DILLON CONSULTING

BURLINGTON MOBILITY HUB

Scoped Environmental Impact Study

Aldershot Mobility Hub

August 2022 – 17-5015

Table of Contents

Figures

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 Aldershot Mobility Hub. The limits of the Aldershot Mobility Hub Planning Area (herein referred to as the "Study Area") are delineated on **Figure 1.** Please note that the Study Area depicted on the Figures included herein illustrates the total Planning Area. A Natural Heritage Study was prepared for the City for the area north of the railway and will be provided to review agencies under separate cover. The Study Area for the Aldershot Mobility Hub was amended to exclude the area north of the railway in 2021 updates.

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:

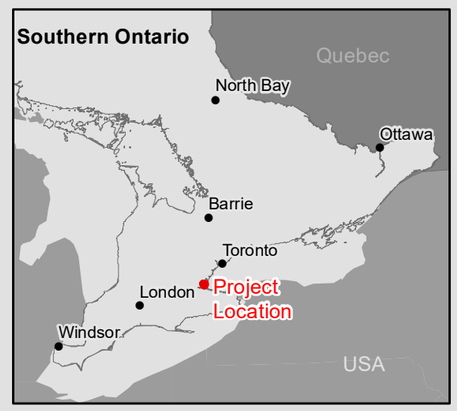
- Conservation Halton ("CH") Environmental Impact Statement Guidelines (November 2005);
- Halton Regions ("Halton") Environmental Impact Assessment Guidelines (2016);
- CH's Guidelines for Ecological Studies (March 2017);
- Regional Official Plan Amendment Number 38 ("ROPA 38", 2015);
- Regional Official Plan Policy 77(5) study requirements for an Area-Specific Plan (2015); as well as,
- 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

ALDERSHOT
BURLINGTON HUB MOBILITY STUDY

STUDY AREA
FIGURE 1

- Study Area
- Road
- Railway
- Watercourse
- Waterbody
- Provincially Significant Wetland
- MNRF Wooded Area
- ANSI, Life Science



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: 2021-11-12

FILE LOCATION: G:\cad\GIS\175015\Mapping\EIS_Aldershot\Aldershot_Fig1_StudyArea.mxd

2.0 Overview of Policy Framework

The Aldershot 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 the purpose 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 Mapping and Schedules referenced within **Section 2.0**.

2.1 Provincial Framework

2.1.1 Provincial Policy Statement (2020)

The Provincial Policy Statement, 2020 (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 efficient development and land use patterns, wise use and management of resources, and protecting public health and safety. The PPS defines the NHS as a '*system made up of natural heritage features and areas, and linkages intended to provide connectivity (at the regional or site level) and support natural processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species and ecosystems.'* 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 ground water 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 ground water features, means areas that are particularly susceptible to impacts from activities or events, including, but not limited to, water withdrawals, and additions of pollutants.*

This report deals specifically with Policies 2.1.1 and 2.1.2 which provides for the long-term protection, management and connectivity of natural features in an area. Policy 2.1.2 states: *'the diversity and connectivity of natural features in an area, and the long-term ecological function and biodiversity of natural heritage systems, should be maintained, restored or, where possible, improved, recognizing linkages between and among natural heritage features and areas, surface water features and ground water features*.'

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 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 (2020)

Pursuant to the Places to Grow Act, 2005, the Growth Plan for the Greater Golden Horseshoe, 2019 (Growth Plan) was approved on June 16, 2006. The Growth Plan has been amended four 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. Following the third amendment (July 1, 2017); the fourth amendment came into effect on May 16, 2019. Lastly, the fifth and final amendment was issued August 28, 2020.

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).

Section 4.2.2 of the Growth Plan states that the NHS mapping will exclude lands within settlement area boundaries that were approved and in effect as of May 16, 2019. As per Section 4.2.2(6), beyond the NHS, including within settlement areas, the municipality will continue to protect any other natural heritage features in a manner that is consistent with the PPS (2020).

As per Schedule 4 of the Greater Golden Horseshoe Growth Plan (**Appendix B**), the Study Area is designated as "*Built-Up Area*". Policies regarding *Built-Up Areas* are listed under Section 2.2.2 of the GPGGH, speak to minimum intensification targets for residential development in delineated *Built-Up Areas*.

2.1.3 Greenbelt Plan (2017)

Pursuant to the Greenbelt Act, 2005, the Greenbelt Plan was introduced in 2005 (MMAH) as a sub strategy to the original 2005 Growth Plan and the PPS (2020) to define growth and development within the GGH along with the Oakridge's Moraine Conservation Plan (ORMCP), and the Niagara Escarpment Plan (NEP). The Greenbelt Plan was recently updated in 2017; the update to the Greenbelt Plan was approved by the Lieutenant Governor in Council, Order in Council No. 1025/2017 as an amendment to the Greenbelt Plan on July 1, 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 largely inside of the Built Boundary identified in Map 1 of the ROP, except for the segment bounded by the railway and Highway 403 east of Waterdown Road.

Based on the most recent consolidation of the ROP (January 13, 2016), the Aldershot Study Area contains the following designations, as shown on Map 1 of the ROP:

- *Urban Area*: Policies 72 – 77(21) of the ROP addresses the Urban Area designation and contains provisions for environmental protection and undertaking environmental studies within the urban area.
- *Regional Natural Heritage System*: The general Natural Heritage System policies that apply to the Study Area are outlined in Policies 113 through 114.2 of the ROP. Specific to the Regional Natural Heritage System are Policies 115.2 through 118.
- *Major Transit Station*: The Aldershot Station is shown as a Major Transit Station 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.

The proposed Study Area is located on lands that are partially within Halton's Natural Heritage System and partially designated Regional Natural Heritage System on Map 1 of the Regional Official Plan (ROP) consolidated June 19 2018. Additionally, the Study Area contains or is adjacent to:

Features identified as Key Features as Illustrated on Map 1G of the ROP including:

- unmapped significant woodlands;
- provincially significant wetlands (PSWs);
- candidate significant wildlife habitat (SWH);
- candidate habitat of endangered or threatened species (SAR); and,
- fish habitat

Conservation Halton (CH) regulation Areas:

- Areas identified as Highly Vulnerable Aquifer Area within the April 2015 Halton-Hamilton Source Protection Region Assessment Report; and,
- Areas regulated by CH such as watercourses and floodplains.

2.3 Municipal Framework

2.3.1 City of Burlington Official Plan

The City's Official Plan 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 Official Plan 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 Official Plan through By-law 24-2018, titled '*Grow Bold: Burlington's Official Plan'.* This new Official Plan 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 Official Plan, the following sections provide a review of the current Official Plan and the Grow Bold Plan in turn.

2.3.1.1 Current Official Plan (July 2015 Consolidation)

Sustainable environment policies described in Part II, Section 2 of the Official Plan 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 lies just south of the North Aldershot Planning Area, and falls within the Urban Area Boundary as depicted on Schedule B of the Official Plan. The land uses in the study area include:

- *General Employment* and *Business Corridor*: These land uses make up the two Employment designations in the City. Development in these areas are subject to the Employment policies outlined in Part III, Section 3.1 to Section 3.2 of the Official Plan. Policies specific to the *General Employment* designation are outlined in Section 3.3, and those specific to the *Business Corridor* are outlined in Section 3.4 of the Plan. It should be noted that the segment of the Study Area bounded by the railway and Highway 403 east of Waterdown Road has a special note 'R16' attached to it, noting an appeal and subsequent amendment to the land use and is awaiting an OMB decision (details provided in Section I of the City's Official Plan).
- *Mixed Use Corridor – Commercial Corridor 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 through Section 5.3.2.

Section 5.3.3 provides policies for the *Mixed Use Corridor – Commercial Corridor* designation, with policies for the *Mixed Use Corridor – Employment* designation outlined in Section 5.3.4.

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

2.3.1.2 Grow Bold: 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 Official Plan, adopted by Burlington City Council on April 26, 2018 (the Grow Bold Plan). 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 Grow Bold Plan (Section 2.3.5).

The policies corresponding to the Natural Heritage System, Parks, and Open Space designation are defined in Section 8.4 of the Grow Bold Plan. Policies state that the City's Natural Heritage System is designated on Schedule C. The Natural Heritage System in the Urban Area is part of the broader city-wide Natural Heritage System, which in turn is part of a much larger system outside of city boundaries.

Schedule A of the Grow Bold Plan designates the majority of the Study Area as Urban Area, with the exception of a few small scattered parcels between Highway 403 and the Rail Line identified as Green System. The Study Area is designated on Schedule B of the Grow Bold Plan as being a Mobility Hub with a combination of Mixed-Use Nodes and Intensification Corridors, Employment Lands (to be added to Region of Halton Employment Area), Residential Neighbourhood Area, and Natural Heritage System, Major Parks and Open Space. Schedule B-1 of the Grow Bold Plan further identifies that the large majority of the Study Area falls within the Primary Growth Area, with a portion of Established Neighbourhood Area, and some Natural Heritage System and Major Parks and Open Space. The northeast portion of the Study Area is outside of the Delineated Built Boundary shown on Schedule B-1. Within this segment, which is bounded by the Grindstone Creek to the south and Highway 403 to the north, the lands are designated as Natural Heritage System and Major Parks and Open Space, with a small portion identified as Developed Area Outside the Delineated Built Boundary.

According to Schedule C of the Grow Bold Plan, the lands adjacent to Waterdown Road and Plains Road West are designated as either Urban Corridor or Urban Corridor- Employment Lands. North of the Rail Line, there is a portion of Business Corridor uses designated for the area between the Rail Line and Highway 403, along with some lands belonging to the City's Natural Heritage System. The policies pertaining to the Urban Corridor and Urban Corridor-Employment Lands designations are provided in Section 8.1.3 of the Grow Bold Plan, with the Business Corridor designation policies provided in Section 8.2.4.

The balance of lands south of the Rail Line includes General Employment, Residential – Low Density, and a portion of the City's Natural Heritage System located towards the western boundary of the Study Area along Grindstone Creek. The General Employment policies are provided in Section 8.2.3 of the Grow Bold Plan, with the Residential Low-Density policies provided in Section 8.3.3.

Schedule M of the new Official Plan identifies the watercourses of Grindstone Creek and wooded area in the northern part of the Study Area designated as a Key Natural Feature as part of the City's Natural Heritage System.

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 by the Ministry of Natural Resources and Forestry (MNRF).

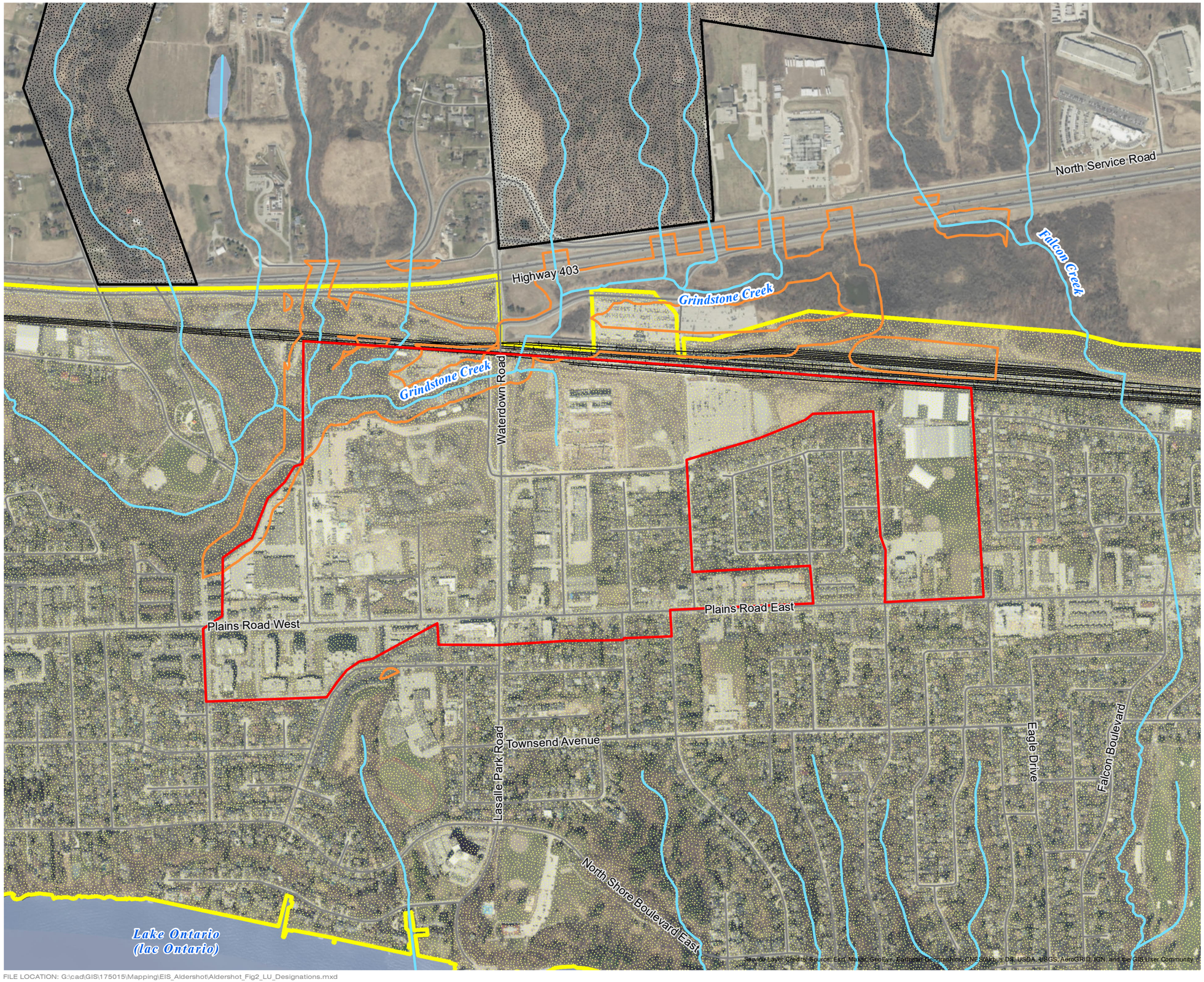
The potential for SAR and SAR habitat to be present within the Study Area is discussed further in **Section 3.4** and **Section 5.5** of this report.

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 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.

The northern portion of the Study Area, attributed to Grindstone Creek, is located within a CH Regulated Area (**Figure 2**).



CITY OF Burlington

ALDERSHOT

BURLINGTON HUB MOBILITY STUDY

PROVINCIAL AND AGENCY LAND USE DESIGNATIONS

FIGURE 2

- Study Area
- Road
- Railway
- Watercourse
- Waterbody
- Built Boundary for the Growth Plan for the Greater Golden Horseshoe (2020)
- Conservation Halton Regulation Limit within Study Area (2012-05-14)

Greenbelt Designation

- Protected Countryside

0 50 100 200 Metres

N W E S

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: 2021-11-12

FILE LOCATION: G:\cad\GIS\175015\Mapping\EIS_Aldershot\Aldershot_Fig2_LU_Designations.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 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, sand bars 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 have 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 two watersheds. The northern portion of the Study Area is within the Grindstone Creek Watershed while the southern portion is within the West Aldershot Watershed; which is one of five watersheds captured within the North Shore Watershed.

3.2.1.1 Grindstone Creek Watershed

This watershed is the smallest of the major watersheds in CH's jurisdiction at approximately 99 km2, conveying 14% of the natural water that flows into Hamilton Harbour (CH, 2006). The watershed has large wetland complexes, on-line ponds, deep valley systems and streams running through intensive agriculture (CH, 2013). Predominately rural in character with the majority of it composed of rural residential, agricultural and open space, it also consists of 28% forest cover. A portion of this forest falls within the Carolinian Forest zone, which reaches its northern limit in this region of Southern Ontario (CH, 2006).

Grindstone Creek Watershed is 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 CH's watersheds. 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. Reports issued in 2009 and 2013 document the monitoring progress and results of environmental assessments (fish community sampling, benthic invertebrate sampling, channel morphology, ecological land classifications, marsh monitoring, etc.; CH 2009 & 2013).

3.2.1.2 North Shore Watershed

The North Shore Watershed is located on the north short of Hamilton Harbour and the western end of Lake Ontario. The creeks in the watershed originate from above the Niagara Escarpment and empty into the Hamilton Harbour on the north shore. The watershed contains four larger watercourses and their associated watersheds; such as West Aldershot watershed. The catchment area for the West Aldershot watershed is 4.4 km^2; which contributes to the overall North Shore Watershed area of about 33 km^2 (CH, 2006). The majority of the North Shore Watershed is characterized as being in a mature stage of urban development; with several major transportation corridors as well as a major hydro utility corridor. The land use includes industrial, commercial, recreational and residential components. The majority of the natural areas are associated with the south slope of the Niagara Escarpment (CH, 2006).

Overall, the urbanization and the demand for development within the watersheds have altered the natural state of the shoreline and many of the tributaries and creeks.

