analysis and 2 dimensional flow routing and potential dam breach assessment. Amec Foster Wheeler's Work Plan identified the concern related to the spill, however no effort was included in the Work Plan to conduct the above noted

assessments. Clearly the detailed analysis that would be required cannot be accommodated by the current Work Plan. That said, it is expected that above noted preliminary analyses can be accommodated within the existing scope. The assessments will necessarily be highly conservative and qualifiers regarding the accuracy will be applied. At best, the outcomes are generally expected to improve the understanding of the potential spatial impact of the spill, and inform the scope of additional future study. Given that there is very limited existing understanding of the hydraulics related to the spills, the level of effort required to establish meaningful parameters around the extent of flood risk in the Mobility Hubs is unknown. Therefore, Amec Foster Wheeler will make best efforts within the existing Work Plan to provide meaningful information around flood hazards related to the spill, however it cannot be guaranteed that outcomes of the spill assessment will meet the specific needs of the Mobility Hub Study. Amec Foster Wheeler will work with the engineering and planning teams such that potential gaps in the flood hazard assessment, as they relate to planning needs, can be identified as early as possible and options to re-assign or add additional scope can be considered by the City and TAC.

**Table C Hydraulic Modeling Requirements**

| **Mobility Hub** | **Hydraulic Modeling Required** | **Available Information** |
|---|---|---|
| Aldershot Mobility Hub | Grindstone Creek (refinement of HEC-2 and conversion to HEC RAS) | Grindstone Creek Subwatershed Study (Cosburn Patterson Wardman Ltd, 1995) |

| | | |
|---|---|---|
| Burlington Mobility Hub | West Rambo Creek and Diversion (review and refinement of Conservation Halton Hager-Rambo Diversion Channel Model, 2014) | Technical Summary Updated Hydrology: Indian Creek, Hager-Rambo System, Roseland Creek (Phillips, 1997) |
| | East Rambo Creek (existing Amec Foster Wheeler model) | Technical Summary Updated Hydrology: Indian Creek, Hager-Rambo System, Roseland Creek (Phillips, 1997) |
| Downtown Mobility Hub | Lower Rambo Creek (create model) | Unavailable |
| | Lower Hager Creek (create model) | Unavailable |
| Appleby Mobility Hub | Appleby Creek (HEC-RAS refinement) | Appleby Creek Floodline Mapping Update (EWRG 1997) |
| | Sheldon Creek (refinement of Hec Ras) | Sheldon Creek Hydrologic and Hydraulic Study (DRAFT, AMEC Foster Wheeler, 2016) |

b) Erosion Hazards

The erosion hazard assessment must be completed in accordance with the most current version of MNRF's "Technical Guide – River & Stream Systems: Erosion Hazard Limit," (currently 2002), which is deemed to be inclusive of Parish Geomorphic's Belt Width Delineation Procedures" (currently Revised 2004). Conservation Halton staff in conjunction with the proponent's geomorphologist and/or geotechnical engineer will determine the status of the valley systems as either confined or unconfined. For confined systems, the erosion hazard is defined as the greater of the physical top of bank or long term stable top of bank. For unconfined systems, the erosion hazard limit is defined as

the meander belt allowance. The 15m and 7.5m regulated setbacks are to be applied to governing erosion hazard (i.e. the meander belt, physical top of bank or stable top of bank).

The erosion hazard assessment must be completed by a licensed qualified professional Fluvial Geomorphologist, Geotechnical Engineer and/or Water Resources Engineer. Justification as to whether climate change impacts need to be considered as part of corridor sizing is required.

Recognizing that some of the Mobility Hub study areas are partially developed, it may be appropriate to analyze meander belt widths on the basis of empirical equations. Where the meander-belt width is determined on the basis of empirical equations, the results of multiple applicable equations are to be presented and justification is to be provided for the equation that is ultimately selected as most appropriate in this area.

At a minimum, the erosion hazard limit must be supported by documentation detailing: collected field data (if applicable), the methodologies applied, analysis and supporting calculations and text justifying the ultimate methodology selected to define the erosion hazard limit. Additionally, digital and hard copy figures must be submitted and shall include a signed and sealed, full size, scaled, plan view drawing showing:

i) Detailed topographic information (contour intervals of less than or equal to 0.5m) with a referenced source for all topographic information;

ii) The current locations of the watercourse centerlines and limits of bankfull channels;

iii) The erosion hazard limits ;

iv) The regulated allowance (15 metres for major valley systems and 7.5 metres for minor systems).

To support the assessments of the erosion hazards, the following must also be assessed:

<u>For unconfined systems:</u>

i) Reach break locations, overlain on an orthophoto complete with topographic mapping,

ii) Any noted areas of erosion concerns and any locations where the 100 year migration rate may have been determined;

iii) The watercourses' current central tendency (meander belt axis);

iv) Available historic watercourse centrelines (where available);

v) The calculated meander belts (preliminary meander belts);

vi) The analyzed 1:100 year erosion setbacks (100 year migration rate) or alternate setbacks using safety factors as required;

For confined systems:

i) Given that this study is intended to support secondary planning and not zoning or lotting, the project consultant is to apply conservative assumptions for stable slope inclinations (i.e. slope inclinations of 3:1 in soil) and toe erosion allowances (maximum tabulated values applicable to site soils) and forego the completion of a detailed geotechnical study at this time. The erosion hazards will need to be further refined through detailed studies at a later date, prior to site development. At that time, the physical top of bank must also be staked by Conservation Halton.

The following must be shown on a scaled sealed figure:

i) Slope cross section locations and I.D.'s

ii) Limit of the Toe Erosion Allowance; and

iii) Limit of the Stable Slope Allowance

**6.4 Digital Data Requirements**

The project consultant will be required to provide the following information to the City of Burlington, Halton Region, and/or Conservation Halton:

a) For modeling related data products, digital and executable copies of model input and output files, as well as licensed copies of any proprietary modeling software and PDF copies of key summary information (such as the model schematics, drainage area plans, hydraulic cross section locations, etc.) are to be provided to the City Region and Conservation Halton.

b) Digital copies of the written reports are to be provided in both MS Word 2010 and PDF format.

c) All mapping products produced for the study shall be geo-referenced to real world coordinates and have a standard UTM NAD 83, Zone 17 projection with NAD83 vertical datum.

d) New features captured by the project consultant using GPS or heads-up digitizing from air photography will have a capture accuracy rating for the feature included as an attribute ( +/- 0.5 m accuracy).

e) A mapping layer index will be provided listing the layer name and providing a description/abstract of the layer's content. Also, FGDC compliant metadata shall be created for each layer produced by the project consultant.

f) Digital data will be delivered in one of the following formats: ESRI file geodatabase v10.2 feature classes or ESRI shape file format ensuring attribute names are not truncated in the shape files. Layers created by the project consultant shall be topologically correct (i.e. adjacent polygon features will be without gaps/overlaps and shall share vertices/nodes where appropriate).

g) If the project consultant utilizes ESRI ArcGIS to produce maps, the matching .mxd will be provided that corresponds to the mapping.

h) If software limitations prevent the project consultant from meeting these requirements, alternate formats may be considered (e.g., DGN) with the written agreement of the City. City GIS staff should be consulted if additional technical details are required to these requirements.

## 7.0 SUPPLEMENTORY INFORMATION

### Table D Terrestrial & Aquatic Studies

| Y/N | Survey | Optimal Inventory Period | Methodology and Protocols | Notes |
|---|---|---|---|---|
| ☒ | Ecological Land Classification (ELC) | • May to early June, July to September | • ELC System for Southern Ontario First Approximation (Lee et al., 1999) or as updated from time to time | • Classification to the Vegetation Type.<br>• Should the community not be available within the Guide, please use the community series level and provide notation as to why this approach is used.<br>• Include all data sheets (e.g., soils, disturbance, etc.).<br>• Mapping should clearly differentiate between the polygons. |
| ☐ | Wetland Evaluation and Delineation | • Evaluation: variety of seasons to ensure the full evaluation occurs as per OWES<br>• Delineation: Late spring to early fall, before the first hard frost with CH and potentially MNRF staff | • Ontario Wetland Evaluation System (OWES) for Southern Ontario (3rd Edition, 2014 or as updated from time to time) | • Detailed inventory and assessment including vegetation, mammals, birds, reptiles, amphibians, fish, insects, benthos etc., using specific protocol noted in this table.<br>• Ensure sufficient time for MNRF to process.<br><br>*Note: presence of wetlands to be confirmed through ELC surveys the next planning stage will require OWES delineation.* |
| ☒ | Vegetation Inventory | • Single-season: mid-June to August, to be completed concurrently with ELC | • Comprehensive vegetation species list to be provided, will be combined with ELC<br>• Details on species including level of invasiveness, CoC, CoW, species rarity etc., should be recorded | Species rarity to be based on:<br><br>• Species at Risk in Ontario list (MNRF)<br>• S-Rank using the Natural Heritage Information Centre species lists<br>• Local rarity using Halton Natural Areas Inventory (2006) and Hamilton Natural Areas Inventory (2014) |
| ☒ | Breeding Birds | • Breeding birds: May 24 to July 10 | Habitat Dependent:<br><br>• Ontario Breeding Bird Atlas protocols | • Point counts required for monitoring.<br>• Generally consists of two survey visits spaced approximately 10 days apart, |

| Y/N | Survey | Optimal Inventory Period | Methodology and Protocols | Notes |
|---|---|---|---|---|
| | | | • Area searches and wandering transects | spread evenly over the season. |
| ☐ | Amphibians | • Early spring – summer (species dependent)<br>• Active Visual Encounter Surveys (VES) on rainy late March – early April nights | • Bird Studies Canada Great Lakes Marsh Monitoring Program (including 3 separate spring/early summer seasonal survey timing windows).<br>• Active Visual Encounter Searches (VES) for salamanders | • Trapping may be required for JESA, if known or suspected and as required and permitted by the MNRF.<br>• If sampling in urban areas, point counts longer than three minutes may be recommended<br><br>*Note: presence of potential amphibian breeding habitat to be confirmed through ELC surveys. Where necessary, recommendations to undertake amphibian breeding surveys will be made as part of the development application process.* |
| ☐ | Reptiles | • April – June<br>• Late Summer/Fall: Late August to October for migration or congregating species<br>• Weather dependent | • Species and habitat dependent<br>• May include cover board surveys, spring emergence surveys etc.<br>• Consultation recommended ahead of work | *Note: presence of potential reptile hibernacula or nesting areas to be confirmed through ELC surveys. Where necessary, recommendations to undertake additional surveys will be made as part of the development application process.* |
| ☐ | Butterflies | • June – August<br>• July (peak)<br>• Weather dependent | • Species and habitat dependent<br>• Consultation recommended ahead of work | *Note: potential significant wildlife habitat for migratory butterflies to be confirmed through ELC surveys.* |
| ☐ | Dragonflies and damselflies | • June – August<br>• July (peak)<br>• Weather dependent | • Species and habitat dependent<br>• Consultation recommended ahead of work | *Note: potential significant wildlife habitat for dragonflies and damselflies to be identified through incidental observations and other field studies (ELC, etc.).* |

| Y/N | Survey | Optimal Inventory Period | Methodology and Protocols | Notes |
|---|---|---|---|---|
| ☐ | Mammals | • Species dependent | • Sightings and tracking<br>• Small mammal trapping depending on the site | *Note: potential significant wildlife habitat for mammals to be identified through incidental observations and other field studies (ELC, etc.). Where necessary, recommendations to undertake species specific surveys will be made as part of the development application process.* |
| ☐ | Bats | • During leaf off season for cavity tree surveys | • Species and habitat dependent<br>• SAR Bats require different surveys than SWH bats.<br>• MNRF Guidelines, where applicable<br>• Consultation recommended ahead of work | *Note: potential for bat habitat to be identified through ELC. Where necessary, recommendations to undertake bat surveys will be made as part of the development process.* |
| ☒ | Stream Classification | • Summer (June- July) | • Ontario Stream Assessment Protocol (OSAP) | • Collect information on riparian and in-stream cover, stream morphology, nutrient input, etc. |
| ☐ | Benthic Invertebrate Sampling | • Spring (May) | • OSAP Section2, Module 3<br>• Travelling kick and sweep methods completed three times over the study period (May) | • Data to be collected includes % abundance, Family Richness, and % Taxa Richness Index<br><br>*Note: to be completed during future investigations closer to construction, to set a baseline for monitoring purposes.* |

*Note: The surveys listed above were agreed to at the meeting with CH on February 14, 2017. Additional surveys may be required as identified through the preliminary field program, to be addressed through the development application and approvals process.*

# ATTACHMENT A:

## Terrestrial and Aquatic Field Study Locations


**CITY OF BURLINGTON**
BURLINGTON HUB MOBILITY STUDY

**ALDERSHOT STUDY AREA**
FIGURE 1

- Study Area
- Railway
- Road
- Watercourse
- Waterbody
- Unevaluated Wetlands
- MNRF Wooded Area
- Ecological Land Classification, Breeding Bird Survey
- Aquatic Assessment

0 50 100 200 Metres

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNRF

MAP CREATED BY: LK
MAP CHECKED BY: WM
MAP PROJECTION: NAD 1983 UTM Zone 17N

DILLON CONSULTING

STATUS: DRAFT
DATE: 2017-02-23

FILE LOCATION: \\dillon.ca\DILLON_DFS\Ottawa\Ottawa CAD\CAD\2017\MK1505 - Burlington Mobility\Figs_StudyAreas.mxd


**CITY OF BURLINGTON**
BURLINGTON HUB MOBILITY STUDY

**BURLINGTON STUDY AREA**
FIGURE 2

- Study Area
- Railway
- Road
- Watercourse
- Waterbody
- Unevaluated Wetlands
- MNRF Wooded Area
- Ecological Land Classification, Breeding Bird Survey
- Aquatic Assessment

0 50 100 200 Metres

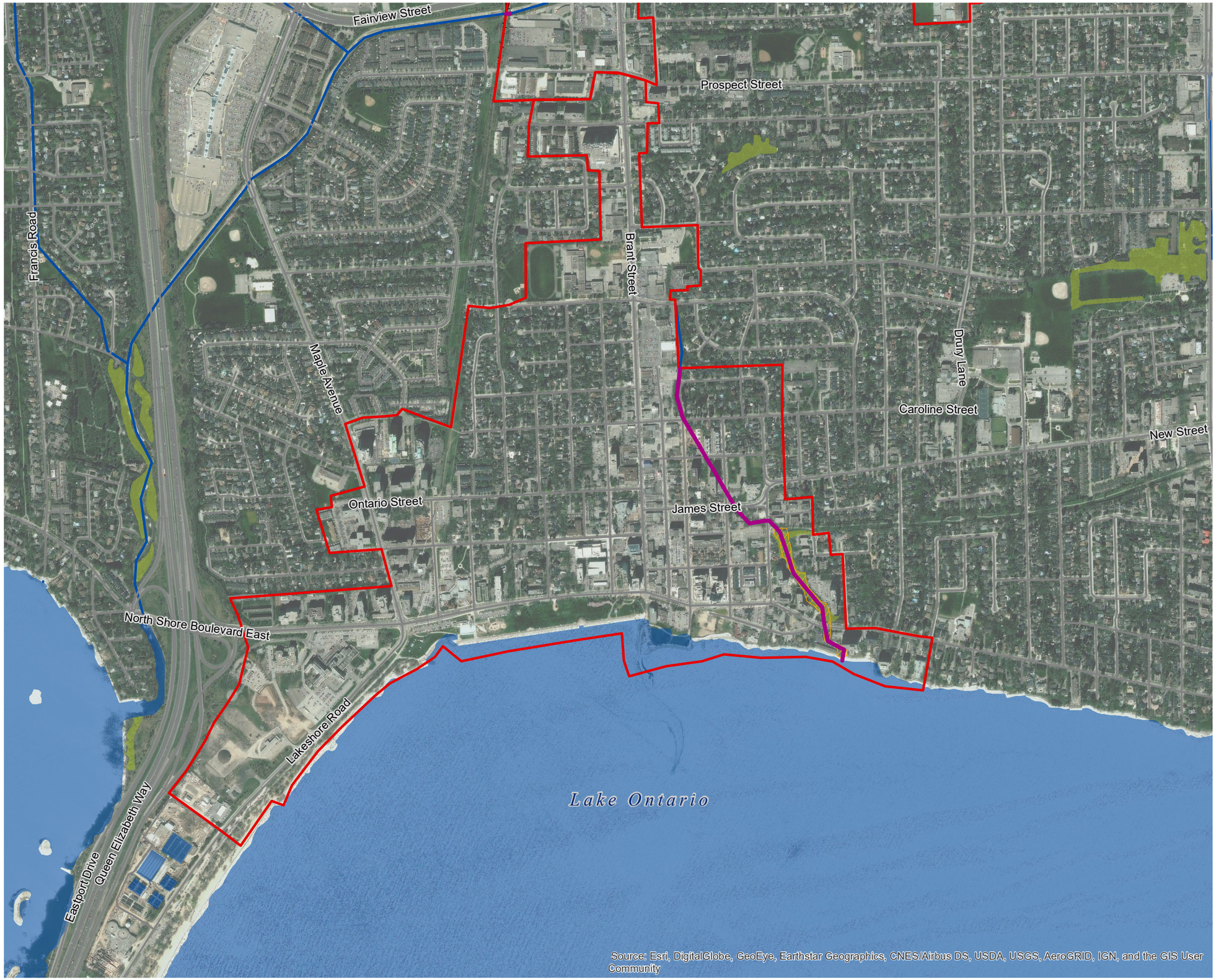
MAP DRAWING INFORMATION:
DATA PROVIDED BY MNRF

MAP CREATED BY: LK
MAP CHECKED BY: WM
MAP PROJECTION: NAD 1983 UTM Zone 17N

DILLON CONSULTING

STATUS: DRAFT
DATE: 2017-02-23

FILE LOCATION: \\dillon.ca\DILLON_DFS\Ottawa\Ottawa CAD\CAD\2017\MK1505 - Burlington Mobility\Figs_StudyAreas.mxd




**CITY OF BURLINGTON**
BURLINGTON HUB MOBILITY STUDY

**DOWNTOWN STUDY AREA**
FIGURE 3

- Study Area
- Railway
- Road
- Watercourse
- Waterbody
- Unevaluated Wetlands
- MNRF Wooded Area
- Ecological Land Classification, Breeding Bird Survey
- Aquatic Assessment

0 50 100 200 Metres

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNRF

MAP CREATED BY: LK
MAP CHECKED BY: WM
MAP PROJECTION: NAD 1983 UTM Zone 17N

DILLON CONSULTING

STATUS: DRAFT
DATE: 2017-02-23

FILE LOCATION: \\dillon.ca\DILLON_DFS\Ottawa\Ottawa CAD\CAD\2017\MK1505 - Burlington Mobility\Figs_StudyAreas.mxd


**CITY OF BURLINGTON**
BURLINGTON HUB MOBILITY STUDY

**APPLEBY STUDY AREA**
FIGURE 4

- Study Area
- Railway
- Road
- Watercourse
- Waterbody
- Unevaluated Wetlands
- MNRF Wooded Area
- Ecological Land Classification, Breeding Bird Survey
- Aquatic Assessment

0 50 100 200 Metres

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNRF

MAP CREATED BY: LK
MAP CHECKED BY: WM
MAP PROJECTION: NAD 1983 UTM Zone 17N

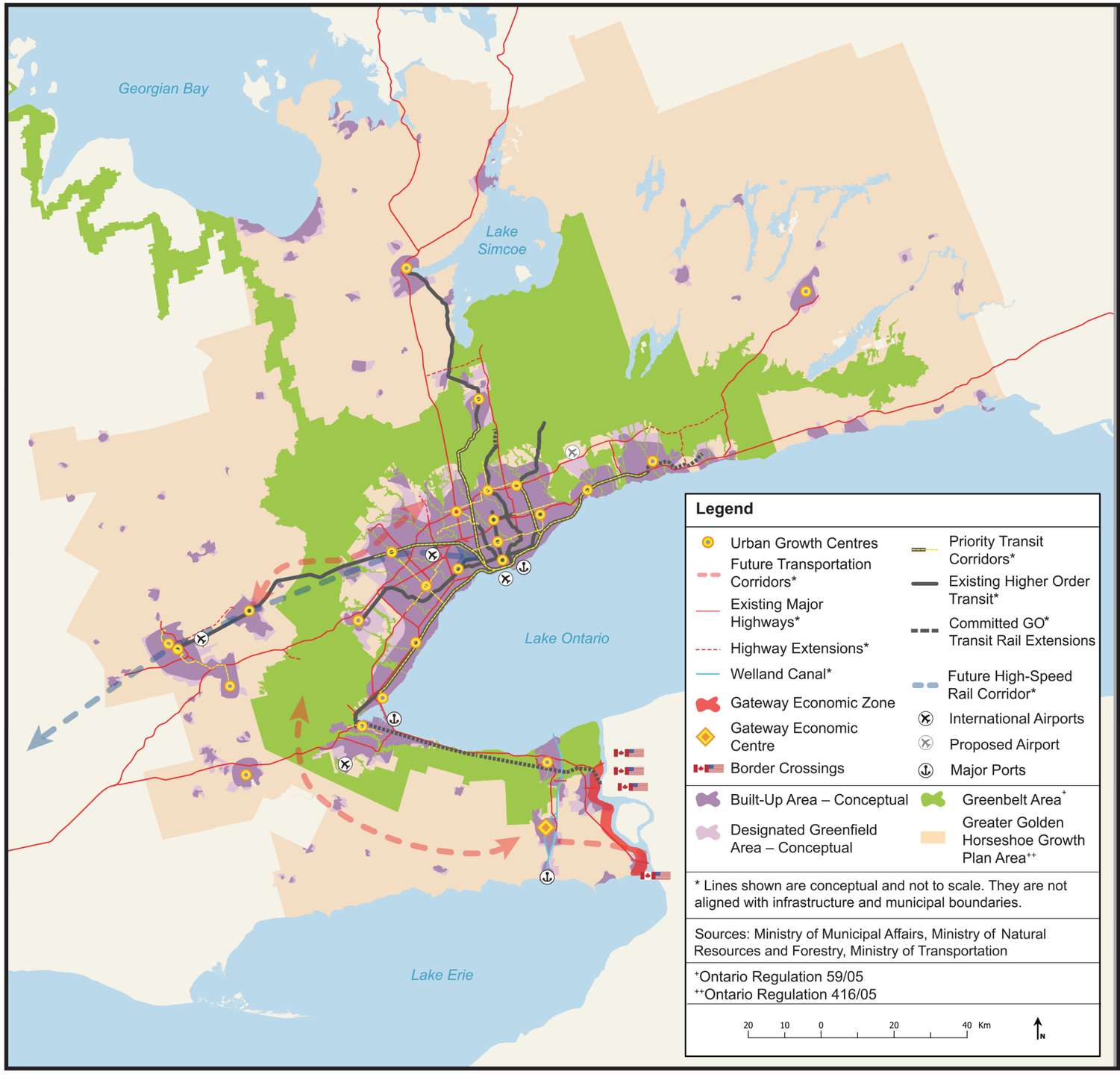
DILLON CONSULTING

STATUS: DRAFT
DATE: 2017-02-23

FILE LOCATION: \\dillon.ca\DILLON_DFS\Ottawa\Ottawa CAD\CAD\2017\MK1505 - Burlington Mobility\Figs_StudyAreas.mxd

# Appendix B

## *Background Mapping & Schedules*




Ontario

PLACES TO GROW

GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE, 2017

## SCHEDULE 2
# Places to Grow Concept

**Legend**

- Urban Growth Centres
- Future Transportation Corridors*
- Existing Major Highways*
- Highway Extensions*
- Welland Canal*
- Gateway Economic Zone
- Gateway Economic Centre
- Border Crossings
- Priority Transit Corridors*
- Existing Higher Order Transit*
- Committed GO* Transit Rail Extensions
- Future High-Speed Rail Corridor*
- International Airports
- Proposed Airport
- Major Ports
- Built-Up Area – Conceptual
- Designated Greenfield Area – Conceptual
- Greenbelt Area+
- Greater Golden Horseshoe Growth Plan Area++

* Lines shown are conceptual and not to scale. They are not aligned with infrastructure and municipal boundaries.

Sources: Ministry of Municipal Affairs, Ministry of Natural Resources and Forestry, Ministry of Transportation

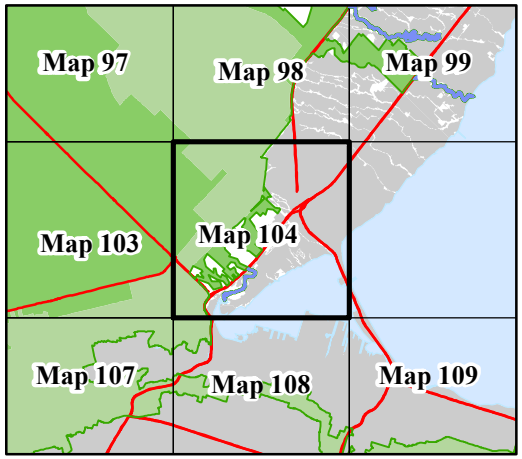
+Ontario Regulation 59/05
++Ontario Regulation 416/05

20 10 0 20 40 Km

N

Note: The information displayed on this map is not to scale, does not accurately reflect approved land-use and planning boundaries, and may be out of date. For more information on precise boundaries, the appropriate municipality should be consulted. For more information on Greenbelt Area boundaries, the Greenbelt Plan should be consulted. The Province of Ontario assumes no responsibility or liability for any consequences of any use made of this map.