3.2.2 Fish Habitat

3.2.2.1 Grindstone Creek

The fish community of Grindstone Creek is varied with 82 different species of fish recorded since the early 1900s (CH Fish Database, 2013). Fish sampling in 2011 by CH for the LEMP documented 876 individuals representing 18 different species. Longnose Dace (*Rhinichthys cataractae*) was the most abundant species, followed by Central Mudminnow (*Umbra limi*) and Rainbow Darter (*Etheostoma caeruleum*); with Creek Chub (*Semotilus atromaculatus*) and Johnny Darter (*Etheostoma nigrum*)

recorded as the most widely distributed species (CH, 2011). Compared to the 2006 LEMP sampling, the 2009 sampling indicated that there was a decrease in indicator species with species composition moving towards more tolerant species (CH, 2011).

3.2.2.2 Falcon Creek

A small section of Falcon Creek is located within the northeast corner of the Study Area. An Environmental Impact Assessment (EIA) was completed for a property (i.e. 1200 King Road) located directly northeast of the Study Area. The EIA encompasses the lands northwest of the railway within the Study Area as well as Falcon Creek (Savanta, 2015). Falcon Creek is noted entering the Study Area south from Highway 403 through a large box culvert, ~4.5 m wide. The channel is noted as deeply incised and fairly wide throughout much of the ravine, reaching up to four-five m wide in some locations. Schools of cyprinids were recorded in various pools along the length surveyed as well as two constructed nesting areas, likely of creek chub, near the Highway 403 culvert (Savanta, 2015).

Previous fish community sampling within Halton Region has been performed by CH. 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 (**Table 1**).

Table 1: Grindstone Creek Fish Species Identified in CH 2009 Surveys

Scientific Name	Common Name	SARA[1]	ESA[2]	S-RANK[3]
Within the Study Area				
Rhinichthys atratulus	Blacknose Dace	---[4]	---	S5
Semotilus atromaculatus	Creek Cub	---	---	S5
Associated with Lake Ontario				
Rhinichthys atratulus	Blacknose dace	---	---	S5
Pimephales notatus	Bluntnose minnow	---	---	S5
Hybognathus hankinsoni	Brassy minnow	---	---	S5
Oncorhynchus tshawytscha	Chinook Salmon	---	---	SNA
Oncorhynchus tshawytscha	Chinook salmon	---	---	SNA
Oncorhynchus kisutch	Coho salmon	---	---	SNA
Luxilus cornutus	Common shiner	---	---	S5
Semotilus atromaculatus	Creek chub	---	---	S5
Etheostoma flabellare	Fantail darter	---	---	S4

[1] Federal Species at Risk Act (SARA)
[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
[4] "---" denotes no information or not applicable

Scientific Name	Common Name	SARA[1]	ESA[2]	S-RANK[3]
Carassius auratus	Goldfish	---	---	SNA
Etheostoma nigrum	Johnny darter	---	---	S5
Micropterus salmoides	Largemouth bass	---	---	S5
Rhinichthys cataractae	Longnose dace	---	---	S5
Lepomis gibbosus	Pumpkinseed	---	---	S5
Etheostoma caeruleum	Rainbow darter	---	---	S4
Ambloplites rupestris	Rock bass	---	---	S5
Micropterus dolomieu	Smallmouth Bass	---	---	S5
Notropis hudsonius	Spottail shiner	---	---	S5
Noturus flavus	Stonecat	---	---	S4
Catostomus commersoni	White Sucker	---	---	S5

3.2.3 Invertebrate Biotic Index

3.2.3.1 Grindstone Creek

Benthic invertebrate sampling is used to quantify the quality of water because benthos are abundant, ubiquitous and are sensitive to the changes in the quality of the aquatic ecosystems (Jones *et al*., 2005). Changes to the environment conditions can results in changes to the benthic community. Invertebrate Biotic Index (IBI) sampling occurred in association with CH's LEMP for Grindstone Creek based on the Ontario Benthos Biomonitoring Network Protocol (Jones et al., 2005). A sampling of 14 stations in 2011 resulted in the collection of approximately 4,400 invertebrates of 47 taxa.

Chironomidae and *Oligochaeta* were the most abundant taxa groups encountered and were collected at each of the stations sampled. Aquatic worms (i.e. *oligochaete*) are typically found in locations that contain organic pollution and anoxic conditions (Borisko 2002). *Chironomidae* are the most common family found in benthic samples as they are tolerant to unhealthy streams. *Chironomidae* made up almost half of the benthic invertebrates found in Grindstone Creek with over 2,000 collected. It is a warning of poor aquatic health caused by pollution if the majority of the species collected are *Chironomidae*.

3.2.3.2 Falcon Creek

One station was sampled within the lower reaches of Falcon Creek as part of the North Shore Watershed Study (2006). The site was documented as lacking many of the organisms expected in a permanent flowing creek resulting in a benthic water quality score of severely impaired. Properties with swimming pools were observed discharging pool water into Falcon Creek. Similarly, the creek likely receives pesticide runoff associated with the upstream watercourse and residential development as well (CH, 2006).

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.

A Provincial Significant Wetland (PSW), was identified within the Study Area, northwest of the railway, within the area excluded from natural heritage inventories in support of the Scoped EIS. This PSW is identified as the Grindstone-Falcon Creeks Headwater Wetland Complex. The complex is the source water for the Grindstone Creek and the Medad Valley - including Lake Medad. This wetland complex acts as the water purifier for waters entering many Medad Valley springs, and helps purify the water that eventually makes its way to Lake Ontario. The Grindstone creek headwaters wetland complex is a key contributor to fresh water for the western basin of Lake Ontario. This complex of wetlands has been formally recognized by the MNRF to be of provincial significance.

The complex contains 15 wetlands which make up a total area of 17.6 ha. They consist of 53% swamps and 47% marshes, and include 24 wetland vegetation communities. The wetland complex lies within three headwater tributaries of Grindstone Creek and a headwater tributary of Bronte Creek.

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).

Although the Study Area contains woodlands, no significant woodlands were specifically identified within the Study Area. However, the size of the woodland(s) as well as their association with Grindstone Creek have the potential to satisfy the criteria for significance under the ROP 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

No ANSIs were identified within the Study Area. The Sassafras-Waterdown Woods ANSI is, however, located adjacent to the Study Area to the northwest of Highway 403.

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[5]	ESA[6]	S-RANK[7]	Info Source[8]
Vascular Plants					
Asplenium scolopendrium var. americanum	Hart's-tongue Fern	SC	SC	S3	NHIC
Hieracium paniculatum	Panicled Hawkweed	---[9]	---	S2?	NHIC
Lithospermum parviflorum	Soft-hairy False Gromwell	---	---	S2	NHIC
Euonymus atropurpureus	Eastern Burning Bush	---	---	S3	NHIC
Carex albicans var. albicans	White-tinged Sedge	---	---	S3	NHIC
Trichophorum clintonii	Clinton's Club-rush	---	---	S2S3	NHIC
Carya glabra	Pignut Hickory	---	---	S3	NHIC
Monarda didyma	Scarlet Beebalm	---	---	S3	NHIC
Hypoxis hirsuta	Yellow Stargrass	---	---	S3	NHIC
Uvularia perfoliata	Perfoliate Bellwort	---	---	S1	NHIC
Pterospora andromedea	Woodland Pinedrops	---	---	S2	NHIC
Nuphar advena	Large Yellow Pond-lily	---	---	S3	NHIC
Aplectrum hyemale	Puttyroot	---	---	S2	NHIC
Dichanthelium dichotomum	Forked Panicgrass	---	---	S2	NHIC

[5] Federal Species at Risk Act (SARA)
[6] Provincial Endangered Species Act (ESA)
[7] 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
[8] 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
[9] "---" denotes no information or not applicable.

Scientific Name	Common Name	SARA[5]	ESA[6]	S-RANK[7]	Info Source[8]
Dichanthelium praecocius	White-haired Panicgrass	---	---	S3	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, MNRF SAR in Area
Aureolaria virginica	Downy Yellow False Foxglove	---	---	S1	NHIC, MNRF SAR in Area
Phegopteris hexagonoptera	Broad Beech Fern	---	SC	S3	MNRF SAR in Area
Birds					
Falco peregrinus	Peregrine Falcon	SC	SC	S3B	MNRF SAR in Area, OBBA
Vermivora chrysoptera	Golden-winged Warbler	THR	SC	S4B	OBBA
Melanerpes erythrocephalus	Red-headed Woodpecker	THR	SC	S4B	OBBA
Hylocichla mustelina	Wood Thrush	---	SC	S4B	OBBA
Contopus virens	Eastern Wood-pewee	---	SC	S4B	OBBA
Nycticorax nycticorax	Black-crowned Night-heron	---	---	S3B, S3N	NHIC
Herpetozoa					
Lampropeltis triangulum	Milksnake	SC	---	S3	NHIC
Chelydra serpentina	Snapping Turtle	SC	SC	S3	MNRF SAR in Area, MNRF Reg. Habitat
Thamnophis sauritus	Eastern Ribbonsnake (Great Lakes population)	SC	SC	S3	MNRF Reg. Habitat
Graptemys geographica	Northern Map Turtle	SC	SC	S3	MNRF Reg. Habitat
Sternotherus odoratus	Eastern Musk Turtle	THR	SC	S3	MNRF SAR in Area, MNRF Reg. Habitat
Lepidoptera					
Danaus plexippus	Monarch	SC	SC	S2N, S4B	MNRF Reg. Habitat
Pieris virginiensis	West Virginia White	---	SC	S4	MNRF Reg. Habitat
Odonata					
Cordulegaster obliqua	Arrow Spiketail	---	---	S2	NHIC
Mammals					
Microtus pinetorum	Woodland Vole	SC	SC	SC3?	MNRF SAR in Area

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 *endangered* and *threatened* species with the potential to occur within and/or adjacent to the Study Area:

- Chimney Swift (*Chaetura pelagica*) listed as *Threatened* under the ESA;
- Bank Swallow (*Riparia riparia*) listed as *Threatened* under the ESA;
- Cerulean Warbler (*Setophaga cerulea*) listed as *Threatened* under the ESA;
- American Columbo (*Frasera caroliniensis*) listed as *Endangered* under the ESA;
- Butternut (*Juglans cinerea*) listed as *Endangered* under the ESA;
- Eastern-flowering Dogwood (*Cornus florida*) listed as *Endangered* under the ESA;
- Jefferson Salamander (*Ambystoma jeffersonianum*) listed as *Endangered* under the ESA;
- Eastern Small-footed Myotis (*Myotis leibii*) listed as *Endangered* under the ESA;
- Little Brown Bat (*Myotis lucifugus*) listed as *Endangered* under the ESA;
- Northern Myotis (*Myotis septentrionalis*) listed as *Endangered* under the ESA; and
- Tri-coloured bat (*Perimyotis subflavus*) listed as *Endangered* under the ESA.

These species are 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 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
June 28	Mostly clear, light breeze, no precipitation	15	Breeding Bird Survey #2, ELC Survey, Botanical Survey

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 0.5 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

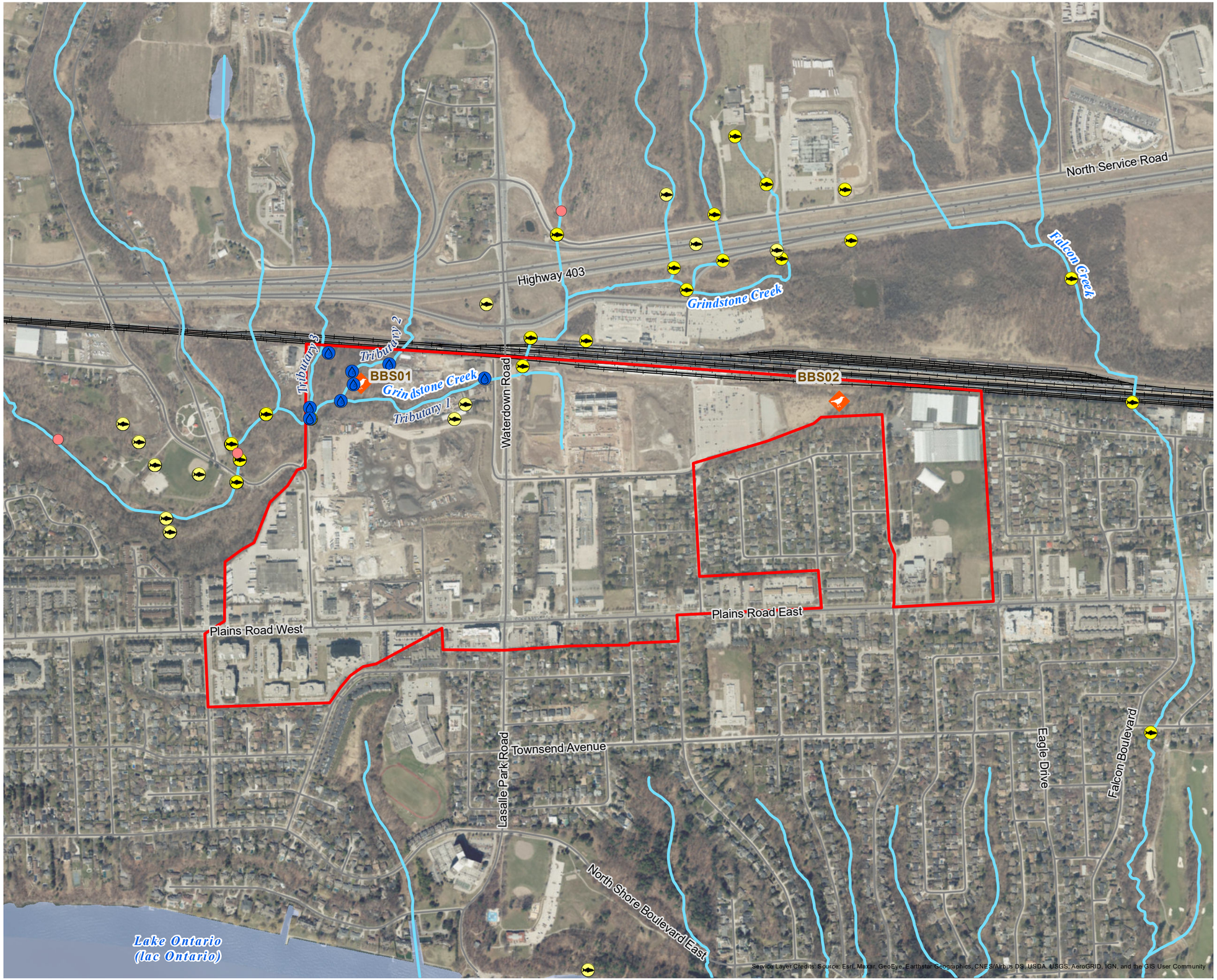
4.3.1 Stream Assessments

The stream assessment was conducted on June 21 to investigate the three Grindstone Creek tributaries mapped within the northwestern portion of the Study Area. 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. Methodologies used to collect this information was akin to the Ontario Stream Assessment Protocol (OSAP). This information was then used to help determine the overall health and sensitivity of each watercourse on site.

The locations of aquatic surveys are shown in **Figure 3**, and results are discussed in **Section 5.3**.

4.3.2 Fluvial Geomorphology Assessment

In addition to the aquatic stream assessments, a fluvial geomorphology assessment was completed by GeoProcess Research Associated within the Study Area. 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 provided in **Section 5.3.**



CITY OF Burlington

ALDERSHOT
BURLINGTON HUB MOBILITY STUDY

2017 FIELD SURVEY LOCATIONS
FIGURE 3

- Study Area
- Breeding Bird Survey Location
- Conservation Halton Fish Record
- Conservation Halton 2011 LEMP
- Stream Assessment Location
- 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: 2021-11-12

FILE LOCATION: G:\cad\GIS\175015\Mapping\EIS_Aldershot\Aldershot_Fig3_SurveyLocations.mxd

4.4 Natural Heritage Features

4.4.1 Wetlands

The Grindstone Creek Headwater Wetland Complex contains 15 wetlands which make up a total area of 17.6 ha. Portions of this PSW are present adjacent to the Study Area (**Figure 2**). MNRF identified that this wetland complex serves a number of important ecological functions, including the following:

- Water storage function that regulates the hydro-period, flow rate and thermal condition in the wetlands;
- In conjunction with the surrounding natural landscape, serves as a local north-south corridor between larger forested areas. At the broader landscape level, serves as a southwest-northeast corridor for wildlife movement across the top of the Mount Nemo plateau;
- Provides connections between the Medad Valley ANSI, the provincially significant Lake Medad Valley Wetland Complex and the Mount Nemo Escarpment ANSI;
- Supports five significant species including a breeding population of the nationally and provincially threatened Jefferson Salamander, the provincially endangered Butternut tree and three locally rare plant species;
- Provides breeding habitat for amphibian populations including Jefferson Salamander, Spotted Salamander, Spring Peeper, Wood Frog, Gray Treefrog, Bullfrog, Green Frog, Leopard Frog, American Toad and Eastern Newt. Wood Duck breeds in the wetland swamps; and
- In conjunction with the surrounding upland forests, provides habitat for area sensitive forest birds, including Wood Duck, Pileated Woodpecker and Ovenbird.