# greenbelt




## LEGEND

Ontario

- Greenbelt Area*
  - Protected Countryside
  - Natural Heritage System
  - Towns / Villages
  - Urban River Valleys
  - Niagara Escarpment Plan Area
  - Oak Ridges Moraine Area
- External Connections
- Settlement Areas Outside the Greenbelt
- Upper Tier Municipal Boundaries
- Lower & Single Tier Municipal Boundaries
- Lots and Concessions
- Major Road or Highway
- Minor Road
- F.N. First Nations

The information displayed on this map has been compiled from various sources. While every effort has been made to accurately depict the information, this map should not be relied on as being a precise indicator of locations of features or roads nor as a guide to navigation.

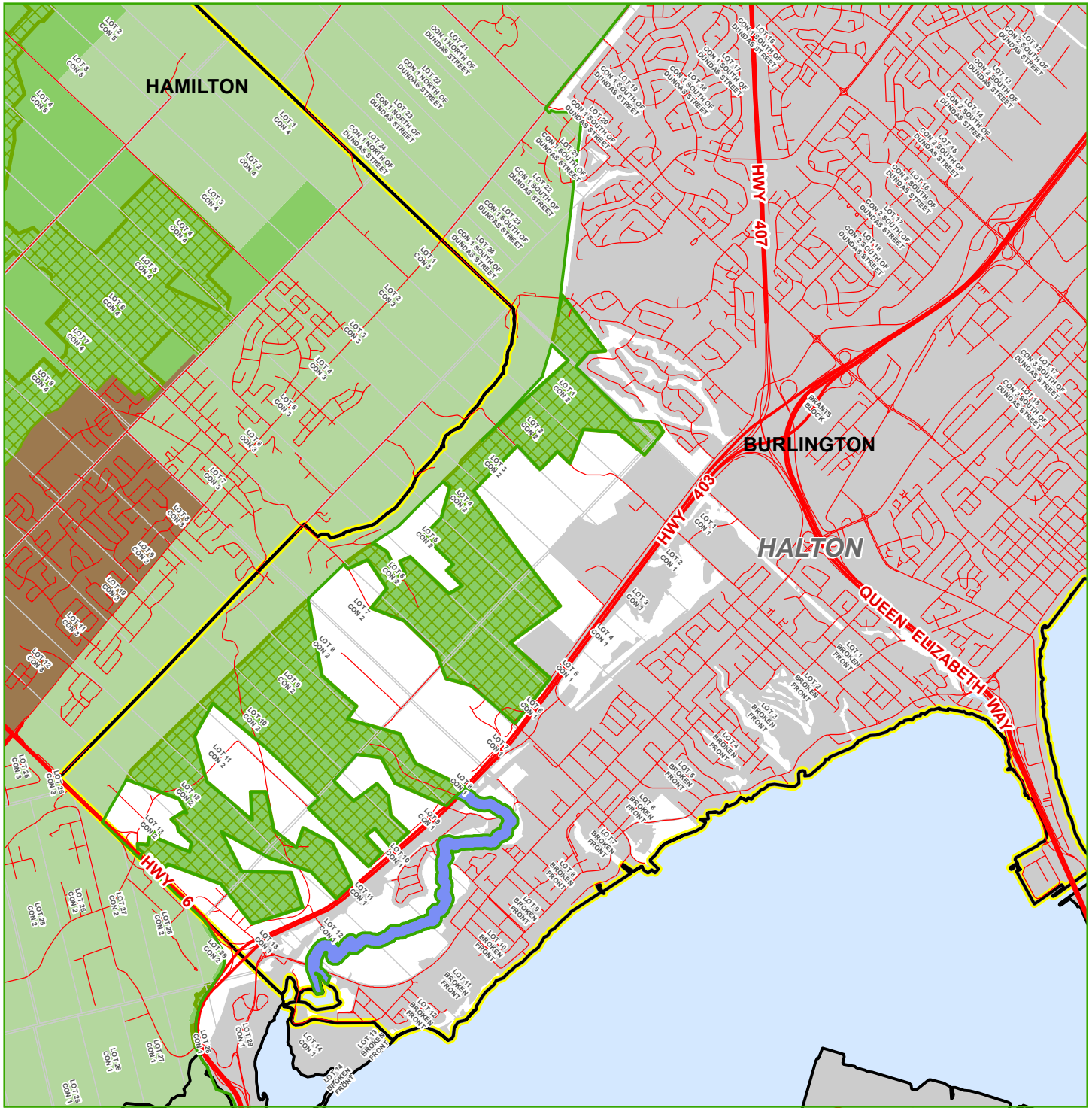
Settlement boundaries generally reflect information provided by the relevant municipality. For precise boundaries and locations of Settlement Areas (Greenbelt Towns/Villages and Hamlets) the appropriate municipalities should be consulted.

Source of Information:
Produced by and using data sources from the Ministry of Municipal Affairs, Ministry of Natural Resources and Forestry and the Ministry of Agriculture, Food and Rural Affairs.

Projection: UTM Zone17 NAD83

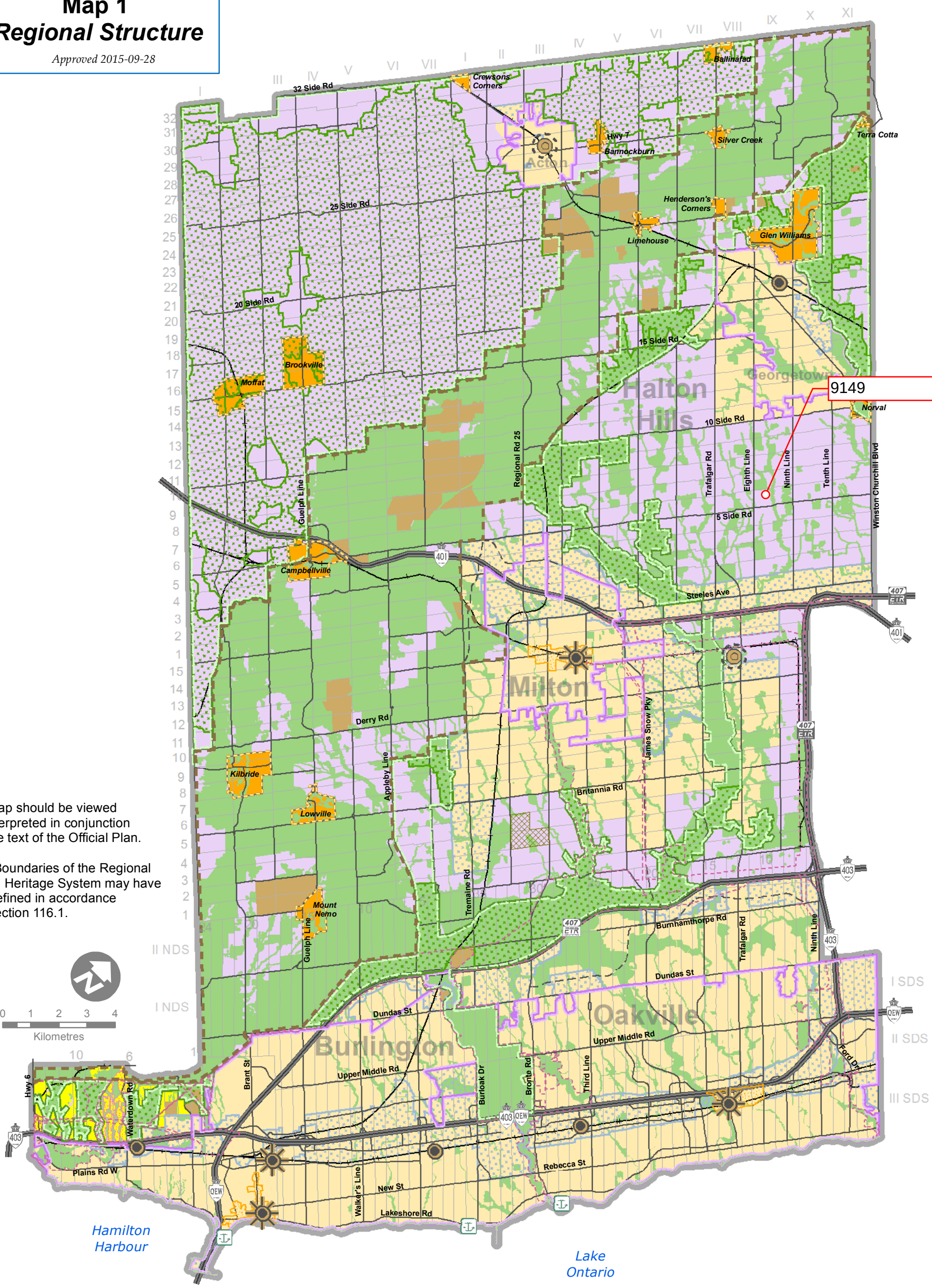

* Ontario Regulation 59/05, as amended.

0 0.25 0.5 1 1.5 2
Kilometres



# Map 1
# *Regional Structure*

*Approved 2015-09-28*




This map should be viewed and interpreted in conjunction with the text of the Official Plan.

* The Boundaries of the Regional Natural Heritage System may have been refined in accordance with Section 116.1.

- Waterfront Park (See Map 2)
- Major Transit Station
- Proposed Major Transit Station
- Mobility Hub
- Rail Line
- Proposed Major Arterial
- Major Road
- Provincial Freeway
- Lot and Concession Line
- Municipal Boundary

- Urban Area *Approved 2013-10-21*
- Hamlet
- Agricultural Area
- Regional Natural Heritage System *
- Mineral Resource Extraction Area
- North Aldershot Policy Area
- Greenbelt Natural Heritage System (Overlay)

- Greenbelt Plan Protected Countryside Boundary
- Niagara Escarpment Plan Boundary
- Parkway Belt West Plan Boundary
- Built Boundary
- Employment Area *Approved 2013-10-21*
- Urban Growth Centre
- Area Eligible for Urban Servicing
- Halton Waste Management Site

September 2, 2015

*Schedule B*

# COMPREHENSIVE LAND USE PLAN- URBAN PLANNING AREA

## Legend

- Residential - Low Density
- Residential - Medium Density
- Residential - High Density
- General Employment
- Business Corridor
- Regional Commercial
- Community Commercial
- Employment Commercial
- Neighbourhood Commercial
- Mixed Use Centre
- Mixed Use Corridor - General
- Mixed Use Corridor - Commercial Corridor
- Mixed Use Corridor - Employment
- Greenlands
- Major Parks and Open Space
- Environmentally Sensitive Area (Note: Boundaries based on Map 1 of the Region of Halton Official Plan (2006)
- Parkway Belt Plan Area (Note: All lands within Parkway Belt West Plan Area Subject to Deferral *9)
- Land Use Designation to be Determined
- Urban Planning Area Boundary
- Watercourses - Conceptual only, refer to Part III, Section 6.4.2 d
- Former Waste Disposal Site
- Downtown Urban Growth Centre Boundary

RURAL PLANNING AREA

NORTH ALDERSHOT PLANNING AREA

HAMILTON

OAKVILLE

BURLINGTON BAY

LAKE ONTARIO

*D31/*D32

*D42

*D47

*R16

*D28

HWY 407

HWY 403

HWY 6

Q.E.W.

C.N.R.

C.P.R.

DUNDAS ST.

UPPER MIDDLE ROAD

UPPER MIDDLE RD.

LEIGHLAND RD.

PLAINS RD. W.

PLAINS RD. E

FAIRVIEW ST.

LAKESHORE RD.

NORTH SERVICE RD.

SOUTH SERVICE RD.

HARVESTER RD.

MAINWAY

NEW ST.

SPRUCE AVE

REBECCA ST.

MOUNTAINSIDE DR.

NORTH SHORE BLVD. E

EASTPORT DR.

OLD YORK RD.

WATERDOWN RD.

TOWNSEND AVE.

CEDAR SPRINGS RD.

GUELPH LINE

APPLEBY LINE

TREMAINE RD.

PALLADIUM WAY

THOMAS ALTON BLVD.

DRYDEN AVE

CAVENDISH DR.

HEADON RD.

HEADON FOREST DR.

WALKER'S LINE

BERWICK DR.

MILLCROFT PARK DR.

SUTTON RD.

BURLOAK DR.

CORPORATE DR.

BRANT ST.

KERNS RD.

FISHER AVE.

KING RD.

MAPLE AVE.

HAGER AVE

DRURY LANE

SENECA AVE.

CUMBERLAND AVE

PINECOVE RD.

BELVENIA ROAD

HEATH RD.

HAMPTON

1:50 000 +/-

NOTE: For information on Deferrals and Referrals (*D or *R), please see the Explanatory Notes of the Official Plan.