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 woodlands 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 late-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 and Bank Swallow were completed in conjunction with diurnal breeding bird surveys outlined above.

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

Results relating to SAR within the Study Area have been 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.

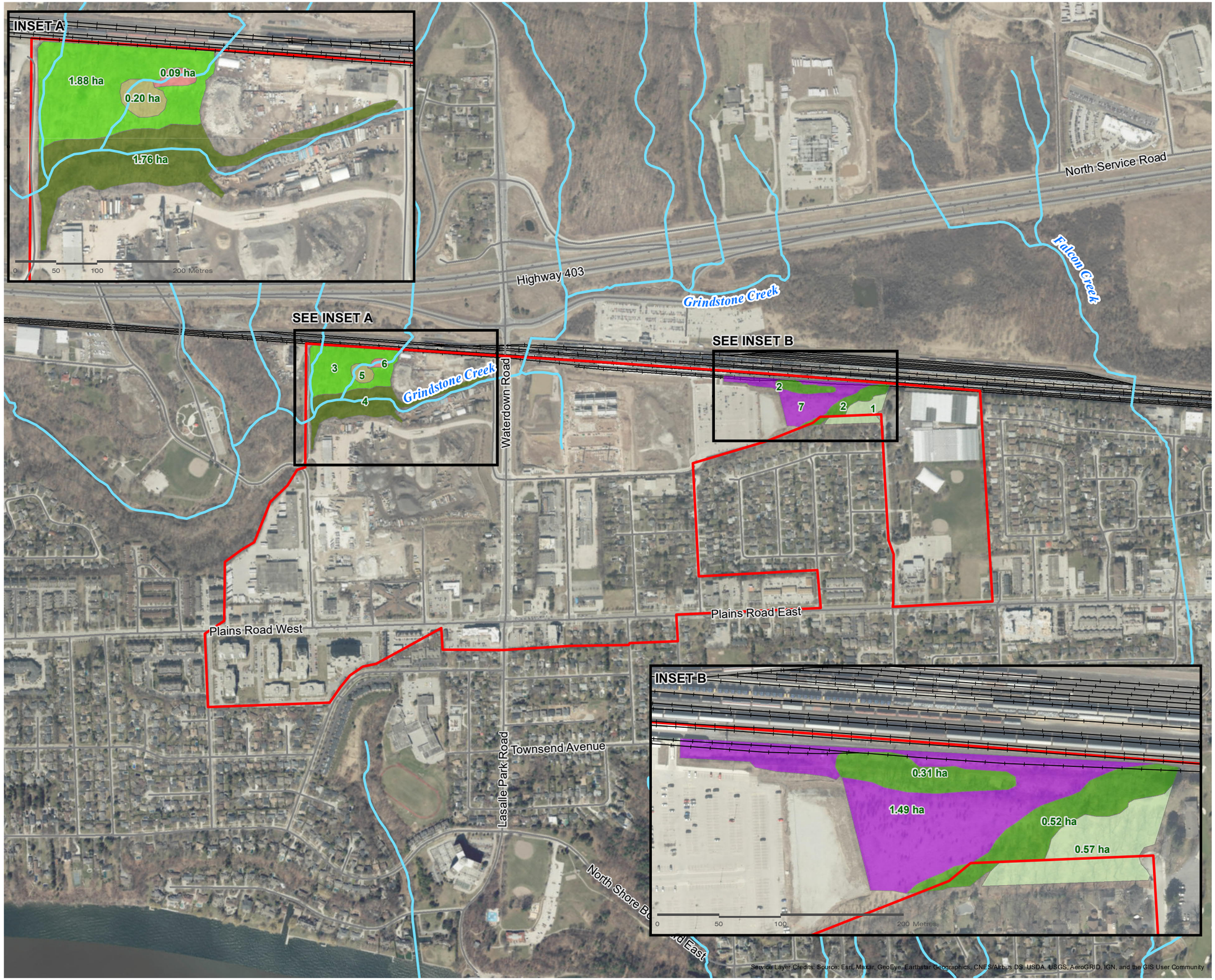
5.1 Ecological Land Classification

Four natural vegetation communities were observed within the Study Area during the ELC survey. The location, type, and boundaries of these communities are delineated in **Figure 4**. The vegetation communities surveyed within the Study Area 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 communities 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
MEMM4/THDM2	Fresh - Moist Mixed Meadow Ecosite/ Dry - Fresh Deciduous Shrub Thicket Ecosite	1.49	The canopy and sub-canopy consist of Black Walnut (*Juglans nigra*) with rare occurrences of Black Locust (*Robinia pseudoacacia*). Understory species consist of rare occurrences of Black Walnut, Staghorn Sumac (*Rhus hirta*) and Black Locust. Ground layer species present consists primarily of Wild Chamomile (*Matricaria chamomilla*), Garden Bird's-foot Trefoil (*Lotus corniculatus*), Canada Thistle (*Cirsium arvense*), Philadelphia Fleabane (*Erigeron philadelphicus*), Canada Goldenrod (*Solidago canadensis*), Aster species (*Aster* sp.), Blunt-leaved Bedstraw (*Galium obtusum*) and Brome species (*Bromus* sp.), with rare occurrences of Fuller's Teasel (*Dipsacus fullonum*), Curly Dock (*Rumex crispus*), Wild Parsnip (*Pastinaca sativa*), Garden Asparagus (*Asparagus officinalis*), Sunflower species (*Helianthus* sp.), Canada Bluegrass (*Poa compressa*), Sulphur Cinquefoil (*Potentilla recta*), Reed Canary Grass (*Phalaris arundinacea*) and Quackgrass species (*Elymus* sp.).	This community is a complex of upland meadow and thicket located in the eastern half of the Study Area and bisects two areas of Dry - Fresh Manitoba Maple Deciduous Forest (FODM4-5). The community contains mostly meadow vegetation with patches of thicket as the community narrows to the east.	Photo 1
FODM4-5	Dry - Fresh Manitoba Maple Deciduous Forest Type	0.83	The canopy and sub-canopy consists primarily of Manitoba Maple (*Acer negundo*), with Tree-of-Heaven (*Ailanthus altissima*), Black Walnut and Eastern Cottonwood (*Populus deltoides* ssp. *deltoides*) associates. Understory species are dominated by Staghorn Sumac (*Rhus hirta*) and Tatarian Honeysuckle (*Lonicera tatarica*), with rare occurrences of White Mulberry (*Morus alba*). Ground layer species present consist of Riverbank Grape (*Vitis riparia*), Thicket Creeper (*Parthenocissus inserta*), White Avens (*Geum canadense*), with rare occurrences of Garlic Mustard (*Alliaria petiolata*) and Common Burdock (*Arctium minus*).	This community occurs as two linear patches in the eastern half of the Study Area, north and south of the Fresh - Moist Mixed Meadow Ecosite/Dry - Fresh Deciduous Shrub Thicket Ecosite. This community has abundant occurrences of invasive species. The southern patch is also adjacent to Greenlands.	Photo 2
FODM7	Fresh – Moist Lowland Deciduous Forest Ecosite	1.76	The canopy and sub-canopy consists primarily of Green Ash (*Fraxinus pennsylvanica*), Manitoba Maple and Crack Willow (*Salix fragilis*), with Paper Birch (*Betula papyrifera*), Northern Catalpa (*Catalpa speciosa*), Eastern Cottonwood, Wild Black Cherry (*Prunus serotina*), Black Walnut and American Elm (*Ulmus americana*) associates. Understory species are dominated by Green Ash, with rare occurrences of Common Buckthorn (*Rhamnus cathartica*), European Alder (*Alnus glutinosa*) and Staghorn Sumac. Ground layer species present consist of Thicket Creeper, Colt's-foot (*Tussilago farfara*), Goldenrod species (*Solidago isp.*), Poison Ivy (*Toxicodendron rydbergii*) and Field Horsetail (*Equisetum arvense*), with rare occurrences of Riverbank Grape, Purple-flowering Raspberry (*Rubus odoratus*), Blunt-leaved bedstraw, White Avens, Fox Sedge (*Carex vulpinoidea*), Reed Canary Grass, Orchard grass (*Dactylis glomerata*), Day Lily species (*Hemerocallis* spp.) and Vetchling Peavine (*Lathyrus palustris*).	This community is located in the northwest portion of the Study Area and contains occasional occurrences of invasive species. The community is associated with a watercourse feature.	Photo 3
FODM5-3 with inclusions of MAMM1-2/ FODM8-1	Dry – Fresh Sugar Maple – Oak Deciduous Forest Type with inclusions of Cattail Graminoid Mineral Meadow Marsh Type and Fresh – Moist Poplar Deciduous Forest Type inclusions	2.17	The canopy and sub-canopy consist primarily of Sugar Maple (*Acer saccharum*) and Red Oak (*Quercus rubra*), with Eastern Hop-hornbeam (*Ostrya virginiana*), Wild Black Cherry, American Beech (*Fagus grandifolia*), Paper Birch and Eastern White Pine (*Pinus strobus*) associates. Understory species consist mostly of Common Buckthorn, with rare occurrences of Choke Cherry (*Prunus virginiana*) and White Poplar (*Populus alba*). Ground layer species present consist primarily of White Avens, Broad-leaved Enchanter's Nightshade (*Circaea canadensis*), Garlic Mustard and Poison Ivy, with rare occurrences of Zigzag Goldenrod (*Solidago flexicaulis*), Canada Wild Ginger (*Asarum canadense*), Geranium species (*Geranium* sp.), Jack-in-the-pulpit (*Arisaema triphyllum*), Wild Strawberry (*Fragaria virginiana*), False-Solomon's Seal (*Maianthemum racemosum*), Wild Lily-of-the-valley (*Maianthemum canadense*), Woodland Strawberry (*Fragaria vesca*), Wild Sarsaparilla (*Aralia nudicaulis*) and Early Meadow-rue (*Thalictrum dioicum*). The MAMM1-2 inclusion was found to be dominated by Broad-leaved Cattail (*Typha latifolia*) and Reed Canary Grass (*Phalaris arundinacea*) with rare occurrences of Silver Maple (*Acer saccharinum*).	FODM5-3: This community is located at the northwest end of the Study Area and has occasional occurrences of invasive species. It has a rolling topography.	Photo 4
				MAMM1-2: This community is located at the northwest end of the Study Area, as an inclusion to the greater Dry – Fresh Sugar Maple – Oak Deciduous Forest.	Photo 5
				FODM8-1: This community is located at the northwest end of the Study Area, as an inclusion to the greater Dry – Fresh Sugar Maple – Oak Deciduous Forest.	Photo 6



CITY OF Burlington

ALDERSHOT
BURLINGTON HUB MOBILITY STUDY

SITE INVESTIGATION RESULTS
FIGURE 4

- Study Area
- Road
- Railway
- Watercourse

Ecological Land Classification

- 1. CGL: Greenlands
- 2. FODM4-5: Dry-Fresh Manitoba Maple Deciduous Forest
- 3. FODM5-3: Dry-Fresh Sugar Maple - Oak Deciduous
- 4. FODM7: Fresh-Moist Lowland Deciduous Forest
- 5. FODM8-1: Fresh-Moist Poplar Deciduous Forest
- 6. MAMM1-2: Cattail Graminoid Mineral Meadow Marsh
- 7. MEMM4/THDM2: Fresh-Moist Mixed Meadow / Dry-Fresh Deciduous Shrub Thicket

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: 2021-11-12

FILE LOCATION: G:\cad\GIS\175015\Mapping\EIS_Aldershot\Aldershot_Fig4_ELC.mxd

5.2 Vegetation

A total of 59 plant species were documented within the six natural communities during 2017 field studies (**Figure 4**). Of the 59 species, 35 are listed as native species considered to be 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 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 59 species identified within the Study Area, none contain a CC value of 7 or greater. The mean CC value for the site was 3.3 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

5.3.1.1 Grindstone Creek Tributary 1

Grindstone Creek tributary 1 was assessed within the Study Area and was observed to drain westerly from the crossing of Waterdown Road to the Study Area's western limit, north of Howard Road. Within this reach of Grindstone Creek tributary 1, Grindstone Creek tributary 2 and 3 converge independently with Grindstone Creek tributary 1. During the aquatic assessment, Grindstone Creek tributary 1 identified through background review was confirmed and assessed from Waterdown Road to the western Study Area limit (**Figure 3**).

Within the Study Area, Grindstone Creek tributary 1 was characterized as a permanent watercourse, observed to be flowing on the day of the assessment and contained direct habitat for fish. The creek contained abundant, natural meandering habitat (**Appendix C**; Photo 7). The morphology of the creek

was dominated by a run and flat habitat with instances of riffles and pools throughout. Average wetted widths and depths ranged from 1.9 m to 3.8 m wide to 0.07 m to 0.18 m deep, respectively.

Eroded and unstable banks were observed throughout the majority of the reach despite a mature mixed deciduous forest riparian area (**Appendix C**; Photo 8). Substrates within the creek were dominated by gravel and sand with the presence of cobble and silt throughout, particularly in the lower end of the reach. No instream aquatic vegetation was observed within the area of assessment. Surrounding land use included commercial property and natural forest.

5.3.1.2 Grindstone Creek Tributary 2

Grindstone Creek tributary 2 flows southwesterly within the Study Area and was assessed from the southern end of the crossing of the railway to the confluence with Grindstone Creek Tributary 1 (**Figure 3**). Within this reach, the watercourse was characterized as a permanent, channelized creek providing direct fish habitat. The creek was linear in form, with subtle meandering. The morphology varied significantly throughout this reach. Within the upstream portion, downstream from the culvert crossing beneath the railway, the tributary was dominated by run habitat within braided flow in a wide channel over cobble and gravel substrates (**Appendix C**; Photo 9). Approximately 30 m downstream from the culvert crossing the channel became undefined as it transitioned into wetland habitat with silt and organic substrates observed (**Appendix C**; Photo 5). Downstream from the wetland outlet, the channel became more defined and substrates became coarse with cobble being dominant. The gradient of the channel increased significantly and steep valley slopes (**Appendix C**; Photo 10) were common in the bottom portion of the reach, prior to its confluence with Grindstone Creek tributary 1. The wetted width in the bottom of the reach averaged approximately 0.9 m and the average depth within this reach was 0.07 m, respectively.

Bank stability varied throughout this tributary from areas of unstable and eroding banks in the lower portion (**Appendix C**; Photo 11) to the gradually sloped, well-vegetated banks present in the mid-reach which contained the wetland habitat. The riparian cover was present and was primarily comprised of mixed deciduous trees and shrubs. Surrounding land use was dominated by natural forest with nearby commercial property including the railway tracks. Cattails were present within the wetland, however, no additional instream, aquatic vegetation was observed.

5.3.1.3 Grindstone Creek Tributary 3

The Grindstone Creek tributary 3 was assessed within the Study Area and was observed to drain southerly along the road allowance north of Howard Road, entering the Study Area through the perched culvert (**Appendix C**; Photo 12) conveying flow beneath the railway tracks at the northern limit of the Study Area before converging with Grindstone Creek Tributary 1. During the aquatic assessment, the Grindstone Creek tributary 3 identified through background review was confirmed and assessed from the perched railway culvert crossing to the confluence with Grindstone Creek Tributary 1.

Within the Study Area, Grindstone Creek tributary 3 was characterized as a permanent watercourse, observed to be flowing on the day of the assessment and contained direct habitat for fish. The tributary was linear in form and contained limited instances of meandering (**Appendix C**; Photo 13). The morphology of the creek was dominated by a run and flat habitat with instances of riffles throughout. A plunge pool was present at the outlet of the perched culvert. Average wetted widths and depths ranged from 1.1 m to 2.2 m wide and 0.09 m to 0.25 m deep.

Eroded and unstable banks (**Appendix C**; Photo 14) were observed along the tributary despite a mature mixed deciduous forest riparian area. Substrates within the creek were variable and included clay, shale, cobble gravel and silt. No instream aquatic vegetation was observed within the area of assessment. Surrounding land use included natural forest, the railway easement and natural forest.

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

5.3.1.4 Fluvial Geomorphology Assessment Summary

The reach directly adjacent to the Aldershot GO station has been previously realigned, incorporating a natural channel design, which has provided some floodplain access in the semi-confined valley. The vegetation encroachment into the channel has resulted in excess sedimentation throughout the reach. Immediately downstream, the creek enters a mature woodlot and becomes confined with indicators of widening and downcutting. The area of the creek through the mature woodlot is the more natural reach of the Grindstone Creek tributary upstream of the Go Station, which combined with its unstable nature, makes it more sensitive.

The watercourse then crosses Highway 403 onramp and Waterdown Road within a fully channelized system, lined with a gabion mattress in a confined valley. Downstream of Waterdown Road, the creek flows through an entrenched valley with limited floodplain access and observations of valley wall contact is frequent as well as indicators of instability in the form of widening and downcutting.

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**.

5.4 Natural Heritage Features

5.4.1 Wetlands

Apart from the PSW identified north of the Study Area boundary, a single 0.09 ha wetland inclusion community was observed during the 2017 field surveys (MAMM1-2, Cattail Graminoid Mineral Meadow Marsh) in association with Grindstone Creek tributary 2 (**Figure 3** and **Figure 4**).

Potential impacts related to this wetland inclusion are included in **Section 8.1.1** through **Section 8.1.3.** With respects to the PSW adjacent to the Study Area this feature should be protected in support of future developments. Due to the PSW occurring outside the limits of the Study Area, as well as upstream from the watercourses investigated in the Aldershot EIS; impacts are not assessed herein. Potential impacts should be assessed at the detail design stage in consultation with the MNRF and City.

5.4.2 Woodlands

The woodlands within the Study Area south of the railway tracks were investigated through ELC surveys in 2017. In accordance with the policies of the Halton Regional Official Plan 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 100m 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.

Below, **Table 5** lists each of the woodlands identified within the Study Area against the aforementioned evaluation criteria for woodland significance. **Table 5** should be read concurrently with **Figure 5**.

Table 5: Woodland Evaluation Table for Aldershot Study Area.

Woodland	Attributes		Evaluation Criteria				
			Size	Age	Patch Size	Interior Area	Proximity to Water
	Size (ha)	Interior Forest (100 m from edge)	Woodland 0.5 ha or larger	Woodland contains forest patch over 99 years old	Patch size of woodland is 2 ha or greater if located in the Urban Area	Woodland contains 4 ha of interior core area measured 100 m from edge	Woodland is wholly or partially within 50 m of a major creek or certain headwater creek
A	3.85	0	√	---	√	---	√
B[10]	0.31	0	---	---	---	---	---
C	0.52	0	√	---	---	---	---

[10] Indicates that woodland does not meet minimum criteria of 0.50 ha to be evaluated for significance under ROPA 38 Section 227; woodland will be evaluated for significant under the Natural Heritage Assessment Guide (2012)

Woodland A is greater than 2.0 ha in an Urban Area and contains a major creek (Grindstone Creek tributary); therefore, Woodland A met the criteria for significance under ROPA 38 Section 277 (**Figure 6**).

Woodland B is less than 0.50 ha and therefore does not meet the minimum criteria to be considered significant under ROPA 38 Section 227.

Woodland C is greater than 0.50 ha and can be assessed for Significant under ROPA 38 Section 277. However, the woodland is not wholly or partially within 50 m of a major creek or headwater feature; therefore, Woodland C does not meet the criteria for significance under ROPA 38 Section 277.

Although Woodlands B & C do not meet the minimum requirement for significance under ROPA 38, they were also assessed under the Natural Heritage Assessment Guide (2012). As outlined in the Natural Heritage Reference Manual (MNRF 2010), for a woodland feature to be significant it must first meet minimum standards for tree crown cover (minimum 60%). If these minimum standards are met, it is then evaluated based on size criterion, ecological function criteria, and uncommon characteristics criteria. Many of the criteria have minimum size thresholds that are based on the percentage of woodland cover in the municipality where the project has been proposed (City of Burlington). Woodlands that meet the minimum standard for any one of the criteria are considered significant.

The estimate of woodland cover within the City of Burlington is 23%; comprising 17% in the urban areas and 28% in the rural areas (City of Burlington, 2010). For the purposes of determining significance, the woodland cover within the urban areas (17%) is used. In order for a woodland to be considered significant, it must be greater than or equal to 20 ha in size. If the woodland fails to meet that criterion, it is considered significant if it meets any one of the following criteria:

a) The interior habitat of 2 ha is present, with a 100 m interior buffer on all sides;
b) Proximity to other woodlands (within 30 m of another significant woodland) and greater than 4 ha in size;
c) Overlap with other natural heritage features (provincially significant wetlands, ANSI's, etc.) and is greater than 4 ha in size;
d) Within 50 m of a sensitive groundwater discharge, watercourse or fish habitat and is greater than 2.0 ha in size; or
e) Contain certain representative native woodland species and is 4.0 ha in size.

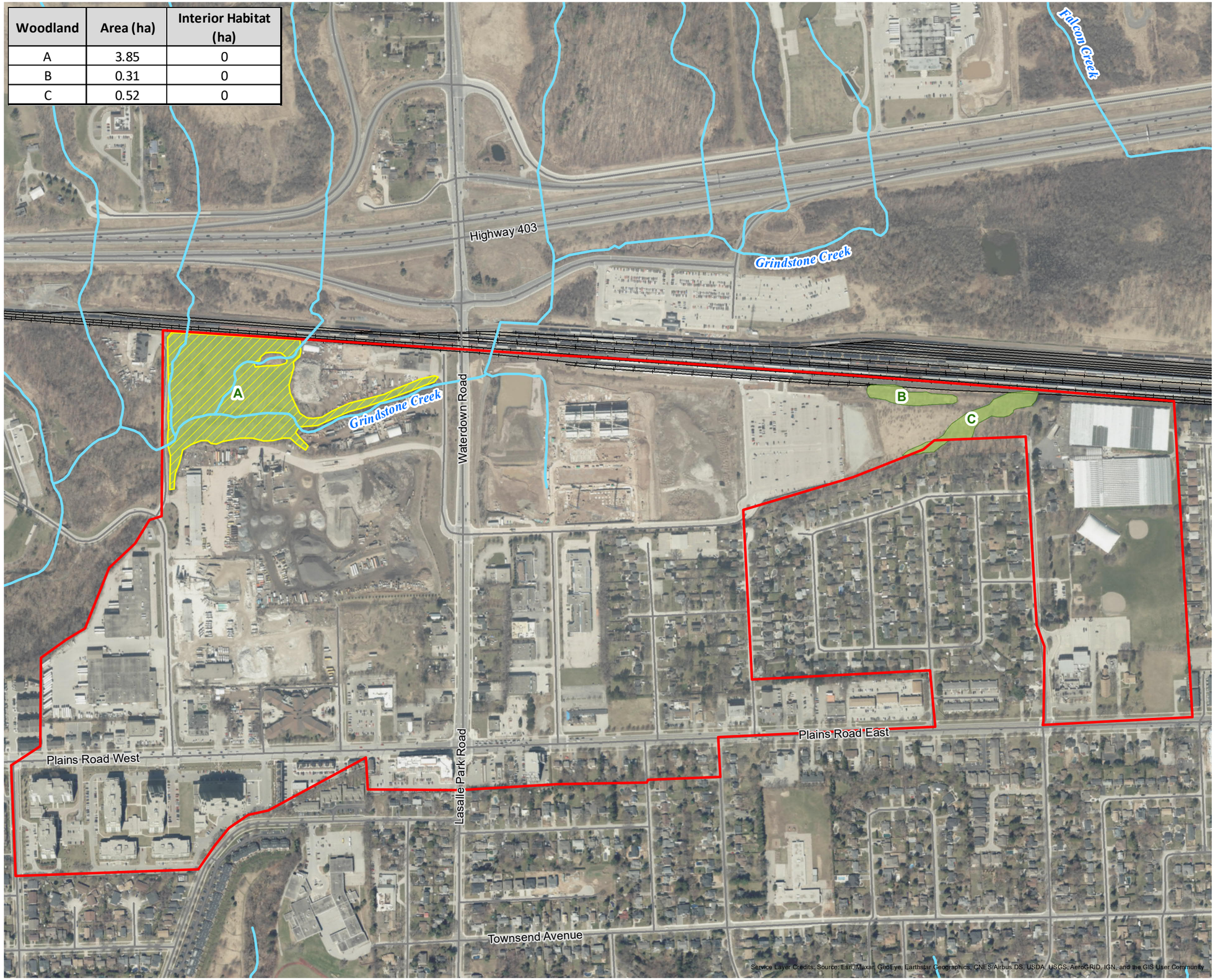
Woodlands B & C are 0.31 ha and 0.52 ha, respectively; they do not contain interior habitat, and are less than 2.0 ha in size. Therefore, the woodlands were determined to be not significant under the Natural Heritage Reference Manual (MNRF 2010).

The 'Adjusted LIO Delineated Woodlands' layer in Figure 5 represents the woodland layer adjusted to the boundaries interpreted from the most recent aerial imagery. Access was not permitted northwest of the railway for the purposes of the 2017 field investigations. Although the woodland features northwest of the railway were not assessed in 2017, it would appear as though several would meet the criteria for

significance under ROPA 38, Section 277 based on their size (>0.50 ha) in addition to their proximity to Grindstone Creek (**Figure 6**).

Potential impacts related to woodlands are included in **Section 8.1.1** and **Section 8.1.3**.

Woodland	Area (ha)	Interior Habitat (ha)
A	3.85	0
B	0.31	0
C	0.52	0



CITY OF Burlington

ALDERSHOT
BURLINGTON HUB MOBILITY STUDY

WOODLANDS
FIGURE 5

- Study Area
- Road
- Railway
- Watercourse
- Dillon Delineated Woodland
- Significant Woodland

0 50 100 200 Metres

N W E S

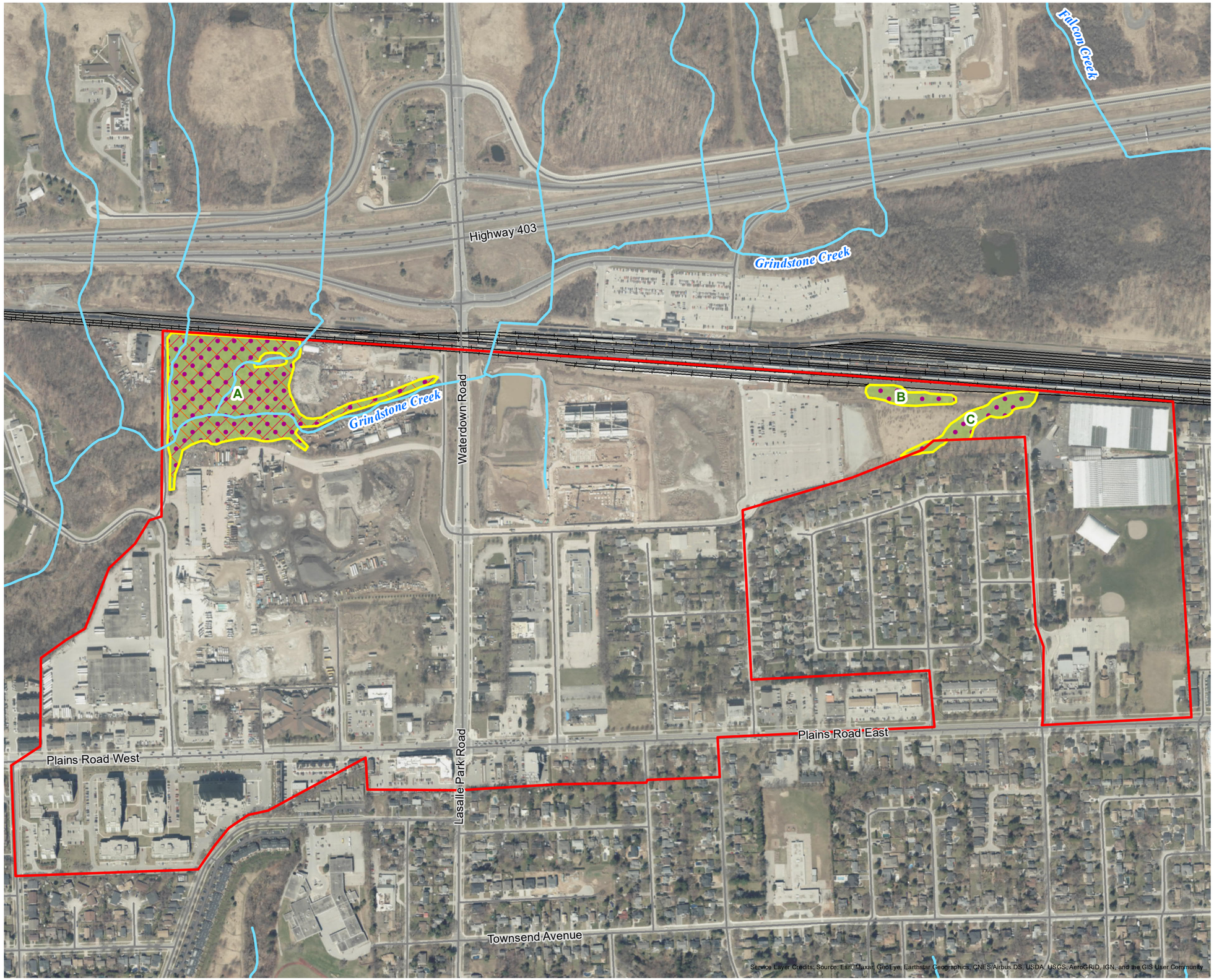
MAP DRAWING INFORMATION:
DATA PROVIDED BY MNRF, CONSERVATION HALTON

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

DILLON CONSULTING

PROJECT: 17-5015
STATUS: DRAFT
DATE: 2021-11-15

FILE LOCATION: G:\cad\GIS\175015\Mapping\EIS_Aldershot\Aldershot_Fig5_Woodlands.mxd



CITY OF Burlington

ALDERSHOT
BURLINGTON HUB MOBILITY STUDY

SIGNIFICANT NATURAL FEATURES
FIGURE 6

- Study Area
- Road
- Railway
- Watercourse
- Dillon Delineated Woodland

Significant Natural Feature

- Woodland

Significant Wildlife Habitat

- Special Concern and Rare Wildlife Species (Eastern Wood Pewee)

Candidate Significant Wildlife Habitat

- Bat Maternity Colonies
- Landbird Migratory Stopover Area

0 50 100 200 Metres

W N S E

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: 2021-11-15

FILE LOCATION: G:\cad\GIS\175015\Mapping\EIS_Aldershot\Aldershot_Fig6_SigNaturalFeatures.mxd

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, Significant Wildlife Habitat (SWH) pertaining to Rare Vegetation Communities and Animal Movement Corridors as defined in the *Eco-region 7E Criterion Schedules* (MNRF, 2015) was not observed. The presence of the unevaluated wetland northwest of the railway in association with significant woodlands (though not assessed by Dillon), meets the minimum criteria to be considered candidate Amphibian Breeding Habitat (woodland) SWH. In addition, SWH for Special Concern and Rare Wildlife Species was confirmed based on the observations of Eastern Wood-pewee (*Contopus virens*) during the 2017 breeding bird surveys (**Figure 6**).

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 terrestrial surveys (e.g. amphibians, bats, etc.) be evaluated during the site-specific development applications. However, given the presence of woodlands within the Study Area, candidate Bat Maternity Colonies SWH has the potential to occur in association with the woodland features identified during ELC as well as the woodlands located northwest of the railway (**Figure 6**). Buffer recommendation for Bat Maternity Colonies SWH be further assessed at the detailed design stage to ensure their extent (width) is sufficient and that they can perform their intended function in light of the likely negative impacts resulting from adjacent development or site alteration (before, during and after construction) add to determine other mitigation measures as needed (i.e. enhancement plantings in the buffer, permanent fencing, sediment and erosion control measures).

5.4.3.1 Breeding Bird Survey

A total of 34 bird species were observed during breeding bird surveys in 2017 (**Table 6**). Of the 34 bird species observed, a single Species of Conservation Concern (Eastern Wood-pewee) was identified. Each of the 34 bird species observed are considered common and secure (SRank S4) to very common (SRank of S5) in the province of Ontario based on the provincial conservation rankings assigned by the NHIC.