JUNE 2015

# SCHEDULE A
## City System
**City of Burlington**

### Legend

**Areas**

- Urban Area
- Rural Area
- Rural Settlement Area Boundary
- North Aldershot

**City-Wide Systems**

- Infrastructure and Transportation Systems
- Green System

**Contextual References**

- Municipal Boundary
- Urban Boundary
- Major Transit Station
- Rail Line
- Provincial Freeway
- Major Roads
- Airport

MILTON

HAMILTON

OAKVILLE

HAMILTON

DERRY RD.

BELL SCHOOL LINE

Kilbride

Lowville

BRITANNIA RD.

RURAL AREA

Mount Nemo

MILBURROUGH LINE

CEDAR SPRINGS RD.

GUELPH LINE

WALKER'S LINE

APPLEBY LINE

NO. 1 SIDE RD.

DUNDAS ST.

HWY. 407

UPPER MIDDLE ROAD

NORTH ALDERSHOT

URBAN AREA

NO. 6 HWY. N

WATERDOWN RD.

BRANT ST.

MAINWAY

HWY. 403

Q.E.W. / HWY. 403

HARVESTER RD.

PLAINS ROAD

FAIRVIEW ST.

BURLOAK DR.

NORTH SHORE BLVD.

KING RD.

Q.E.W.

MAPLE AVE

GUELPH LINE

WALKER'S LINE

APPLEBY LINE

NEW ST.

LAKESHORE RD.

*BURLINGTON BAY*

*LAKE ONTARIO*

0 0.5 1 2 3 4 Kilometers

*This schedule shall be used in conjunction with other applicable schedules and policies of this Plan.*

APRIL 2018

# SCHEDULE A-1
## City System - Provincial Land Use Plans and Designations
### City of Burlington

**Legend**

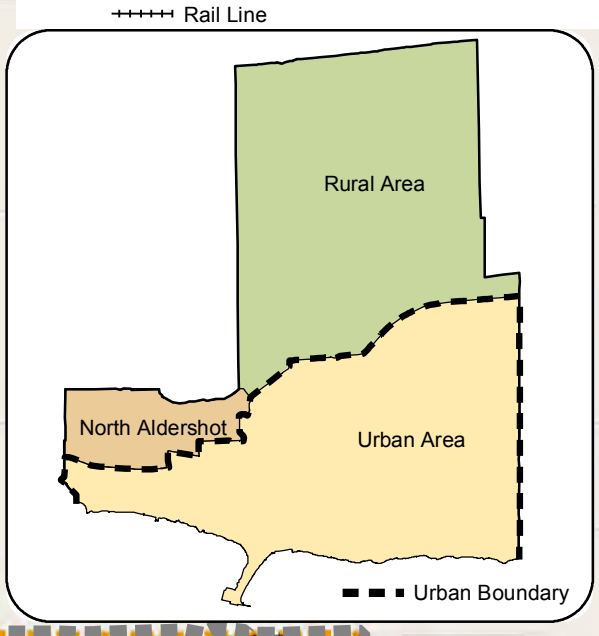
**Niagara Escarpment Plan**
- Niagara Escarpment Plan Boundary
- North Aldershot Policy Area
- Escarpment Natural Area
- Escarpment Protection Area
- Escarpment Rural Area
- Minor Urban Centre
- Urban Area
- Mineral Resource Extraction Area

**Greenbelt Plan**
- Protected Countryside Area
- Greenbelt Natural Heritage System

**Provincial Growth Plan**
- Delineated Built Boundary
- Urban Growth Centre Boundary
- Designated Greenfield Area

**Parkway Belt West Plan Area**

**Contextual References**
- Municipal Boundary
- Urban Boundary
- Rail Line




MILTON
HAMILTON
OAKVILLE
HAMILTON
DERRY RD.
Kilbride
Lowville
BRITANNIA RD.
BELL SCHOOL LINE
MILBUROUGH LINE
CEDAR SPRINGS RD.
GUELPH LINE
Mount Nemo
WALKER'S LINE
APPLEBY LINE
NO. 1 SIDE RD.
DUNDAS ST.
HWY. 407
UPPER MIDDLE ROAD
BRANT ST.
MAINWAY
Q.E.W. / HWY. 403
HARVESTER RD.
FAIRVIEW ST.
BURLOAK DR.
NO. 6 HWY. N
WATERDOWN RD.
HWY. 403
PLAINS ROAD
NORTH SHORE BLVD.
KING RD.
Q.E.W.
MAPLE AVE.
GUELPH LINE
WALKER'S LINE
APPLEBY LINE
NEW ST.
LAKESHORE RD.
BURLINGTON BAY
LAKE ONTARIO

0 0.5 1 2 3 4 Kilometers

*This schedule shall be used in conjunction with other applicable schedules and policies of this Plan.*

APRIL 2018

# SCHEDULE B
## Urban Structure
**City of Burlington**

### Legend

**Mixed Use Intensification Areas**
- Urban Centres
- Mobility Hubs
- Mixed Use Nodes and Intensification Corridors

**Employment Lands**

**Region of Halton Employment Area**

To be added to Region of Halton Employment Area

**Residential Neighbourhood Areas**

**Natural Heritage System, Major Parks and Open Space**

**Mineral Resource Extraction Area**

**Infrastructure and Transportation Corridors**

- Tremaine Road Special Planning Area (see Chapter 12)
- Bronte Creek Meadows (see Chapter 5)
- Innovation District (see Chapter 5)

**Contextual References**
- Municipal Boundary
- Urban Boundary
- Delineated Built Boundary
- Urban Growth Centre Boundary
- Parkway Belt West Plan Area
- Major Transit Station
- Potential Future Major Transit Station (Approximate Location)
- Rail Line
- Provincial Freeway

RURAL AREA

HAMILTON

NORTH ALDERSHOT

OAKVILLE

HWY 407

HWY 403

Q.E.W.

C.N.R.

PALLADIUM WAY

THOMAS ALTON BLVD.

DUNDAS ST.

CEDAR SPRINGS RD.

GUELPH LINE

APPLEBY LINE

TREMAINE RD.

CAVENDISH DR.

UPPER MIDDLE ROAD

HEADON FOREST DR.

HEADON RD.

WALKER'S LINE

BERWICK DR.

MILLCROFT PARK DR.

DRYDEN AVE.

SUTTON RD.

UPPER MIDDLE RD.

CORPORATE DR.

BURLOAK DR.

WATERDOWN R.D.

KERNS RD.

BRANT ST.

FISHER AVE.

MOUNTAINSIDE DR.

MAINWAY

NORTH SERVICE RD.

SOUTH SERVICE RD.

LEIGHLAND RD.

HARVESTER RD.

FAIRVIEW ST.

PLAINS RD. W.

PLAINS RD. E

TOWNSEND AVE.

KING RD.

MAPLE AVE.

NORTH SHORE BLVD. E

LAKESHORE RD.

EASTPORT DR.

NEW ST.

SPRUCE AVE

BELVENA ROAD

HEATH RD.

HAMPTON

BURLOAK DR.

BURLINGTON BAY

LAKE ONTARIO

HAMILTON

0 0.5 1 2 3 4 Kilometers

*This schedule shall be used in conjunction with other applicable schedules and policies of this Plan.*

APRIL 2018

# SCHEDULE B-1
## Growth Framework
**City of Burlington**

### Legend

**Growth Areas**
- Primary Growth Area
- Secondary Growth Area
- Employment Growth Area
- Established Neighbourhood Area

**Mobility Hubs**

**Designated Greenfield Area**
- Developed Area Outside Delineated Built Boundary
- Undeveloped Area Outside Delineated Built Boundary (not subject to Intensification Framework)

**Contextual References**
- Natural Heritage System and Major Parks and Open Space
- Infrastructure and Transportation Corridors
- Municipal Boundary
- Urban Boundary
- Delineated Built Boundary
- Urban Growth Centre Boundary

RURAL AREA
HAMILTON
NORTH ALDERSHOT
BURLINGTON BAY
LAKE ONTARIO
HAMILTON
OAKVILLE
HWY 6
HWY 403
HWY 407
Q.E.W.
C.N.R.
CEDAR SPRINGS RD.
GUELPH LINE
APPLEBY LINE
TREMAINE RD.
PALLADIUM WAY
THOMAS ALTON BLVD.
DUNDAS ST.
DRYDEN AVE
CAVENDISH DR.
HEADON FOREST DR.
HEADON RD.
WALKER'S LINE
BERWICK DR.
SUTTON RD.
MILLCROFT PARK DR.
UPPER MIDDLE RD.
UPPER MIDDLE ROAD
KERNS RD.
FISHER AVE.
BRANT ST.
MOUNTAINSIDE DR.
MAINWAY
CORPORATE DR.
BURLOAK DR.
NORTH SERVICE RD.
SOUTH SERVICE RD.
HARVESTER RD.
FAIRVIEW ST.
LEIGHLAND RD.
PLAINS RD. W.
PLAINS RD. E
TOWNSEND AVE.
WATERDOWN RD.
KING RD.
MAPLE AVE.
NEW ST.
SPRUCE AVE
BELVENIA ROAD
HEATH RD.
HAMPTON
NORTH SHORE BLVD. E
LAKESHORE RD.
EASTPORT DR.

0 0.5 1 2 3 4 Kilometers

*This schedule shall be used in conjunction with other applicable schedules and policies of this Plan.*

APRIL 2018

# SCHEDULE C
## Land Use - Urban Area
### City of Burlington

**Legend**

**MIXED USE INTENSIFICATION AREAS**
- Urban Centres

**Mixed Use Nodes and Intensification Corridors**
- Mixed Use Commercial Centre
- Neighbourhood Centre
- Local Centre
- Employment Commercial Centre
- Urban Corridor
- Urban Corridor - Employment Lands

**RESIDENTIAL NEIGHBOURHOOD AREAS**
- Residential - Low Density
- Residential - Medium Density
- Residential - High Density

**EMPLOYMENT LANDS**
- General Employment
- Business Corridor

**NATURAL HERITAGE SYSTEM AND MAJOR PARKS AND OPEN SPACE**
- City's Natural Heritage System
- Major Parks and Open Space

**MINERAL RESOURCE EXTRACTION AREA**

**INFRASTRUCTURE AND TRANSPORTATION CORRIDORS**

**TREMAINE ROAD SPECIAL PLANNING AREA**

**CONTEXTUAL REFERENCES**
- Municipal Boundary
- Urban Boundary
- Urban Growth Centre Boundary

RURAL AREA
HAMILTON
NORTH ALDERSHOT
BURLINGTON BAY
LAKE ONTARIO
OAKVILLE
HAMILTON
HWY 6
HWY 403
HWY 407
Q.E.W.
CEDAR SPRINGS RD.
GUELPH LINE
APPLEBY LINE
TREMAINE RD.
PALLADIUM WAY
THOMAS ALTON BLVD.
DUNDAS ST.
DRYDEN AVE.
CAVENDISH DR.
HEADON FOREST DR.
HEADON RD.
WALKER'S LINE
BERWICK DR.
MILLCROFT PARK DR.
SUTTON RD.
UPPER MIDDLE ROAD
UPPER MIDDLE RD.
**Uptown Urban Centre
WATERDOWN RD.
KERNS RD.
BRANT ST.
FISHER AVE.
MOUNTAINSIDE DR.
MAINWAY
CORPORATE DR.
BURLOAK DR.
NORTH SERVICE RD.
SOUTH SERVICE RD.
LEIGHLAND RD.
HARVESTER RD.
C.N.R.
FAIRVIEW ST.
PLAINS RD. W.
PLAINS RD. E
TOWNSEND AVE.
KING RD.
MAPLE AVE.
NEW ST.
SPRUCE AVE
BELVENIA ROAD
HEATH RD.
HAMPTON
NORTH SHORE BLVD. E
LAKESHORE RD.
EASTPORT DR.
*Downtown Urban Centre