Table 6: Breeding Bird Survey Results 2017 Field Investigations

Scientific Name	Common Name	GRank[11]	SRank[12]	SARA[13]	ESA[14]	Breeding Evidence[15]
Turdus migratorius	American Robin	G5	S5B	---	---	NB, S, FY
Mniotilta varia	Black-and-white Warbler	G5	S5B	---	---	S
Cardinalis cardinalis	Northern Cardinal	G5	S5	---	---	S
Corvus brachyrhynchos	American Crow	G5	S5B	---	---	S
Pipilo erythrophthalmus	Eastern Towhee	G5	S4B	---	---	S
Contopus virens	Eastern Wood-pewee	G5	S4B	---	SC	S
Quiscalus quiscula	Common Grackle	G5	S5B	---	---	H
Cyanocitta cristata	Blue Jay	G5	S5	---	---	S
Setophaga striata	Blackpoll Warbler	G5	S4B	---	---	S
Picoides villosus	Hairy Woodpecker	G5	S5	---	---	S
Picoides pubescens	Downy Woodpecker	G5	S5	---	---	S
Troglodytes aedon	House Wren	G5	S5B	---	---	S
Carduelis tristis	American Goldfinch	G5	S5B	---	---	H
Catharus guttatus	Hermit Thrush	G5	S5B	---	---	S
Charadrius vociferus	Killdeer	G5	S5B,S5N	---	---	S
Empidonax minimus	Least Flycatcher	G5	S4B	---	---	S
Geothlypis philadelphia	Mourning Warbler	G5	S4B	---	---	S
Oreothlypis ruficapilla	Nashville Warbler	G5	S5B	---	---	S
Oreothlypis celata	Orange-crowned Warbler	G5	S4B	---	---	S
Vireo olivaceus	Red-eyed Vireo	G5	S5B	---	---	S
Agelaius phoeniceus	Red-winged Blackbird	G5	S4	---	---	S

[11] Glabl conservation status is an indicator of commonness across the species entire rank
[12] 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
[13] Federal Species at Risk Act (SARA)
[14] Provincial Endangered Species Act (ESA)
[15] Breeding Bird Codes from Breeding Bird Atlas of Ontario (Cadman *et al.* 2007)

Scientific Name	Common Name	GRank[11]	SRank[12]	SARA[13]	ESA[14]	Breeding Evidence[15]
Melospiza melodia	Song Sparrow	G5	S5B	---	---	S
Oreothlypis peregrina	Tennessee Warbler	G5	S5B	---	---	S
Zonotrichia leucophrys	White-crowned Sparrow	G5	S4B	---	---	S
Cardellina pusilla	Wilson's Warbler	G5	S4B	---	---	S
Poecile atricapillus	Black-capped Chickadee	G5	S5	---	---	S
Dumetella carolinensis	Gray Catbird	G5	S4B	---	---	S, A
Bombycilla cedrorum	Cedar Waxwing	G5	S5B	---	---	F/O
Setophaga pensylvanica	Chestnut-sided Warbler	G5	S5B	---	---	S
Anas platyrhynchos	Mallard	G5	S5	---	---	F/O
Setophaga petechia	Yellow Warbler	G5	S5B	---	---	S
Molothrus ater	Brown-headed Cowbird	G5	S4B	---	---	S
Larus delawarensis	Ring-billed Gull	G5	S5B,S4N	---	---	S
Sayornis phoebe	Eastern Phoebe	G5	S5B	---	---	S

Observed

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

Possible

H Species observed in its breeding season in suitable nesting habitat

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

Probable

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

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

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 an occupied nest

FS Adult carrying fecal sac

CF Adult carrying food for young

NE Nest containing eggs

NY Nest with young seen or heard

Although woodlands within the Study Area are within 2 km of Lake Ontario and they do not equate to ≥5.0 ha they are considered candidate Landbird Migratory Stopover Area Significant Wildlife Habitat. This is due to the rarity of woodlands within the shoreline and woodland fragments "2 - 5 ha can be considered for this habitat" (SWH, MNRF 2010).

5.5 Species at Risk

Although Chimney Swift individuals were not observed during the 2017 field investigations, there is potential for chimneys and/or stacks associated with buildings located within the Study Area to provide habitat for the species. It is recommended that potential Chimney Swift habitat be further evaluated during the site-specific development application.

With respect to SAR bats, the candidate SWH for Bat Maternity Colonies identified in **Figure 6** also has the potential to serve as habitat for SAR bats. The natural features associated with the candidate and confirmed SWH will be protected as part of the future developments and is further discussed in **Section 9.1**.

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 Area. As the majority of the Study Area is comprised of urban, recreational and industrial land uses, the potential ecological functions within the Study Area are minimal.

The significant woodlands as well as Grindstone Creek tributaries corridor in the northern portion of the Study Area is one of only a few natural areas within the highly urbanized Burlington City with a high percentage of tree cover. This section of Grindstone Creek and its associated woodland features provides ecological function, with 59 botanical species observed in association with natural areas, and a subsequent coefficient of conservation ranking indicating a heavily altered landscape. The tributaries of Grindstone Creek were determined to provide permanent, direct fish habitat, providing ecological linkages from Lake Ontario north of the Study Area.

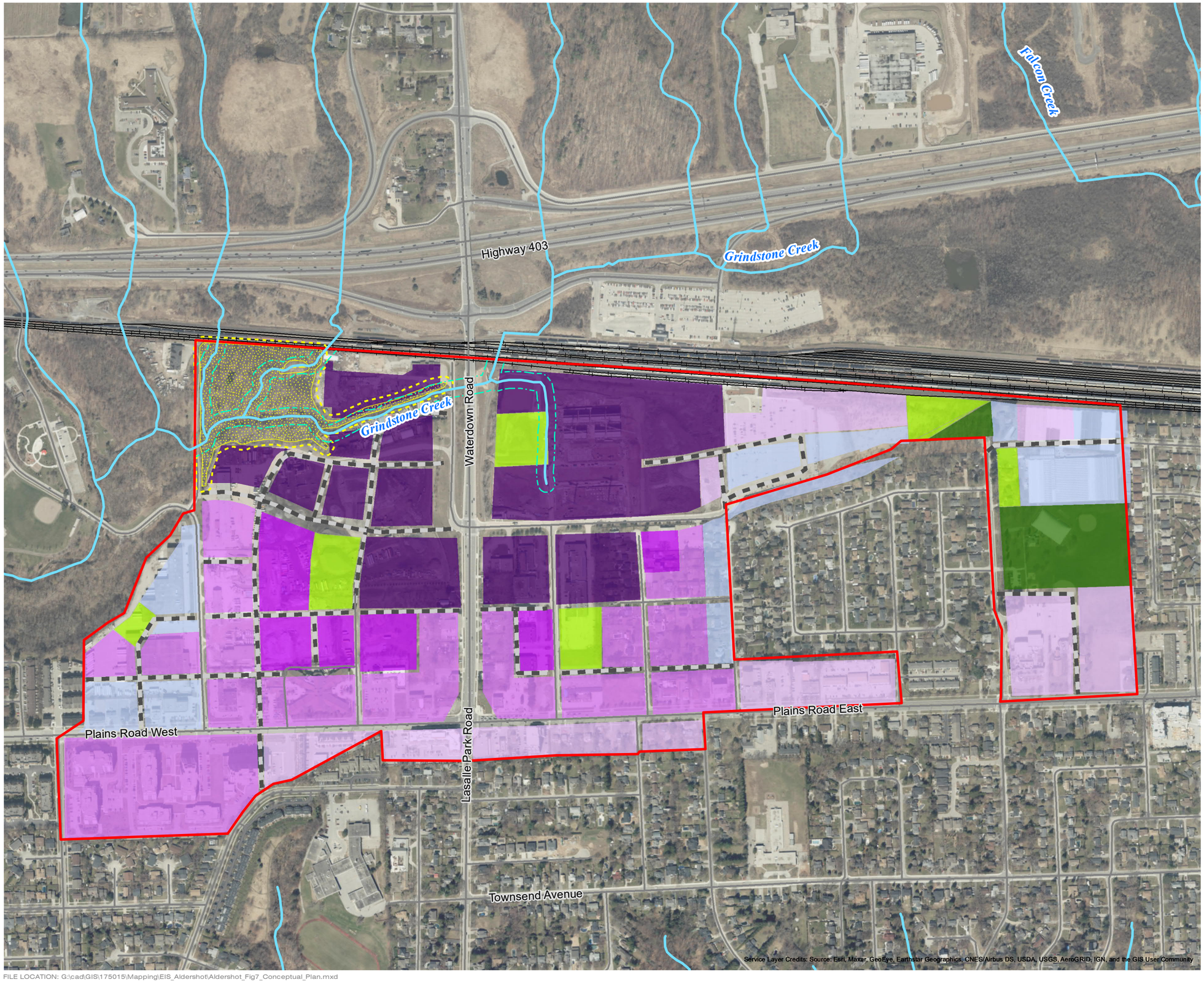
From a terrestrial perspective, the woodland features provide limited cover, foraging, refuge, and nesting habitat for terrestrial wildlife (though limited). Each of the woodlands within the Study Area have been designated as candidate SWH for Bat Maternity Colonies and Landbird Migratory Stopover Area with Woodland A designated as SWH for Special Concern and Rare Wildlife Species (Eastern Wood-peewee). Similarly, given the presence of provincially significant wetlands associated with the woodlands northwest of the railway (though not assessed by Dillon), requires consultation with the MNRF at the detail design stage. However, due to the surrounding urbanized area and the disturbed nature of the Study Area, the creek corridors (including the woodlands) provide limited habitat function for both urban tolerant flora and fauna.

7.0 Description of Proposed Development

The City is embarking on an ambitious program to complete a comprehensive intensification planning framework. Conceptualizing Area Specific Plans for the Aldershot Mobility Hub is an important step to ensure the City continues to 'Grow Bold' 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 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 Aldershot Mobility Hub will, through strategic infill, protect and enhance the quaint village of Aldershot; add new development of the highest quality that frames the street; add attractive boulevards, landscaping as well as direct pedestrian connections to Aldershot GO Station.

The Conceptualized Plan for the Aldershot Mobility Hub is illustrated in **Figure 7** along with the assessed natural heritage features with their associated recommended buffers. Changes to the concept plan and potential densities are not expected to have a significant impact on the natural environment, so long as the recommended setbacks are respected. The Aldershot Mobility Hub will continue to develop as an Urban Growth Centre as well as the City's western gateway. Key considerations implemented in the Aldershot Hub Conceptualized Plan are:

- Concentrate mid-rise buildings near the intersection of Waterdown Road and Plains Road, with taller buildings near the station;
- Protect existing stable employment lands along Cooke Boulevard;
- Support mixed-use redevelopment on vacant and underutilized sites, that frame and address the street;
- Provide new street connections, and extend existing streets (i.e. Clearview Ave.) to maximize connectivity and permeability through blocks;
- Create improved pedestrian and cycling connections across the GO rail corridor and within the mobility hub area (i.e. along Gallagher Road, Masonry Court, and Emery Avenue);
- Enhance access and connections to Hidden Valley Park, Grove Park and Aldershot; and
- Enhance streetscape design through landscaping, and new parks and plazas.



CITY OF Burlington

ALDERSHOT
BURLINGTON HUB MOBILITY STUDY

CONCEPTUALIZED PLAN
FIGURE 7

- Study Area
- Road
- Railway

Assessed Natural Heritage Features

- Watercourse
- 15 m Setback from Watercourse
- Natural Heritage System
- 10 m Setback from Natural Heritage System

Concept Plan Features

- Low Rise (1-3 Stories)
- Mid Rise (4-6 Stories)
- Mid Rise (7-11 Stories)
- Tall (12-19 Stories)
- Tallest (20+ Stories)
- Proposed Parks / Open Space
- Existing Parks / Open Space
- Proposed Street

0 50 100 200 Metres

N W E S

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: 2021-11-16

FILE LOCATION: G:\cad\GIS\175015\Mapping\EIS_Aldershot\Aldershot_Fig7_Conceptual_Plan.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 Aldershot Mobility Hub may include the following:

- Tree and vegetation removal;
- Diversion of surface water flows;
- Erosion and sedimentation into natural features (Grindstone Creek); and
- Loss of/disturbance to wildlife and general wildlife habitat.

The majority of the intensification redevelopment activities are proposed outside of the recommended buffer setbacks. Potential direct impacts would generally be limited to pre-existing disturbed areas which currently consist of industrial infrastructure and asphalt parking lots (**Figure 7**).

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 in **Figure 7** 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. We do propose through the Landscape and Planting Plan discussed further in **Section 9.2** below, that the re-planting following the re-intensification will the off-set proposed tree and vegetation removal as well as provide enhancements and/or restoration function to natural areas and their associated setbacks/buffers, where possible.

Refer to **Section 9.0** for mitigation and enhancement opportunities.

8.1.2 Diversion of Surface Water Flows

The Grindstone Creek corridors within the Study Area contribute as "natural" conveyance infrastructure (i.e. drainage system), riparian habitat, 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 in the context of future intensification of redevelopment have been proposed (**Section 9.0**).

8.1.2.1 Riverine Flooding Hazard

The Aldershot Mobility Hub includes portions of Grindstone Creek, West Aldershot Creek, Falcon Creek, and Teal Creek watersheds. Of these four watersheds, only Grindstone Creek includes portions of open channel, with an associated riverine flooding hazard. Based on the most currently developed floodplain mapping, some areas could potentially be impacted during the Regional Storm Event.

Wider floodplain impacts are noted to the west of Waterdown Road, between Highway 403 and the CNR tracks, however, it is understood that this area will not be subject to future development. A wider floodplain is also noted upstream of Howard Road, which would be expected to overtop during both the 100-year storm and Regional Storm Event. A slight encroachment of the floodplain onto the property at 1160 Waterdown Road is noted during both the 100-year storm and Regional Storm Event.

Grindstone Creek tributaries east of Waterdown Road are primarily contained to channel blocks, although overtopping of the CNR tracks is noted for the Regional Storm Event. While the most easterly portion of the channel has a larger floodplain, this area is being addressed by a separate study for that parcel of land (1200 King Road).

Urban Flooding Hazard

Urban (overland) flooding hazards have been noted along roadway systems within the Teal Creek and West Aldershot Creek areas, primarily along Plains Road and adjacent side streets, including Waterdown Road. Overland flow depths in excess of 0.3 m have been noted for both the 100-year storm and Regional Storm Event. Storm sewer capacity and potential surcharging has not yet been evaluated.

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 Flood Hazard and Scoped Stormwater Management Assessment Report prepared by Wood Environment & Infrastructure Solutions (Wood) in **Appendix F**.

8.1.2.2 Potential Development Impacts

Changes in land cover associated with development (increased imperviousness) has the potential to generate impacts to downstream receivers, both with respect to water quantity (increased peak flows and erosion potential) and water quality (increased contaminants due to paved surfaces in particular). As noted in the Flood Hazard and Scoped Stormwater Management Assessment Report, the City of Burlington's current Stormwater Management Design Guidelines would be applied for any new development. This would require post to pre-peak flow control at a minimum (2 through 100-year storm events) and over-control (100-year post to 5-year pre) for more constrained areas. Erosion control measures (extended detention storage) would also be required, potentially in combination with LID BMPs (City now recommends the retention and on-site infiltration of the first 5 mm of rainfall). Enhanced water quality controls (80% average annual TSS removal) would also be required.

With respect to hydraulic impacts, no development would be permitted within the Regulatory Floodplain (or within the associated additional buffer width), thus no off-site impacts would be expected. Development within spill areas could potentially be considered; however, such areas are now regulated by Conservation Halton. As noted within the Flood Hazard and Scoped SWM Assessment Reporting, further study in such areas would need to be completed to confirm no off-site impacts and safe conveyance of flood flows (including a cut/fill balance and additional overland hydraulic modelling). Additional flood proofing measures would also be required for the development site itself.

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 Grindstone Creek):

- Disturbance to or loss of additional vegetation due to the deposition of dust and/or overland mobilization of soil; and
- Loss of general wildlife habitat.

Refer to **Section 9.0** 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.

Significant wildlife habitat for Eastern Wood-pewee was identified within forested communities as a result of species observations made during breeding bird surveys. In addition, there is potential for Bat Maternity Colonies SWH, including SAR bat habitat, to be present in association with woodlands in addition to Amphibian Breeding Habitat (woodland). Since development activities are proposed wholly outside of the woodlands, and its associated 10 m buffer, the potential for impacts to SAR, Species of Conservation Concern or amphibians utilizing the woodland is limited. As previously mentioned, vegetation communities within the Study Area were found to have species composition indicating an altered landscape, with existing disturbances and adjacent development activities and recreational uses. Therefore, impacts to SWH and general wildlife within adjacent natural features are not anticipated.

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.

Accordingly, wildlife impact mitigation measures have been recommended for the development area are included in **Section 9.4**.

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 the adjacent residential

area. 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 edges, meadows and creek corridors shown in **Figure 4**. Site visits determined that the ground layers contained invasive species such as Broad-leaved Enchanter's Nightshade (*Circaea canadensis*), Garlic Mustard (*Alliaria petiolata*), Tatarian Honeysuckle (*Lonicera tatarica*) and Common Buckthorn (*Rhamnus cathartica*). In order to maximize ecological function within the Study Area, removal of invasive species paired with the 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. Detailed mitigation measures will be finalized in consultation with the City, CH and Halton Region as part of the preliminary and site-specific development applications.

9.1 Natural Heritage Feature Buffers

Recommended buffers are illustrated in the Conceptualized Plan for the Aldershot Mobility Hub (**Figure 7**). As discussed in **Section 5.4.2**, Woodland A 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 the Grindstone Creek corridor, we have applied a recommended 10 m buffer to the woodland. Additionally, the woodlands northwest of the railway were presumed to be considered significant based on size and proximity to Grindstone Creek (**Figure 6**). As illustrated in **Figure 7**, there are pre-existing disturbances such as residential housing, parking lots, industrial infrastructure and buildings within this recommended buffer. As such, the buffer applies to areas without pre-existing disturbances in order to prevent potential adverse effects to habitat and ecological function that the woodlands and creek corridor provides in the current urban setting.

Grindstone Creek is regulated by CH. New development adjacent to watercourses will be subject to a setback from the stable top of bank, the flooding hazard and/or meaderbealt allowance (whichever is greater) that are associated with the watercourse.A 15 m buffer (as per CH policy) from Grindstone Creek is required from future development (**Figure 7**). It is recommended that the stable top of bank, flooding hazard and/or meaderbealt allowance be confirmed with the City and CH at the site specific development application stage.

It should be noted that the buffer recommendations will be further assessed at the site specific development application stage.