0 0.5 1 2 3 4 Kilometers

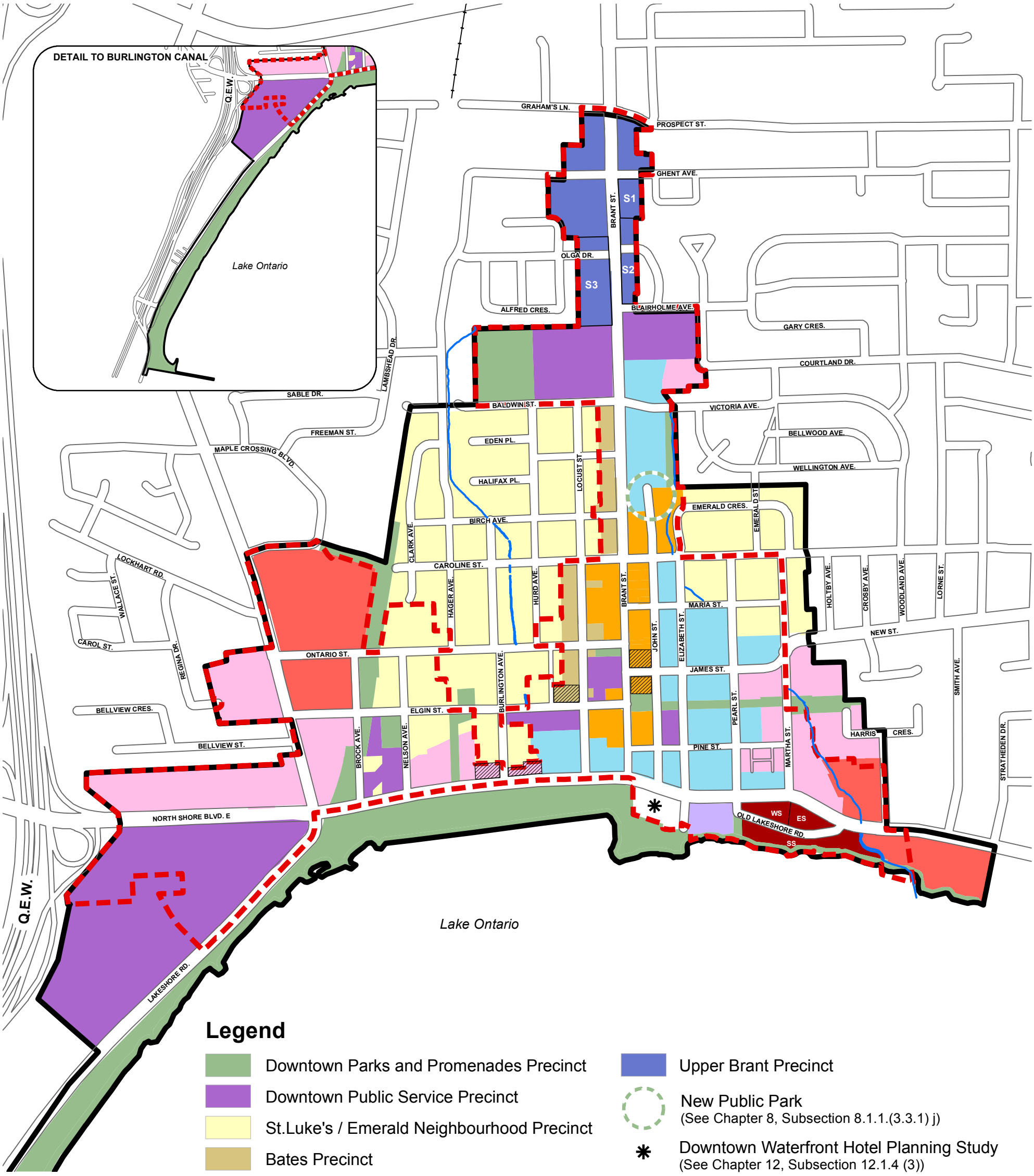
*For land use precincts within the Downtown Urban Centre see Schedule D.
**For land use designations within the Uptown Urban Centre see Schedule E.

*This schedule shall be used in conjunction with other applicable schedules and policies of this Plan.*

APRIL 2018

# SCHEDULE D
## Land Use - Downtown Urban Centre
**City of Burlington**

*Note: For lands outside of the Downtown Urban Centre, refer to Schedule C.*




SEE INSET MAP FOR DETAILS TO BURLINGTON CANAL

## Legend

- Downtown Parks and Promenades Precinct
- Downtown Public Service Precinct
- St.Luke's / Emerald Neighbourhood Precinct
- Bates Precinct
- Brant Main Street Precinct
- Downtown Mid-Rise Residential Precinct
- Downtown Tall Residential Precinct
- Old Lakeshore Road Precinct
- Downtown Core Precinct
- The Cannery Precinct
- Upper Brant Precinct
- New Public Park (See Chapter 8, Subsection 8.1.1.(3.3.1) j)
- * Downtown Waterfront Hotel Planning Study (See Chapter 12, Subsection 12.1.4 (3))
- Downtown Watercourse
- Urban Growth Centre Boundary
- Downtown Urban Centre Boundary/ Mobility Hub Boundary
- Special Planning Area

*This schedule shall be used in conjunction with other applicable schedules and policies of this Plan.*

APRIL 2018

# SCHEDULE M
## The Natural Heritage System
### City of Burlington

**Legend**

**Natural Heritage System**
- Key Natural Features
- Prime Agricultural Lands in Enhancements, Linkages and Buffers
- Other Enhancement Areas, Linkages and Buffers
- Greenbelt Natural Heritage System
- Shorelines of Lake Ontario and Burlington Bay

**Provincial Plans**
- Greenbelt Plan Protected Countryside Boundary
- Niagara Escarpment Plan Boundary

**Contextual References**
- Rural Settlement Area Boundary
- Rural Settlement Area
- Mineral Resource Extraction Area
- Municipal Boundary
- Urban Boundary


MILTON

DERRY RD.

Kilbride

Lowville

BRITANNIA RD.

BELL SCHOOL LINE

MILTON

MILBUROUGH LINE

Mount Nemo

CEDAR SPRINGS RD.

GUELPH LINE

WALKER'S LINE

APPLEBY LINE

NO. 1 SIDE RD.

HAMILTON

DUNDAS ST.

HWY. 407

BRANT ST.

UPPER MIDDLE ROAD

MAINWAY

NO. 6 HWY. N

WATERDOWN RD.

HWY. 403

Q.E.W. / HWY. 403

HARVESTER RD.

PLAINS ROAD

FAIRVIEW ST.

BURLOAK DR.

OAKVILLE

NORTH SHORE BLVD.

KING RD.

Q.E.W.

MAPLE AVE.

GUELPH LINE

WALKER'S LINE

APPLEBY LINE

NEW ST.

LAKESHORE RD.

*BURLINGTON BAY*

*LAKE ONTARIO*

HAMILTON

0 0.475 0.95 1.9 2.85 3.8 Kilometers

*This schedule shall be used in conjunction with other applicable schedules and policies of this Plan.*

APRIL 2018

City of Burlington

# Appendix C

## *Site Photos*

| | |
|---|---|
| **Photo 1**<br><br>June 28, 2017<br><br>FODM7-8: Fresh-Moist Norway maple Lowland Deciduous Forest Type. |  |
| **Photo 2**<br><br>June 22, 2017<br><br>Looking downstream within the upper portion of the reach at coarse substrates and channel braiding. |  |

**Photo 3**

June 22, 2017

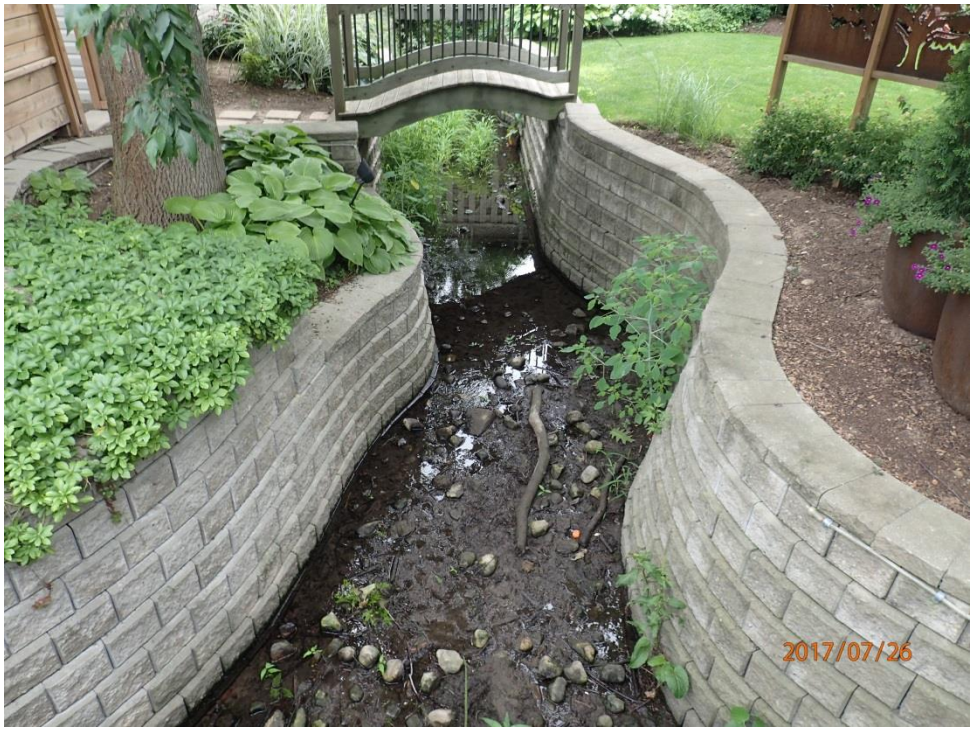
Looking downstream at the confluence of the creek with Lake Ontario. This portion of the reach is wide and flat and is subject to fluctuations in the water level as well as seiche.


**Photo 4**

June 22, 2017

Looking at bank erosion along the right upstream bank, south of James Street.

| | |
|---|---|
| **Photo 5**<br><br>June 22, 2017<br><br>Looking upstream at the James Street crossing and the outlet of the underground portion of Rambo Creek which stretches upstream to Caroline Street. |  |
| **Photo 6**<br><br>June 22, 2017<br><br>Looking at the seasonal barrier to fish migration located immediately upstream of the Caroline Street crossing. No low flow channel was present. |  |

| | |
|---|---|
| **Photo 7**<br><br>July 26, 2017<br><br>Looking upstream the Lower Hager Creek. Flat habitat within a linear form is typical for this reach. |  |
| **Photo 8**<br><br>July 26, 2017<br><br>Looking at an instance of bank stability within the residential area. Retaining walls are common throughout this reach. |  |

# Appendix D

## *Botanical List*

| Scientific Name | Common Names | SARA[1] | ESA[2] | SRank[3] | Coefficient Conservation | Coefficient Wetness |
|---|---|---|---|---|---|---|
| *Acer nigrum* | Black Maple | --- | --- | S4? | 7 | 3 |
| *Acer platanoides* | Norway Maple | --- | --- | SNA | --- | 5 |
| *Alliaria petiolata* | Garlic Mustard | --- | --- | SNA | --- | 0 |
| *Arctium minus* | Common Burdock | --- | --- | SNA | --- | 5 |
| *Chelidonium majus* | Greater Celandine | --- | --- | SDNA | --- | 5 |
| *Crataegus mollis* | Downy Hawthorn | --- | --- | S5 | 4 | -2 |
| *Fallopia japonica* | Japanese Knotweed | --- | --- | SNA | --- | 3 |
| *Fraxinus pennsylvanica* | Green Ash | --- | --- | S4 | 3 | -3 |
| *Juglans nigra* | Black Walnut | --- | --- | S4 | 5 | 3 |
| *Leonurus cardiaca* | Common Motherwort | --- | --- | SNA | --- | 5 |
| *Morus alba* | White Mulberry | --- | --- | SNA | --- | 0 |
| *Poa pratensis* ssp. *pratensis* | Kentucky Bluegrass | --- | --- | S5 | 0 | 1 |
| *Populus deltoides* | Cottonwood | --- | --- | S5 | 4 | -1 |
| *Populus nigra* | Black Poplar | --- | --- | SNA | --- | 5 |
| *Solidago spp.* | Goldenrod species | --- | --- | --- | --- | --- |
| *Salix fragilis* | Crack Willow | --- | --- | S4? | --- | -1 |
| *Ulmus americana* | American Elm | --- | --- | S5 | 3 | -2 |

[1]Federal Species at Risk Act (SAR); [2]Provincial Endangered Species Act (ESA); [3]S-Rank is an indicator of commonness in the Province of Ontario. A scale between 1 and 5, with 5 being very common and 1 being the least common.

# Appendix E

## *Fluvial Geomorphology Assessment*



DILLON CONSULTING

GeoProcess
RESEARCH ASSOCIATES
Knowledge
Research
Consulting

February 26, 2018

Mr. Daniel Bourassa
Dillon Consulting Limited
1155 North Service Road West
Oakville, ON, L6M 3E3

Re: **Burlington Mobility Hub**

**Preliminary Fluvial Geomorphology Assessment Results – Downtown Hub**

## 1 Introduction

GeoProcess Research Associates Inc. was retained by Dillon Consulting Limited to conduct a preliminary fluvial geomorphology assessment for several watercourses in the City of Burlington, in support of the Scoped Environmental Impact Study (EIS) for the City's Mobility Hub Planning. The terms of this study were per the revised scoping document provided by AMEC Foster Wheeler in March of 2017.