In its 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. In addition, this naturalized, vegetated buffer will provide protection to adjacent natural features through filtration of overland flows and protection from edge effects to the woodlands. As the proposed buffer enhancements will not only increase the overal quality of available habitat within the buffer areas, but also the quality and protection of both aquatic and terrestrial habitat within the adjacent natural features, the intensitifcation of redevelopment limit as shown, with minimal encroachment into the buffer areas should not result in ngegative 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 and plant movement and dispersal;
  - Contribution of recourses 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
  - Maximize potential for wildlife passage, forage, residency, hibernation, and breeding habitat.

Furthermore, buffer recommendation should be further assessed at the detailed design stage to ensure their extent (width) is sufficient and that they can perform their intended function in light of the likely negative impacts resulting from adjacent development or site alteration (before, during and after construction) add to determine other mitigation measures as needed (i.e. enhancement plantings in the buffer, permanent fencing, sediment and erosion control measures).

9.2 Landscaping and Planting Plan

The proposed intensification of redevelopment plan will require the potential removal of select trees, shrubs, wildflowers and wild grasses and are limited to the Conceptualized Plan illustrated in **Figure 7**.

As a result, a Landscaping and Planting Plan is required to off-set proposed vegetation removal and propose enhancements to natural areas where possible. Compensation plantings of trees are generally based on the number of removals required to facilitate construction of the development. 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 recommend approaches to improving overall tree canopy in an urban area;
- A mix of native deciduous and coniferous trees and shrubs throughout the development and buffer areas;
- Sodding within the residential portions of the development; and
- A native seed mix recommended by suppliers for enhancement within the buffer area and/or 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., Bittersweet Nightshade, Garlic Mustard, Tatarian Honeysuckle and Common Buckthorn), 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.

Conservation Halton's Landscaping and Tree Preservation Plan Guidelines (2010) is recommended to be consulted for further information and direction at the detail design stage.

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 Flood Hazard and Scoped Stormwater Management Assessment prepared by Wood in **Appendix F**. A summary of the aforementioned as it relates to the Integrated Stormwater Management Plan and LID is provided below.

Riverine flood management strategies are expected to be minimal. CH would be expected to restrict or prevent development within floodplain areas of Grindstone Creek.

For urban flooding hazard areas (not regulated by CH) opportunities for road re-grading or localized flood storage should be explored by the City. Any proposed development within these potential hazard areas should incorporate flood-proofing into building design to address overland flooding risk. Storm sewer capacity and potential surcharging would need to be considered in the design of basement foundation drainage systems.

Consistent with the approach employed for each of the four Mobility Hubs, it is expected that each development requiring 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.

The currently proposed land use plan for the Aldershot Go Mobility Hub indicates the use of "Green Streets" for area roadways. Green Streets provide the opportunity to incorporate LID Best Management Practices (BMPs) 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 quality, quantity, and water budget, infiltration and erosion.

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

- 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 or demonstrated capacity) of peak flows for areas connecting to storm sewers or where major system is constrained. Additional over-control may also be warranted where modelling results indicate storm sewer capacity is less than 5-year storm event standard;
- 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 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 and road reconstruction projects in particular ("Green Streets").

It is also recognized that the City currently finalized its Stormwater Management Design Policies and Guidelines (2020). As a result, future works must conform to the documents in the design of storm drainage infrastructure within the City. 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 breeding amphibians and other sensitive wildlife species where possible;
- Where possible, maximize the distance of construction equipment used from the woodland/wetland edge to avoid disturbing wildlife;
- Limit the use of lighting where possible. Avoid light effects entering the woodland/wetland (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 (e.g. Grindstone Creek corridor);
- 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 to make glass more visible to avian wildlife include:

- Applying films 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 Guidelines 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 Species at Risk 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 detailed design 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 observe 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 soil 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.

As discussed previously in **Section 8.1**, the proposed development may result in diversion of surface water flows as well as increased erosion and sedimentation into regulated watercourses, potentially affecting water quality. Changes in land cover associated with development has the potential to generate impacts to watercourse, both with respect to water quantity (increased peak flows and erosion potential) and water quality (increased contaminants due to paved surfaces in particular). The following mitigation measures are recommended to help mitigate negative impacts post-development:

- Implementation of Low Impact Development Best Management Practices (LID BMPs) for roadway reconstructions;
- Vegetation planting of watercourse banks with native riparian species;
- Surface features such as bio swales and bio retention areas, soil retention cells, tree planters;
- Sub surface features such as exfiltration pipes and storage chambers; and
- End of pipe (EOP) measures (i.e. plunge pools, velocity reducers).

Implementation of these measures would benefit both water quantity, quality and water budget, infiltration, and erosion. Additional, site specific in-stream mitigation measures include the following:

- Vegetated buttresses and riffle-pool morphology bed features;
- Naturalized erosion protection such as armour stone or boulder steps;
- Cobble bed and bank material for erosion protection; and
- Floodplain benches can be added to reconnect the frequent flow regime to the floodplain.

As discussed previously in **Section 5.3.1.4,** site specific stream rehabilitation opportunities for Appleby Creek have been evaluated by GeoProcess and are provided under separate cover in **Appendix G**.

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 development area 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 ensure that they are not impacted by adjacent development. Should any impacts be observed, necessary steps will be taken to ensure 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 and 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.

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 Aldershot 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; lands north of the railway were not included as part of the natural heritage inventories.

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 Grindstone Creek in the northwest portion of the Study Area, its associated woodland and the woodlands directly southeast of the railway. Woodland A, associated with Grindstone Creek, was assessed as significant under the ROPA 38. Based on aerial interpretation, it is assumed that the woodlands north of the railway also meet the criteria to be considered significant under the ROPA 38 due to their size and proximity with Grindstone Creek.

A total of 34 common bird species were observed during field studies, including one Species of Conservation Concern (i.e. Eastern Wood-pewee). Candidate SWH for Eastern Wood-pewee was identified within the Study Area in association with Woodland A. Similarly, each of the woodlands within the Study Area were designated as candidate SWH for Bat Maternity Colonies. The presence of the unevaluated wetland associated with the woodlands north of the railway (though not assessed by Dillon), meets the minimum criteria to be considered candidate SWH for Amphibian Breeding Habitat (Woodland). Finally, a total of 59 botanical species were observed, 35 of which are native and considered *Secure* of *Apparently Secure* in Ontario.

Based on the proposed redevelopment areas associated with the Aldershot Mobility Hub, potential impacts of development may include potential 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, restoration, and management measures described in this report.

As there are a number of Species at Risk in the lands within or adjacent to the Study Area or that may be impacted by the proposed works. It is recommended that engagement with the Ministry of Environment, Conservation and Parks (MECP) at the detail design stage is initiated to determine if there are requirements under the Endangered Species Act (2007).

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:

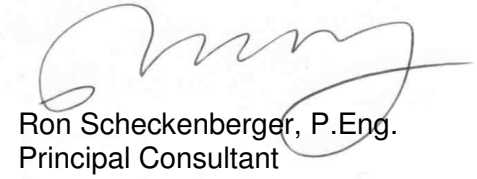
1. Page 6 of PDF (5.0 - Table A) – Aldershot has been revised to a "Yes*", based on the qualifiers and conditions outlined under the "*".
2. Page 10 of PDF (5.0 – Water Quality/Benthic Invertebrates) – Asteriks added for Burlington and Appleby Line.
3. Page 11 of PDF (5.0 – Stream/Drainage Corridor and 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) Indian Creek Grade Separation Design (AMEC 2013) 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 4th, 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. • 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. • Include all data sheets (e.g., soils, disturbance, etc.). • Mapping should clearly differentiate between the polygons.
☐	Wetland Evaluation and Delineation	• Evaluation: variety of seasons to ensure the full evaluation occurs as per OWES • 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. • Ensure sufficient time for MNRF to process. *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 • Details on species including level of invasiveness, CoC, CoW, species rarity etc., should be recorded	Species rarity to be based on: • Species at Risk in Ontario list (MNRF) • S-Rank using the Natural Heritage Information Centre species lists • 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: • Ontario Breeding Bird Atlas protocols	• Point counts required for monitoring. • 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) • 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). • 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. • If sampling in urban areas, point counts longer than three minutes may be recommended *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 • Late Summer/Fall: Late August to October for migration or congregating species • Weather dependent	• Species and habitat dependent • May include cover board surveys, spring emergence surveys etc. • 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 • July (peak) • Weather dependent	• Species and habitat dependent • Consultation recommended ahead of work	*Note: potential significant wildlife habitat for migratory butterflies to be confirmed through ELC surveys.*
☐	Dragonflies and damselflies	• June – August • July (peak) • Weather dependent	• Species and habitat dependent • 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 • 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 • SAR Bats require different surveys than SWH bats. • MNRF Guidelines, where applicable • 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 • 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 *Note: to be completed during future investigations closer to construction, to set a baseline for monitoring purposes.*

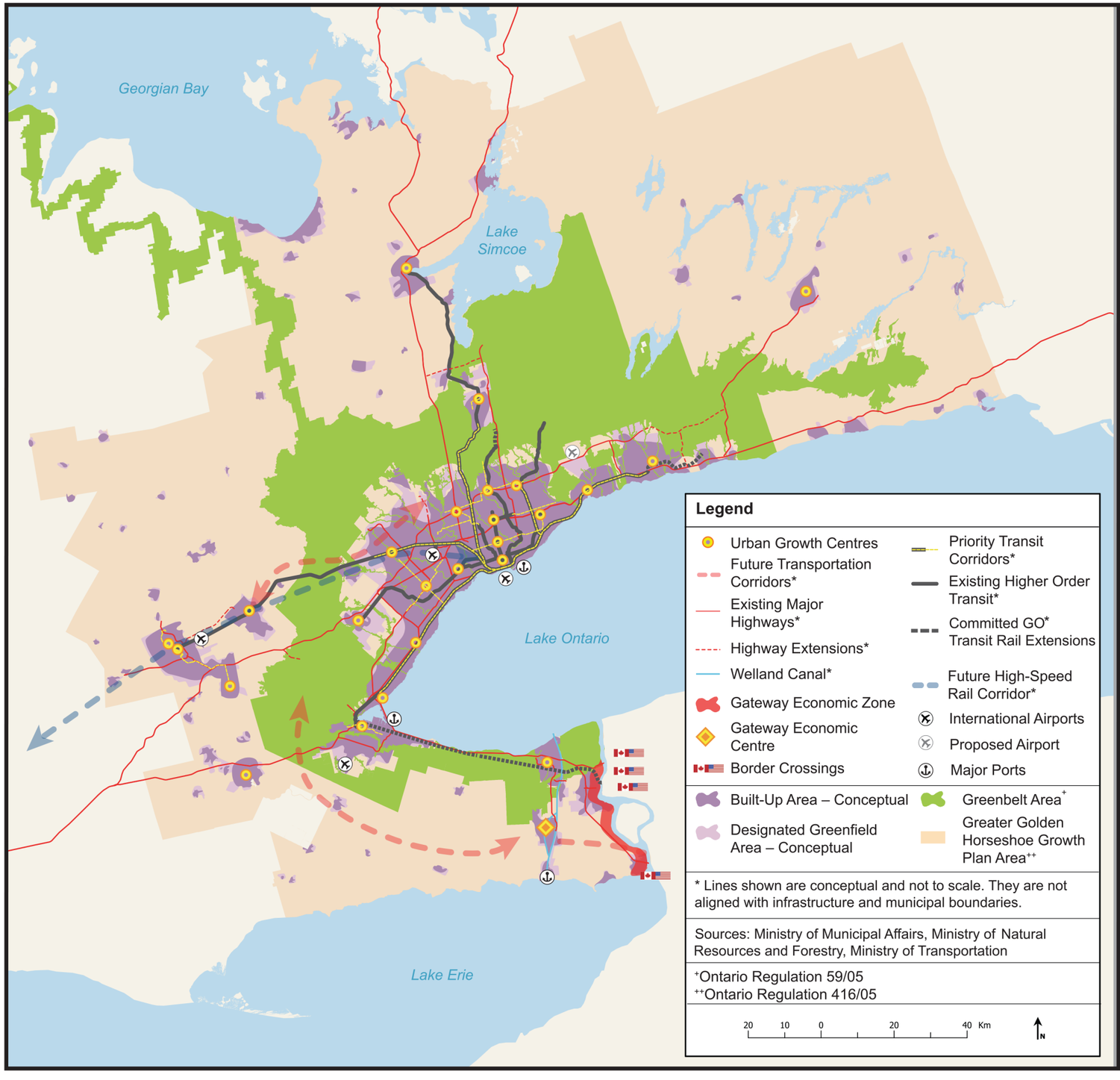
Note: The surveys listed above were agreed to at the meeting with CH on February 14, 2017. Additional surveys may be required as identified through the preliminary field program, to be addressed through the development application and approvals process.

ATTACHMENT A:

Terrestrial and Aquatic Field Study Locations

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

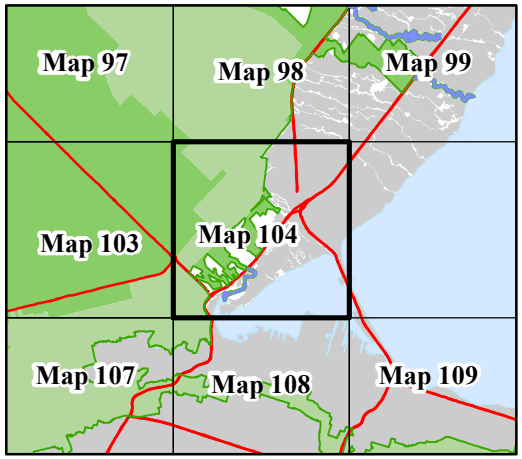
+Ontario Regulation 59/05
++Ontario Regulation 416/05

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.

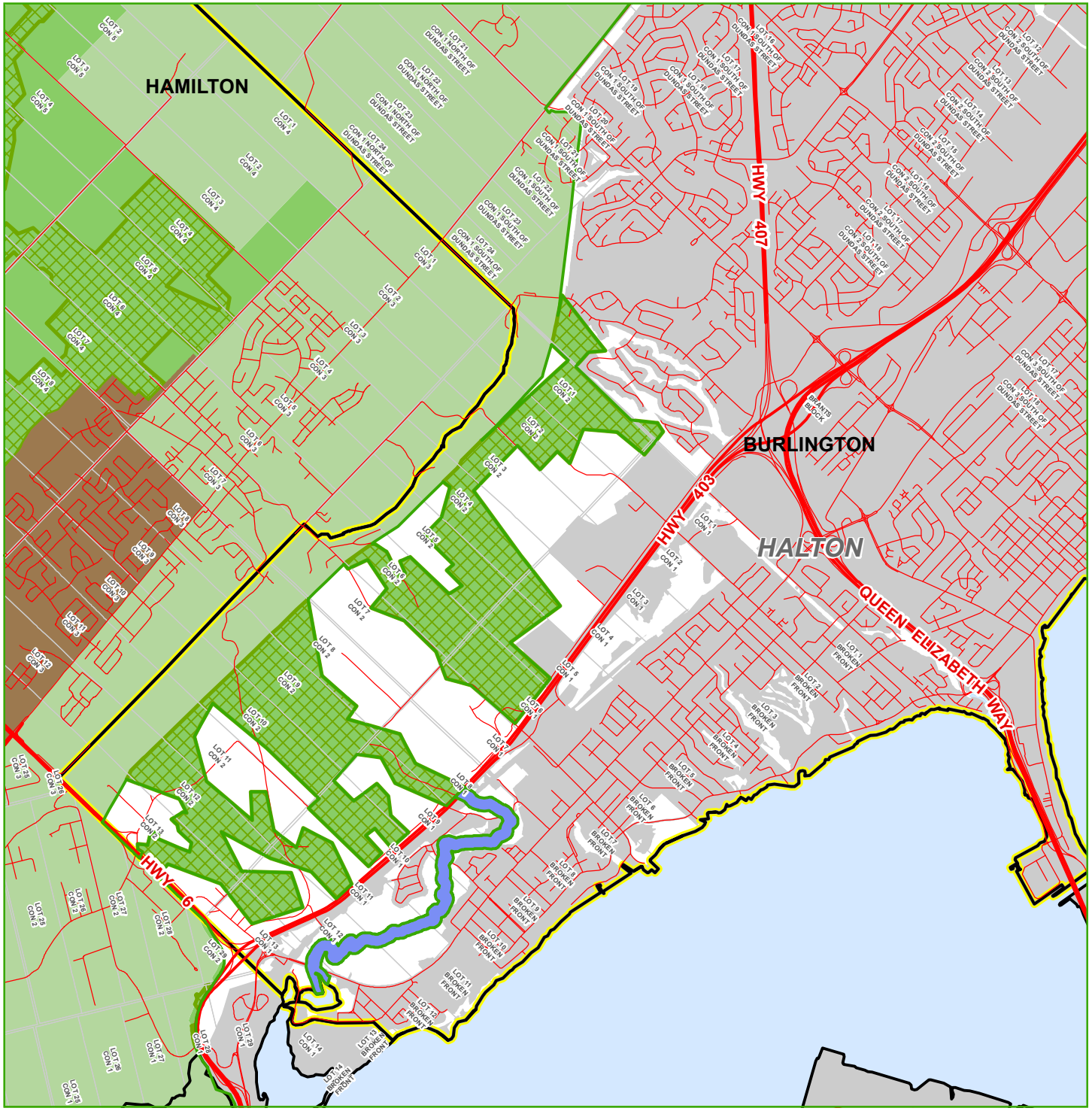
Settlement boundaries generally reflect information provided by the relevant municipality. For precise boundaries and locations of Settlement Areas (Greenbelt Towns/Villages and Hamlets) the appropriate municipalities should be consulted.

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

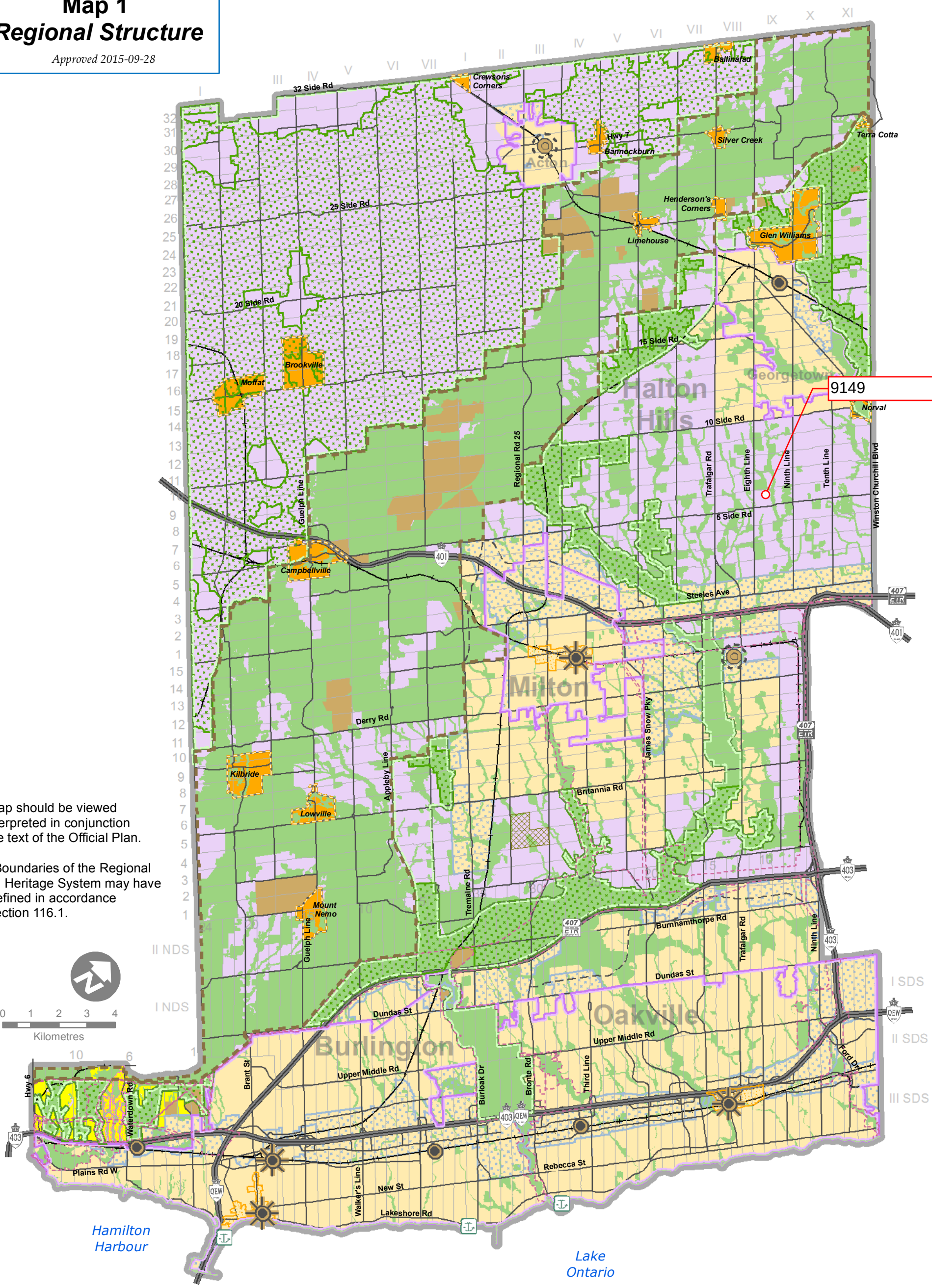
* Ontario Regulation 59/05, as amended.

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 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

RURAL AREA

URBAN AREA

NORTH ALDERSHOT

Kilbride

Lowville

Mount Nemo

DERRY RD.

KILBRIDE ST.

NO. 8 SIDE RD.

APPLEBY LINE

BRITANNIA RD.

MILBURROUGH LINE

BLIND LINE

BELL SCHOOL LINE

COLLING RD.

NO. 4 SIDE RD.

NO. 2 SIDE RD.

NO. 1 SIDE RD.

CEDAR SPRINGS RD.

TREMAINE RD.

DUNDAS ST.

KERNS RD.

GUELPH LINE

WALKER'S LINE

UPPER MIDDLE RD.

BRANT ST.

MAINWAY

WATERDOWN RD.

SNAKE RD.

NORTH SERVICE RD.

KING RD

QUEENSWAY DR.

HARVESTER RD.

PLAINS RD. E

PLAINS RD. W

FAIRVIEW ST.

NORTH SHORE BLVD. W

NORTH SHORE BLVD. E

MAPLE AVE.

NEW ST.

LAKESHORE RD.

BURLOAK DR.

BURLINGTON BAY

LAKE ONTARIO

0 0.5 1 2 3 4 Km

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

NOVEMBER 2020

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

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

CONTEXTUAL REFERENCES
- Municipal Boundary
- Urban Boundary
- Urban Growth Centre Boundary
- Special Street (Tremaine Dundas Secondary Plan)

RURAL AREA

HAMILTON

NORTH ALDERSHOT

HAMILTON

OAKVILLE

BURLINGTON BAY

LAKE ONTARIO

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

**Uptown Urban Centre

*Downtown Urban Centre

0 0.5 1 2 3 4 5 Km

*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.

NOVEMBER 2020

CITY OF Burlington

Appendix C

Site Photos

Photo 1 June 28, 2017 Fresh-Moist Mixed Meadow Ecosite/Dry - Fresh Deciduous Shrub Thicket Ecosite (MEMM4/THDM2).	
Photo 2 June 28, 2017 Dry-Fresh Manitoba Maple Deciduous Forest Type (FODM4-5)	

Photo 3 June 28, 2017 Fresh-Moist Lowland Deciduous Forest Ecosite (FODM7)	
Photo 4 June 28, 2017 Dry – Fresh Sugar Maple – Oak Deciduous Forest Type (FODM5-3)	

Photo 5 June 28, 2017 Cattail Graminoid Mineral Meadow Marsh Type (MAMM1-2)	
Photo 6 June 28, 2017 Fresh – Moist Poplar Deciduous Forest Type (FODM8-1)	

Photo 7 June 21, 2017 Looking upstream the Grindstone Creek tributary 1. Flats and riffles present as the tributary meanders downstream.	
Photo 8 June 21, 2017 Looking downstream at bank instability within the forested riparian area, immediately downstream of the Waterdown Road crossing.	

Photo 9 June 21, 2017 Looking upstream Grindstone Creek tributary 2. Within this instream debris is the outlet of the culvert crossing conveying flows south of the railway track easement.	
Photo 10 June 21, 2017 Looking downstream towards the wetland within Grindstone Creek tributary 2.	

Photo 11 June 21, 2017 Looking upstream the Grindstone Creek tributary 2. Within the lower reach of this tributary the gradient increased and the steep slopes became unstable.	
Photo 12 June 21, 2017 Looking upstream Grindstone Creek tributary 3 at the perched culvert outlet present at the railway track crossing.	

Photo 13 June 21, 2017 Looking downstream the Grindstone Creek tributary 3. Limited meandering was observed.	
Photo 14 June 21, 2017 Looking downstream Grindstone Creek tributary 3 along an area of poor bank stability.	

Appendix D

Botanical List

Scientific Name	Common Name	SARA[16]	ESA[17]	SRank[18]	Coefficient Conservation	Coefficient Wetness
Aralia nudicaulis	Wild Sarsaparilla	---	---	S5	4	3
Arctium minus	Common Burdock	---	---	SNA	---	5
Arisaema triphyllum	Jack-in-the-pulpit	---	---	S5	5	-2
Asarum canadense	Canada Wild-ginger	---	---	S5	6	5
Asparagus officinalis	Garden Asparagus	---	---	SNA	---	3
Betula papyrifera	Paper Birch	---	---	S5	2	2
Briza sp.	Quakegrass species					
Bromus sp.	Brome species					
Carex vulpinoidea	Fox Sedge	---	---	S5	3	-5
Catalpa speciosa	Northern Catalpa	---	---	SNA	---	3
Circaea canadensis	Broad-leaved Enchanter's Nightshade	---	---	S5	3	3
Cirsium arvense	Canada Thistle	---	---	SNA	---	3
Dactylis glomerata	Orchard Grass	---	---	SNA	---	3
Dipsacus fullonum	Fuller's Teasel	---	---	SE5	---	5
Equisetum arvense	Field Horsetail	---	---	S5	0	0
Erigeron philadelphicus	Philadelphia Fleabane	---	---	S5	1	-3
Fagus grandifolia	American Beech	---	---	S4	6	3
Fragaria vesca	Woodland Strawberry	---	---	S5	4	4
Fraxinus pennsylvanica	Green Ash	---	---	S4	3	-3
Galium obtusum	Blunt-leaved Bedstraw	---	---	S4S5	6	-5
Geranium sp.	Geranium species					
Geum canadense	White Avens	---	---	S5	3	0
Helianthus sp.	Sunflower species					
Hemerocallis sp.	Day Lily species					
Juglans nigra	Black Walnut	---	---	S4	5	3
Lathyrus palustris	Vetchling Peavine	---	---	S5	6	-3
Lonicera tatarica	Tartarian Honeysuckle	---	---	SNA	---	3
Lotus corniculatus	Garden Bird's-foot Trefoil	---	---	SNA	---	1
Maianthemum canadense	Wild Lily-of-the-valley	---	---	S5	5	0
Maianthemum racemosum	False Solomon's-seal	---	---	S5	4	3

[16] Federal Species at Risk Act.
[17] Provincial Endangered Species Act.
[18] S-Rank is an indicator of commonness in the Province of Ontario.

Scientific Name	Common Name	SARA[16]	ESA[17]	SRank[18]	Coefficient Conservation	Coefficient Wetness
Matricaria chamomilla	German Mayweed or Wild Chamomile	---	---	SNA	---	5
Morus alba	White Mulberry	---	---	SNA	---	0
Ostrya virginiana	Eastern Hop-hornbeam	---	---	S5	4	4
Parthenocissus inserta	Thicket Creeper	---	---	S5	3	3
Pastinaca sativa	Wild Parsnip	---	---	SNA	---	5
Phalaris arundinacea	Reed Canary Grass	---	---	S5	0	-4
Pinus strobus	Eastern White Pine	---	---	S5	4	3
Poa compressa	Canada Bluegrass	---	---	SNA	0	2
Populus alba	White Poplar	---	---	SNA	---	5
Populus deltoides ssp. *deltoides*	Eastern Cottonwood	---	---	S5	4	-1
Potentilla recta	Sulphur Cinquefoil	---	---	SNA	---	5
Prunus serotina	Wild Black Cherry	---	---	S5	3	3
Prunus virginiana	Choke Cherry	---	---	S5	2	1
Quercus rubra	Northern Red Oak	---	---	S5	6	3
Rhamnus cathartica	Common Buckthorn	---	---	SNA	---	3
Rhus hirta	Staghorn Sumac	---	---	S5	1	5
Robinia pseudoacacia	Black Locust	---	---	SNA	---	4
Rubus odoratus	Purple-flowering Raspberry	---	---	S5	3	5
Rumex crispus	Curly Dock	---	---	SNA	---	-1
Salix fragilis	Crack Willow	---	---	S4?	---	-1
Solidago canadensis var. *canadensis*	Canada Goldenrod	---	---	S5	1	3
Solidago flexicaulis	Zigzag Goldenrod	---	---	S5	6	3
Solidago sp.	Goldenrod species					
Thalictrum dioicum	Early Meadow-rue	---	---	S5	5	2
Toxicodendron rydbergii	Rydberg's Poison Ivy	---	---	S5	0	0
Tussilago farfara	Colt's-foot	---	---	SNA	---	3
Typha latifolia	Broad-leaved Cattail	---	---	S5	3	-5
Ulmus americana	American Elm	---	---	S5	3	-2
Vitis riparia	Riverbank Grape	---	---	S5	0	-2

Appendix E

Fluvial Geomorphology Assessment

GeoProcess
RESEARCH ASSOCIATES
Knowledge
Research
Consulting

February 28, 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 – Aldershot GO 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.

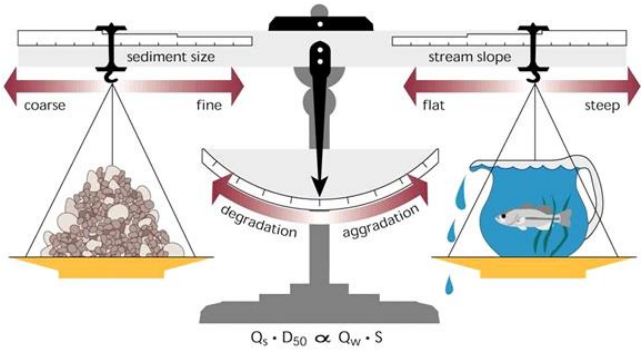
The objective of this assessment was to provide a preliminary assessment and screening pertaining to the geomorphic resiliency of watercourses located within the Mobility Hub study areas, and to identify reaches that are lacking resiliency, and therefore are potentially sensitive to watershed changes (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.

2 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)

3 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.

4 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.

5 Results

Reach Descriptions

Grindstone Tributary

The Grindstone Tributary within the Study Area (Figure 2) begins adjacent to the Aldershot GO Station. The reach adjacent to the Go Station has been previously realigned to accommodate the Highway 403 interchange (Reach GST01). This realignment and the associated natural channel design provides some floodplain access in a semi-confined valley. Here, vegetation has encroached into the channel and has resulted in excess sedimentation throughout the reach. Immediately downstream of the realignment, the watercourse enters a mature woodlot, becomes confined and shows indicators of widening and downcutting (GST02). This is the most natural reach of the Grindstone tributary upstream of the GO Station which, combined with its unstable nature (in adjustment, per the mapping) makes it one of the more sensitive Aldershot reaches and a good candidate for future detailed erosion threshold investigation.

Downstream of GST02 the watercourse is fully channelized, lined with gabion mattress and in a confined valley, where it crosses under the Highway 403 onramp, Waterdown Road and Railway Road (GST03). Downstream of Railway Road, the river flows through an entrenched valley with limited floodplain access (GST04 and GST05). Here, valley wall contact is frequent, along with indicators of instability in the form of widening and downcutting. Downstream, the valley becomes less entrenched, with some floodplain access (GST06). Here, a small tributary confluences (GST06i), which flows south through an entrenched valley with significant erosion. The most downstream reach begins to interact with the shale-dolomite bedrock (GST07), with an incised and overly widened channel until the confluence with Grindstone Creek.

Rapid Assessment Summary

Figure 3 illustrates the reach characterizations stemming from the RGA results. In addition, valley confinement was mapped and is illustrated in Figure 4. The results for each component of the RGA are summarized in Table 1. A detailed matrix associated with the field assessment is presented in Appendix A.

Table 1 Rapid Geomorphic Assessment Results

Reach	Form/Process Factor Value				Stability Index	Classification
	Aggradation	Degradation	Widening	Planimetric Adjustment		
GST01	0.83	0.5	0	0.14	0.37	Transitional or Stressed
GST02	0.29	0.5	0.75	0.57	0.53	In Adjustment
GST03	0.5	0.25	0.5	0.14	0.35	Transitional or Stressed
GST04	0.5	0.17	0.57	0.2	0.36	Transitional or Stressed
GST05	0.17	0.75	0.86	0	0.44	In Adjustment
GST06	0.29	0.2	0.63	0.29	0.35	Transitional or Stressed
GST06i	0.25	1	0.57	0.29	0.53	In Adjustment
GST07	0.17	0.67	0.57	0	0.35	Transitional or Stressed

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.