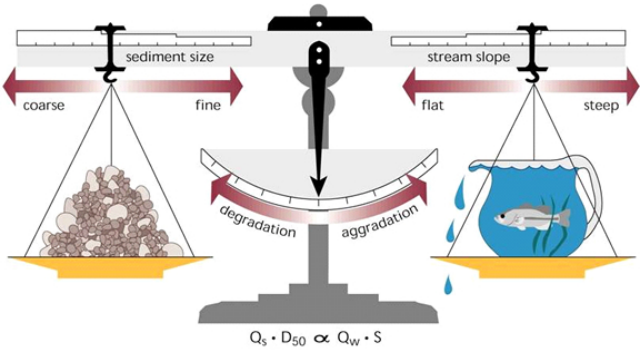
The objective of this assessment was to provide a preliminary assessment and screening pertaining to the geomorphic resiliency of watercourses located within the Mobility Hub study areas, and to identify reaches that are lacking resiliency, and therefore are potentially sensitive to watershed changes (e.g. changes in land-use and rainfall runoff, etc.). Any reaches deemed highly sensitive to change may warrant additional study (e.g. erosion threshold analyses), per the terms of the scoped EIS.

## 1 Geomorphic Context

Geomorphic resiliency, or stability, refers to a watercourse's ability to absorb changes to inputting watershed conditions that influence geomorphic processes, such as changes to hydrology or sediment supply, while remaining functional. Rivers are inherently dynamic systems and a stable river may not have zero erosion. Rather, it will achieve a balance between erosion and sedimentation while conveying the water and sediment inputted to the system. This is referred to as a state of quasi-equilibrium. Many factors can influence a river's resiliency including, but not limited to; slope, surficial geology, bed and bank material composition, interaction with floodplain, valley form (confined vs. unconfined), watershed land-use characteristics and proximal or on-line infrastructure (e.g. dams, bridge piers, weirs). The river's existing stability may also influence its continuing ability to absorb change. For example, if a river is already adjusting to a past disturbance, it may be more susceptible to future disturbances (changes). A river in quasi-equilibrium may also have a low resiliency depending on natural factors such as geology. For example, a stable river having sand bed and banks will be less resilient than a bedrock

PO Box 65506 Dundas
DUNDAS, ON, L9H 6Y6
905.466.6721
www.geoprocessresearch.com

dominated channel. The balance between formative river processes and channel stability is classically illustrated in Lane's diagram, shown in the schematic below.




*Lane's (1955) balance scale schematic (from Rosgen, 1996)*

## 2 Study Area

The Study Area consists of areas around the four Burlington Mobility Hubs: Aldershot GO Station, Appleby GO Station, Burlington GO Station and Downtown (Figure 1). The reaches within each mobility hub are indicated in Figures 2-5. These include reaches of:

- Grindstone Creek Tributary;
- Sheldon Creek;
- Appleby Creek;
- Hager Creek;
- Rambo Creek, and;
- Hager-Rambo Channel.

All Mobility Hubs are within the Iroquois Plain physiological region. Here, watercourses transition from the Niagara Escarpment to the relatively flat plains that were the historic location of the Lake Iroquois shoreline. As such, surficial geology ranges from interbedded shale and dolomite bedrock to glaciolacustrine deposits (sandy-clay till) (OGS, 2010). In the northern most areas, closer to the Escarpment transition, rivers have steeper gradients and gradually flatten as they approach Lake Ontario. Descriptions of each watercourse are provided in the Results section.

## 3 Methods

### *Reach Delineation*

A single river may transition between different morphologies along its course due to changes in geology, slope, valley type, sediment sources, anthropogenic influences or discharge. As such, it is common to separate rivers into segments, or reaches. A reach can range in length, depending on the size and characteristics of the river. However, it should be sufficiently long such that average hydraulic and morphologic characteristics can be confidently estimated. Often, in urban settings, reaches are delineated based on interactions with infrastructure such as bridge crossings or channel erosion protection (e.g. segments entirely lined with gabion baskets). In this assessment, reaches were first delineated based on desktop analyses of planform conditions and further refined after the field investigation, taking into consideration the previously mentioned factors as well as field observations.

### *Field Assessments*

Field assessments were conducted throughout May and June of 2017. Assessments included reconnaissance-level investigations where indicators of channel stability and instability were observed and documented (including GPS locations). Additionally, erosion prone areas were documented, including the extent of channel and valley confinement. Stream and river erosion hazard criteria are governed by Section 3.0 of the Provincial Policy Statement of the *Planning Act*, and are managed locally by Conservation Halton. Erosion hazard (from fluvial processes) identification assists in developing long-term erosion rates and toe erosion setbacks, which differ for different valley types and depend on the river's proximity to the toe of slope. Results from these high-level assessments can be used to identify critical erosion prone reaches that may require more detailed field investigation, and also assist in future land-use planning exercises such as meander beltwidth delineations and erosion hazard setbacks. Detailed, site level erosion hazard delineations were beyond the scope of this study.

A Rapid Geomorphic Assessment (RGA) was conducted for each reach, following the Ministry of Environment (2003) standards. The RGA assesses channel stability in four geomorphic regimes; aggradation, degradation, channel widening and planimetric form adjustment. Each component has several indicators of instability that are itemized on a standardized field form. These indicators were observed (or were omitted from the evaluation if not present) during the field reconnaissance and were noted on the field form. A Stability Index (SI) for each of the four components is obtained by the following formula:

$$SI_i = \frac{IN_{OBS}}{IN_{OBS} + IN_{NOT}}$$

where $IN_{OBS}$ is the number of observed indicators and $IN_{NOT}$ is the number of indicators that were not observed. It should be noted that $IN_{OBS} + IN_{NOT}$ may not always correspond with the total number of indicators for that specific component as there may be some indicators which do not apply to a specific reach. For example, if a reach does not have any storm sewers, then the degradation indicator "Elevated storm sewer outfall(s)" would not be included in either $IN_{OBS}$ or $IN_{NOT}$. The overall reach Stability Index is obtained by taking the average of the four component's Stability Index.

An SI index between 0 and 0.2 corresponds to a channel in quasi-equilibrium, or "In Regime". This implies that observed instabilities are nominal and associated with normal fluvial processes, being local instances of erosion or deposition and not representative of systemic instability. Values between 0.2 and 0.4 correspond with a channel that is "Transitional or Stressed", implying that evidence of instability is more common. An SI greater than 0.4 corresponds to a channel that is "In Adjustment", meaning that instability is likely systemic (at least reach-wide) and that the channel is shifting to a new state of quasi-equilibrium, likely in response to the adjusting watershed conditions (e.g. likely due to urbanization or past instances of channel alterations).

As mentioned, the current degree of stability relates to a channel's resiliency and ability to absorb additional change (i.e. new stormwater runoff from mobility hub areas). A channel that is currently in adjustment may be more sensitive to additional change, and thus is less resilient. When combined with other field observations such as degree of confinement, ready access to a floodplain and proximity of the channel to the toe of slope, an overall estimate of channel resiliency and sensitivity to change can be established.

### *Mapping*

Results from the field assessments were incorporated into a Geographic Information System (GIS) database to effectively visualise different parameters characterized throughout the assessments.

# 4 Results

## Reach Descriptions

### Hager Creek

Hager Creek downstream of the Hager-Rambo Channel does not receive water from the upper Hager watershed due to the diversion (Figure 2). This entire river has been historically channelized to accommodate the development of downtown Burlington. Due to the lack of watershed area and channelization, the watercourse does not have a large topographic difference between the channel and surrounding land. Instead, the river flows adjacent to many residential lots and, in some cases, under private infrastructure such as decks. Erosion protection is common on the banks in the form of riprap, armourstone and retaining walls. Common to channelized rivers, evidence of incision and widening were observed, however these impacts have likely been mitigated due to the Hagar-Rambo Channel diversion, such that the extent of channel adjustment does not reflect the density of urban development throughout the watershed.

### Rambo Creek

Similar to Hager Creek, the lower reach of Rambo Creek is disconnected from its headwaters due to the Hager-Rambo Channel Diversion (Figure 2). Again, the entire length of channel has been historically channelized to accommodate the development of downtown Burlington. Correspondingly, incision and widening have occurred over time, resulting in the erosion protection measures commonly being undermined along the channel. In general, Rambo Creek is in a more degraded state than the adjacent Hager Creek, possibly due to a lesser density of bank protection, which offers more opportunity for fluvial forces to erode the exposed banks. Evidence of channel adjustment decreases as the gradient diminishes approaching Lake Ontario, which corresponds to a decrease in erosive forces and the mitigating effect of the Lake Ontario backwater.

## Rapid Assessment Summary

Figure 3 illustrates the reach characterizations associated with the RGA results. Per the terms of the scoped EIS, the valley confinement was also mapped and is illustrated in Figure 4. The results for each component of the RGA are summarized in Table 1. A detailed table associated with the field assessment is provided in Appendix A.

*Table 1 Rapid Geomorphic Assessment Results*

| Reach | Form/Process Factor Value | | | | Stability Index | Classification |
|---|---|---|---|---|---|---|
| | Aggradation | Degradation | Widening | Planimetric Adjustment | | |
| HC01 | 0.57 | 0.17 | 0.57 | 0.14 | 0.36 | Transitional or Stressed |
| HC02 | 0.4 | 0 | 0.14 | 0 | 0.14 | In Regime |
| HC03 | 0.2 | 0 | 0.14 | 0.14 | 0.12 | In Regime |
| RC04 | 0.43 | 0.25 | 0.67 | 0.29 | 0.41 | In Adjustment |
| RC05 | 0.14 | 0.11 | 0.56 | 0.29 | 0.27 | Transitional or Stressed |
| RC06 | 0 | 0.33 | 0.56 | 0.29 | 0.29 | Transitional or Stressed |
| RC07 | 0.43 | 0.29 | 0.75 | 0.29 | 0.44 | In Adjustment |
| RC08 | 0.25 | 0.22 | 0.29 | 0 | 0.19 | In Regime |

## Culvert Inventory

Figure 5 illustrates the locations of outfalls within each reach. A corresponding photo and description of each culvert can be found in Appendix B.

## 5 Conclusions and Discussion

In general, both channels in the Downtown Hub are considered geomorphically strained due to their channelized nature and other urban stressors. However, the Rambo Creek reaches are considerably more degraded. The more entrenched valley, lack of floodplain access and existing instability make this river less resilient to future alterations to hydrology, sediment supply or proximal infrastructure.

Although the existing stability of Hager Creek is greater than Rambo Creek, its confined nature and lack of floodplain also decrease the stream's resiliency to future changes, especially where existing bank hardening is already being compromised. It is suspected that the common impacts of urbanization and channelization (channel enlargement through incision and widening) have been mitigated through both the extensive bank hardening and the Hagar-Rambo Channel diversion. However, given that the stream has been adjusting to this new flow regime since the diversion was completed, any alterations may cause additional incision that could compromise the bank erosion protection infrastructure.

It should be noted that the Rapid Geomorphic Assessment is intended for channels that still have a natural planimetric shape (i.e. not realigned) and only have minimal channel alterations. Given the heavily modified condition of most of these reaches some of the assessment indicators are not relevant, specifically those in the planimetric adjustment section. However, the assessments were still completed to the typical standards and in such a way to best account for this divergence from the standard procedure. The results of the assessments remain effective indicators of the state of channel equilibrium; however, should be interpreted with the noted limitations in mind.

The reach mapping accompanying this technical memo should be considered within the context of the overall impact assessment and combined with the results of other studies, with the least resilient reaches (those indicated as in-adjustment) shown on the mapping being the focus of future site-level studies related to SWM sizing, outlets and the detailed erosion hazard mapping.

Regards,

**GEOPROCESS RESEARCH ASSOCIATES INC.**

Jeffrey Hirvonen, MASc.
Principal, Fluvial Geomorphologist


## Legend

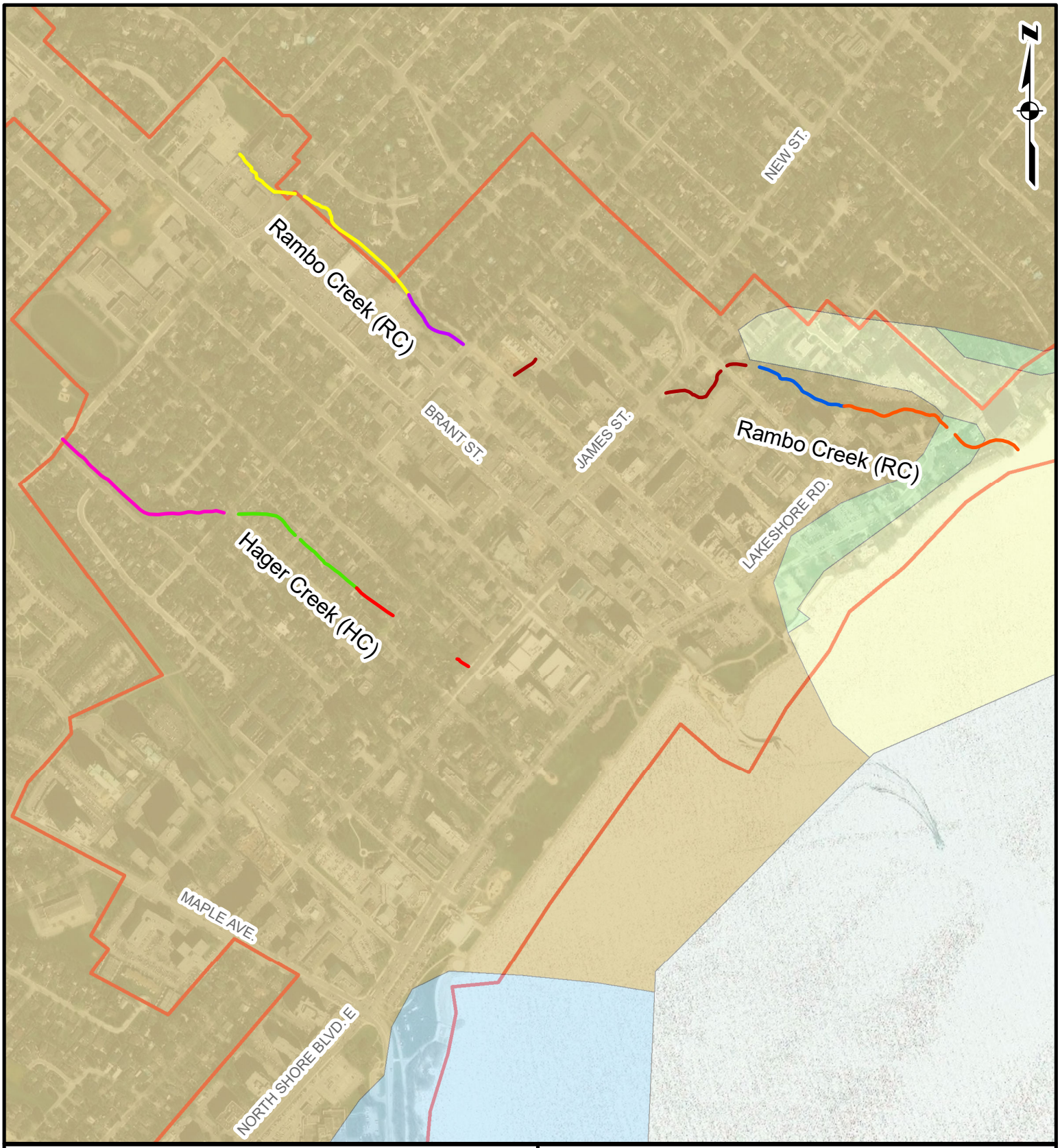
- Aldershot GO Hub Study Area
- Appleby GO Hub Study Area
- Burlington GO Hub Study Area
- Downtown Hub Study Area
- Watercourse
- Ponds

GeoProcess RESEARCH ASSOCIATES

Scale: 0 625 1,250 2,500 Meters

Title: **P2017-237 Mobility Hub Study Site Overview**

| Created By: | MI | Checked By: | BP |
|---|---|---|---|
| Date: | 2018-01-17 | Figure: | 1 |




## Legend

- RC04
- RC05
- RC06
- RC07
- RC08
- HC01
- HC02
- HC03
- Study Area
- Bedrock
- Halton Till
- Lacustrine and outwash sand
- Lake Ontario deposits

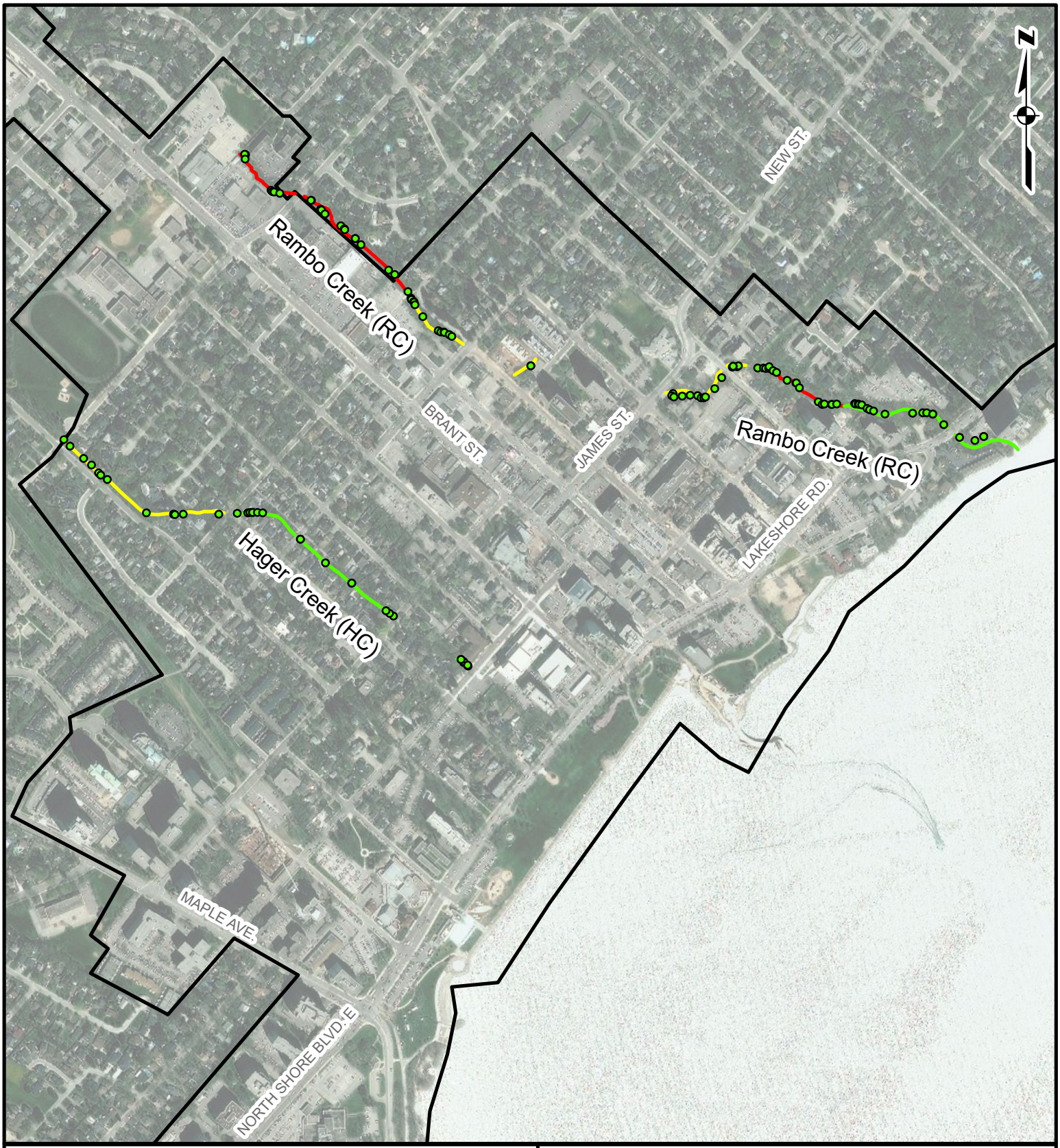
Ontario Geological Survey 2010. Surficial geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release - Data 128 - Revised.

GeoProcess RESEARCH ASSOCIATES

Scale: 0 100 200 400 Meters

Title: **P2017-237 Downtown Hub Reach Delineation**

| Created By: | MI | Checked By: | BP |
|---|---|---|---|
| Date: | 2018-01-17 | Figure: | 2 |




## Legend

- In Adjustment
- In Regime
- Transitional or Stressed
- GRA Photo
- Study Area

GeoProcess RESEARCH ASSOCIATES

Scale: 0 100 200 400 Meters

Title: **P2017-237 Downtown Hub Rapid Assessment Summary**

| Created By: | MI | Checked By: | BP |
|---|---|---|---|
| Date: | 2018-01-17 | Figure: | 3 |


## Legend

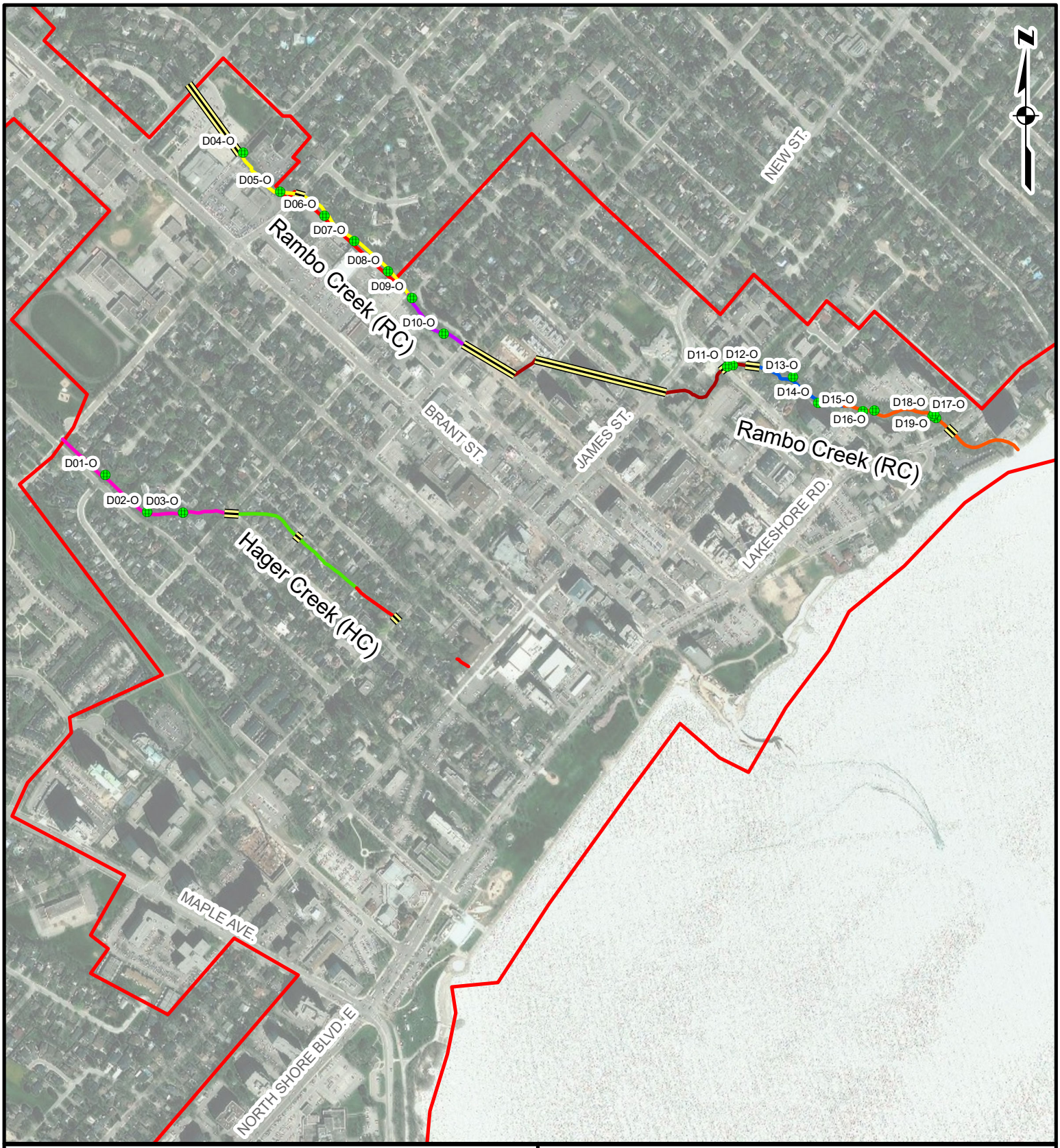
- Confined
- Study Area

GeoProcess RESEARCH ASSOCIATES

Scale: 0 100 200 400 Meters

Title: **P2017-237 Downtown Hub Valley Confinement**

| Created By: | MI | Checked By: | BP |
|---|---|---|---|
| Date: | 2018-01-17 | Figure: | 4 |




## Legend

- RC04
- RC05
- RC06
- RC07
- RC08
- HC01
- HC02
- HC03
- Outfall Structure
- Culvert Structure
- Study Area

GeoProcess RESEARCH ASSOCIATES

Scale: 0 100 200 400 Meters

Title: **P2017-237 Downtown Hub Outfall Locations**

| Created By: | MI | Checked By: | BP |
|---|---|---|---|
| Date: | 2018-01-18 | Figure: | 5 |

***Appendix A***

*Detailed Assessment Summary Table*

*Table 2 Burlington Mobility Hub - Detailed Assessment Summary Table – Downtown Hub*

| Reach | Dominant Morphology | Dominant Bank Material | Dominant Bed Material | Floodplain Access? | Erosion Protection Present? | Valley Confinement | Valley Toe Contact? | RGA Score | RGA Description | Dominant Instability |
|---|---|---|---|---|---|---|---|---|---|---|
| HC01 | Channelized - Riffle-pool | Sandy-clay till | Sand / gravel | No | Armourstone / riprap / concrete (partial) | Confined | Yes | 0.36 | Transitional or Stressed | Widening, Aggradation |
| HC02 | Channelized - Plane-bed | Sandy-clay till | Sand / gravel | No | Armourstone | Confined | Yes | 0.14 | In Regime | N/A |
| HC03 | Channelized - Plane-bed | Sandy-clay till | Sand / gravel | No | Gabion / riprap / concrete / wood / armourstone | Confined | Yes | 0.12 | In Regime | N/A |
| RC04 | Channelized - Riffle-pool | Sandy-clay till | Gravel / cobble | No | Armourstone / riprap / concrete (partial) | Confined | Yes | 0.41 | In Adjustment | Widening |
| RC05 | Channelized - Riffle-pool | Sandy-clay till | Gravel / cobble with bedrock outcrop | No | No | Confined | Yes | 0.27 | Transitional or Stressed | Widening |
| RC06 | Channelized - Riffle-pool | Sandy-clay till | Gravel / cobble with bedrock outcrop | No | Gabion / concrete / armourstone | Confined | Yes | 0.29 | Transitional or Stressed | Widening |
| RC07 | Channelized - Riffle-pool | Sandy-clay till | Sand / gravel with bedrock outcrop | No | Gabion / riprap (partial) | Confined | Yes | 0.44 | In Adjustment | Widening |
| RC08 | Channelized - Plane-bed | Sandy-clay till | Sand | No | Armourstone / concrete (partial) | Confined | Yes | 0.19 | In Regime | N/A |

***Appendix B***

*Infrastructure Inventory*

| | |
|---|---|
| **Name:** | D01-O |
| **Area:** | Downtown |
| **Watercourse:** | Hager Creek |
| **Reach:** | HC01 |
| **Coordinates:** | E596761.183, N4797796.449 |
| **Reach Assessment Result:** | Transitional or Stressed |
| **Description:** | Interlocking stone headwall and PVC pipe |

| | |
|---|---|
| **Name:** | D02-O |
| **Area:** | Downtown |
| **Watercourse:** | Hager Creek |
| **Reach:** | HC01 |
| **Coordinates:** | E596825.476, N4797739.934 |
| **Reach Assessment Result:** | Transitional or Stressed |
| **Description:** | Concrete headwall and gate |

| | |
|---|---|
| **Name:** | D03-O |
| **Area:** | Downtown |
| **Watercourse:** | Hager Creek |
| **Reach:** | HC01 |
| **Coordinates:** | E596880.973, N4797738.862 |
| **Reach Assessment Result:** | Transitional or Stressed |
| **Description:** | Concrete wall with PVC pipe and gate |

| | |
|---|---|
| **Name:** | D04-O |
| **Area:** | Downtown |
| **Watercourse:** | Rambo Creek |
| **Reach:** | RC04 |
| **Coordinates:** | E596973.564, N4798294.091 |
| **Reach Assessment Result:** | In Adjustment |
| **Description:** | Concrete headwall and gate |

| | |
|---|---|
| **Name:** | D05-O |
| **Area:** | Downtown |
| **Watercourse:** | Rambo Creek |
| **Reach:** | RC04 |
| **Coordinates:** | E597030.423, N4798234.190 |
| **Reach Assessment Result:** | In Adjustment |
| **Description:** | Concrete headwall |

| | |
|---|---|
| **Name:** | D06-O |
| **Area:** | Downtown |
| **Watercourse:** | Rambo Creek |
| **Reach:** | RC04 |
| **Coordinates:** | E597099.016, N4798197.584 |
| **Reach Assessment Result:** | In Adjustment |
| **Description:** | Concrete headwall with clay pipe |

| | |
|---|---|
| **Name:** | D07-O |
| **Area:** | Downtown |
| **Watercourse:** | Rambo Creek |
| **Reach:** | RC04 |
| **Coordinates:** | E597144.842, N4798157.685 |
| **Reach Assessment Result:** | In Adjustment |
| **Description:** | CSP |

| | |
|---|---|
| **Name:** | D08-O |
| **Area:** | Downtown |
| **Watercourse:** | Rambo Creek |
| **Reach:** | RC04 |
| **Coordinates:** | E597197.442, N4798110.589 |
| **Reach Assessment Result:** | In Adjustment |
| **Description:** | Clay pipe with concrete protection |

| | |
|---|---|
| **Name:** | D09-O |
| **Area:** | Downtown |
| **Watercourse:** | Rambo Creek |
| **Reach:** | RC05 |
| **Coordinates:** | E597234.219, N4798069.843 |
| **Reach Assessment Result:** | Transitional or Stressed |
| **Description:** | PVC pipe |

| | |
|---|---|
| **Name:** | D10-O |
| **Area:** | Downtown |
| **Watercourse:** | Rambo Creek |
| **Reach:** | RC05 |
| **Coordinates:** | E597283.087, N4798014.281 |
| **Reach Assessment Result:** | Transitional or Stressed |
| **Description:** | Pipe with concrete protection |

| | |
|---|---|
| **Name:** | D11-O |
| **Area:** | Downtown |
| **Watercourse:** | Rambo Creek |
| **Reach:** | RC06 |
| **Coordinates:** | E597720.709, N4797964.539 |
| **Reach Assessment Result:** | Transitional or Stressed |
| **Description:** | Concrete outfall and gate |

| | |
|---|---|
| **Name:** | D12-O |
| **Area:** | Downtown |
| **Watercourse:** | Rambo Creek |
| **Reach:** | RC06 |
| **Coordinates:** | E597729.060, N4797965.867 |
| **Reach Assessment Result:** | Transitional or Stressed |
| **Description:** | Gabion wall and concrete pipe |

| | |
|---|---|
| **Name:** | D13-O |
| **Area:** | Downtown |
| **Watercourse:** | Rambo Creek |
| **Reach:** | RC06 |
| **Coordinates:** | E597821.912, N4797947.738 |
| **Reach Assessment Result:** | In Adjustment |
| **Description:** | Outfall pipe |

| | |
|---|---|
| **Name:** | D14-O |
| **Area:** | Downtown |
| **Watercourse:** | Rambo Creek |
| **Reach:** | RC07 |
| **Coordinates:** | E597861.005, N4797907.389 |
| **Reach Assessment Result:** | In Adjustment |
| **Description:** | Concrete headwall |

| | |
|---|---|
| **Name:** | D15-O |
| **Area:** | Downtown |
| **Watercourse:** | Rambo Creek |
| **Reach:** | RC08 |
| **Coordinates:** | E597929.903, N4797895.442 |
| **Reach Assessment Result:** | In Regime |
| **Description:** | Gabion wall and concrete pipe |

| | |
|---|---|
| **Name:** | D16-O |
| **Area:** | Downtown |
| **Watercourse:** | Rambo Creek |
| **Reach:** | RC08 |
| **Coordinates:** | E597947.683, N4797896.236 |
| **Reach Assessment Result:** | In Regime |
| **Description:** | Concrete headwall and clay pipe |

| | |
|---|---|
| **Name:** | D17-O |
| **Area:** | Downtown |
| **Watercourse:** | Rambo Creek |
| **Reach:** | RC08 |
| **Coordinates:** | E598038.022, N4797887.902 |
| **Reach Assessment Result:** | In Regime |
| **Description:** | Concrete headwall and pipe |

| | |
|---|---|
| **Name:** | D18-O |
| **Area:** | Downtown |
| **Watercourse:** | Rambo Creek |
| **Reach:** | RC08 |
| **Coordinates:** | E598039.822, N4797890.937 |
| **Reach Assessment Result:** | In Regime |
| **Description:** | Concrete headwall |

| | |
|---|---|
| **Name:** | D19-O |
| **Area:** | Downtown |
| **Watercourse:** | Rambo Creek |
| **Reach:** | RC08 |
| **Coordinates:** | E598043.553, N4797884.984 |
| **Reach Assessment Result:** | In Regime |
| **Description:** | Stone wall and pipe |

# References

Bird Studies Canada. 2009. Marsh Monitoring Program. 32 pgs.

Cadman, M.D., D.A. Sutherland, G.G. Beck, D. Lepage, and A.R. Couturier. 2007. Atlas of the Breeding Birds of Ontario 2001-2005. Bird Studies Canada, Environmental Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources, and Ontario Nature, Toronto. 706 pgs.

Chapman, L.J. and D.F. Putnam, 1984. The Physiography of Southern Ontario. 3rd ed. Ontario Geological Survey, Special Volume 2, 270p.

City of Burlington. 1997. Official Plan of the Burlington Planning Area. As approved by the Region of Halton 1995; Office Consolidation 2017.

City of Burlington. 2010. Urban Forestry Management Plan; 2011-2030. 60 pgs.

Conservation Halton. 2005. Environmental Impact Statement Guidelines. 48 pgs.

Conservation Halton. 2017. Guidelines for Ecological Studies. 6 pgs.

Conservation Halton. 2013. Long Term Environmental Monitoring Program 2012 Bronte

Creek, Urban Creeks and Supplemental Monitoring. Conservation Halton, Burlington, ON. 173 pgs.

Conservation Halton. 2009. Long Term Environmental Monitoring Program 2008 Urban Creeks and Supplemental Monitoring. Conservation Halton, Burlington, ON. 92 pgs.

Conservation Halton. 2009. Long Term Environmental Monitoring Program 2006 Grindstone Streek and Annual Monitoring. Conservation Halton, Burlington, ON. 76 pgs.

Conservation Halton. 2006. The North Shore Watershed Study. 228 pgs.

Conservation Halton. 2006. Policies and Guidelines for the Administration of Ontario Regulation 162/06 and Land Use Planning Policy Document. 93 pgs.

Conservation Halton. 2006. Policies and Guidelines for the Administration of Ontario Regulations 162/06 and Land Use Planning Document. April 27, 2006, last amended November 26, 2015. 89 pgs.

GeoProcess Research Associates (GeoProcess). 2018. Burlington Mobility Hub – Preliminary Fluvial Geomorphology Assessment Results – Downtown Hub. 20 pgs.

Halton-Hamilton Source Protection Staff. 2012. Assessment Report for the Halton Region Source Protection Area Version 2.1. Approved by the Ministry of Environmental 2012. 403 pgs.

Lee, H. T., W.D. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig 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.

Newmaster, S. G., Lehela, A., Uhlig, P. W. C., McMurray, S., & Oldham, M. J. (1998). Ontario plant list. Sault Ste. Marie, Ontario: Ontario Ministry of Natural Resources.

Ontario Breeding Bird Atlas. 2001. Guide for Participants. Atlas Management Board, Federation of Ontario Naturalists, Don Mills.

Ontario Breeding Birds Atlas. 2002. Standard Owl Surveys. Instruction Manual. 17pgs.

Ministry of Natural Resources and Forestry (MNRF). 2000. Significant Wildlife Habitat Technical Guide. 151 pgs.

Ministry of Natural Resources and Forestry (MNRF). 2010. Natural Heritage Reference Manual for Policies of the Provincial Policy Statement, Second Edition. March 18, 2010. 369 pgs. + Appendix.

Ministry of Natural Resources and Forestry (MNRF). 2013. Ontario Wetland Evaluation System. Southern Manual. Third Edition, Version 3.2. 294 pgs.

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

Ministry of Municipal Affairs and Housing. 2014. Provincial Policy Statement under the Planning Act. 56 pgs.

Ministry of Municipal Affairs and Housing. 2017. Greenbelt Plan. 98 pgs.

Ministry of Public Infrastructure Renewal. 2017. Places to Grow: Growth Plan for the Greater Horseshoe. 54 pgs.

Provincial Policy Statement, 2014.

Regional Municipality of Halton. 2009. Halton Region Official Plan [2009]. Interim Office Consolidation of the Regional Official plan September 28, 2015. Based on Amendment 30 “An Amendment to Incorporate the Results of Sustainable Halton, Official Plan Review Directions and Related Matters.” 196 pgs. + Maps.

Regional Municipality of Halton. 2016. Environmental Impact Assessment Guidelines: Regional Official Plan Guidelines. 54 pgs.

Regional Municipality of Halton. 2006. Halton Region Natural Areas Inventory. Volume 2 : Species Checklist.

Stanfield, L., Del Giudice, L., Bearss, E., and D. Morodvanschi 2009. Ontario Stream Assessment Protocol. Ontario Ministry of Natural Resources, Peterborough. 277 pgs.

Wood Environment & Infrastructure Solutions (Wood). 2019. Flood Hazard and Scoped Stormwater Management Assessment – Burlington Go and Downtown Mobility Hubs. February 25, 2019. 234 pgs.

Wood Environment & Infrastructure Solutions (Wood). 2019. Downtown Stormwater Quality Control Plan – DRAFT Final. March 25, 2019. 36 pgs.