Photographic Record

The photograph locations are shown on the RGA mapping, with locations and images compiled in Google Earth format and available from the following download link:

https://drive.google.com/open?id=1b40dIlcpamYNcEUjGNj0tZ7aXeqmDSVG

6 Conclusions and Discussion

Although the upstream, previously realigned, reach is classified as stressed, most of the instability arises from sedimentation, which should be considered when looking at sustained low flows (flushing flows) associated with proposed changes to the stormwater regime stemming form the mobility hub development. Vegetation here has encroached into the channel, thus stabilizing the bed and banks and lowering velocities, influencing the rate of sedimentation of fine material. The abundance of riparian vegetation and ready floodplain access, however, adds resiliency to this reach. Immediately downstream, however, the floodplain access lessens and channel instability is evident. GST02 is one of the most sensitive reaches and, due to its natural valley setting and the absence of engineered channel alterations, is a good candidate for a future, more detailed, erosion threshold assessment.

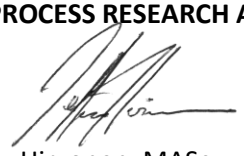
Downstream of GST02 the least resilient reaches are those having minimal bank protection (either from natural vegetation or artificial revetments) and bed/bank material that is more susceptible to erosion. For example, although the downstream reach (GST07) exhibits many signs of instability, the boundary material is bedrock which is more resistant to erosion than the upstream reaches. As such, slower rates of adjustment are expected here. Correspondingly, upstream reaches with less resistive material, no floodplain access and entrenched/confined valleys are more susceptible to negative impacts associated with boundary condition alterations. The three in adjustment reaches shown on the mapping are those least resilient segments of channel, and should be the focus for the more detailed, site-specific studies.

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. It should be noted that the surficial geology mapping in Figure 2 is provided for reference only and may not correspond to the dominant bed and bank material in each reach due to the coarse scale of the mapping. Refer to Appendix A for a summary of reach conditions.

Regards,

GEOPROCESS RESEARCH ASSOCIATES INC.



Jeffrey Hirvonen, MASc.
Principal, Fluvial Geomorphologist

Legend

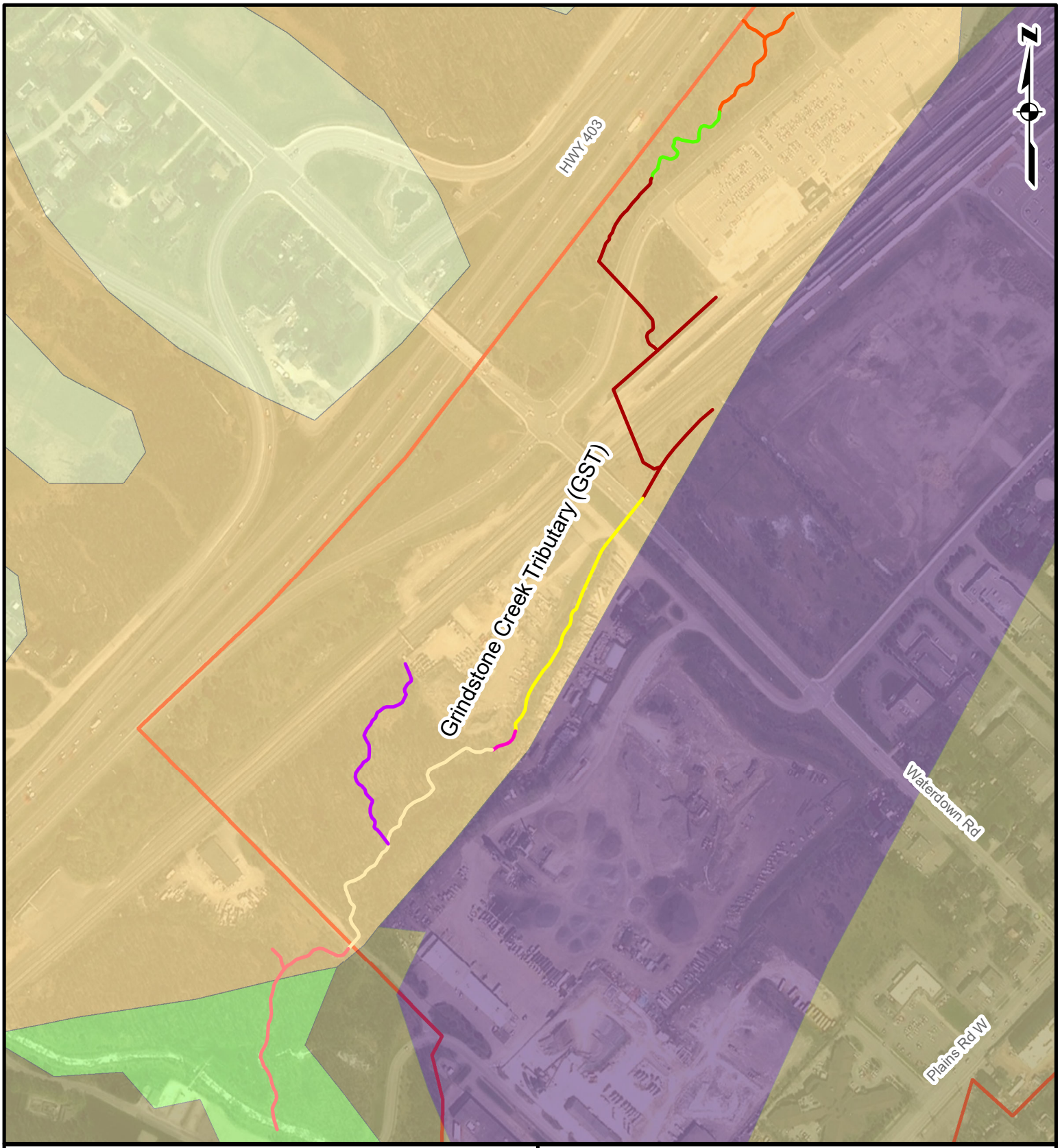
- Aldershot GO Hub Study Area
- Appleby GO Hub Study Area
- Burlington GO Hub Study Area
- Downtown Hub Study Area
- Watercourse
- Ponds

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

GST01	Study Area
GST02	Beach gravel
GST03	Bedrock
GST04	Halton Till
GST05	Lacustrine and outwash sand
GST06	Stream deposits
GST06i	
GST07	

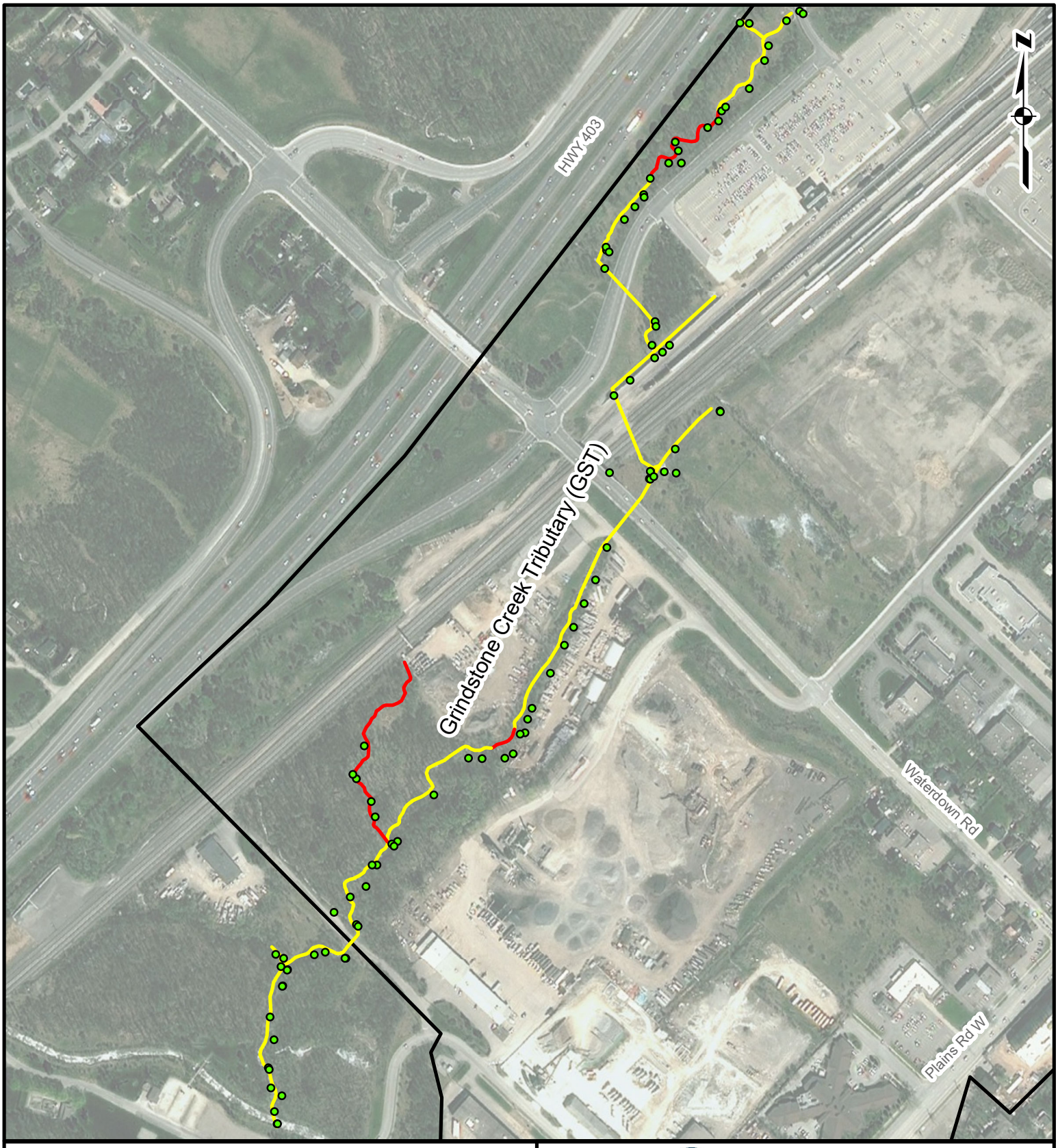
Ontario Geological Survey 2010. Surficial geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release - Data 128 - Revised.

GeoProcess RESEARCH ASSOCIATES

Scale: 0 62.5 125 250 Meters

Title: **P2017-237 Aldershot GO Hub Reach Delineation**

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



Legend

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

GeoProcess RESEARCH ASSOCIATES

Scale: 0 62.5 125 250 Meters

Title: **P2017-237 Aldershot GO Hub Rapid Assessment Summary**

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

Legend

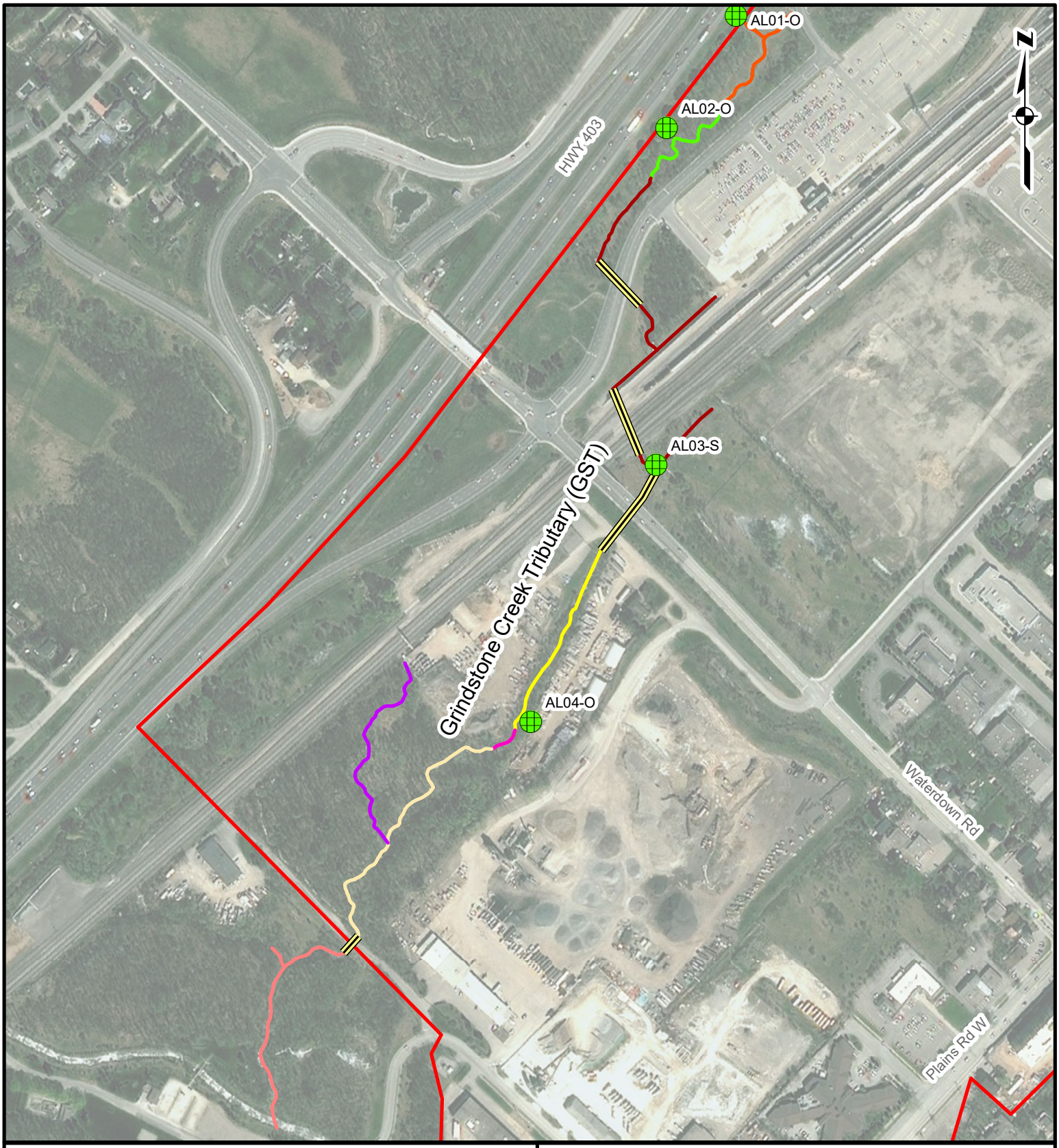
- Confined
- Semi-Confined
- Study Area

GeoProcess RESEARCH ASSOCIATES

Scale: 0 62.5 125 250 Meters

Title: **P2017-237 Aldershot GO Hub Valley Confinement**

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



Legend

- GST01
- GST02
- GST03
- GST04
- GST05
- GST06
- GST06i
- GST07
- Outfall Structure
- Culvert Structure
- Study Area

GeoProcess RESEARCH ASSOCIATES

Scale: 0 62.5 125 250 Meters

Title: **P2017-237 Aldershot GO Hub Outfall Locations**

Created By:	**MI**	Checked By:	**BP**
Date:	**2018-01-24**	Figure:	**5**

Appendix A

Detailed Assessment Summary Table

Table 2 Burlington Mobility Hub - Detailed Assessment Summary Table – Aldershot GO 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
GST01	Riffle-pool	Sandy-clay till	Sand / gravel with fine deposition	Yes	No	Semi-Confined	No	0.37	Transitional or Stressed	Aggradation
GST02	Riffle-Pool	Sandy-clay till	Gravel / cobble	Partial	No	Confined	Yes	0.53	In Adjustment	Widening
GST03	Channelized-Plane-bed	Sandy-clay till	Gravel / cobble	No	Gabion (partial)	Confined	Yes	0.35	Transitional or Stressed	Aggradation, Widening
GST04	Riffle-pool	Sandy-clay till	Sand / gravel	Partial	Riprap (partial)	Confined	Yes	0.36	Transitional or Stressed	Widening
GST05	Irratic debris forming steps	Sandy-clay till	Gravel / cobble	No	Large concrete debris	Confined	Yes	0.44	In Adjustment	Widening, Degradation
GST06	Riffle-pool	Sandy-clay till	Gravel / cobble	Partial	No	Confined	Yes	0.35	Transitional or Stressed	Widening
GST06i	Ravine/Gulley	Sandy-clay till	Sand / gravel	No	No	Confined	Yes	0.53	In Adjustment	Degradation
GST07	Plane bed	Shale with till overburden	Shale / cobble	No	No	Confined	Yes	0.35	Transitional or Stressed	Degradation, Widening

Appendix B

Infrastructure Inventory

Name:	AL01-O
Area:	Aldershot
Watercourse:	Grindstone Creek Tributary
Reach:	GST01
Coordinates:	E592725.672, N4796421.474
Reach Assessment Result:	Transitional or Stressed
Description:	Box culvert outfall

Name:	AL02-O
Area:	Aldershot
Watercourse:	Grindstone Creek Tributary
Reach:	GST02
Coordinates:	E592658.123, N4796312.968
Reach Assessment Result:	In Adjustment
Description:	Outfall pipe

Name:	AL03-S
Area:	Aldershot
Watercourse:	Grindstone Creek Tributary
Reach:	GST03
Coordinates:	E592646.460, N4795975.791
Reach Assessment Result:	Transitional or Stressed
Description:	Sanitary manhole riser

Name:	AL04-O
Area:	Aldershot
Watercourse:	Grindstone Creek Tributary
Reach:	GST04
Coordinates:	E592526.583, N4795739.914
Reach Assessment Result:	Transitional or Stressed
Description:	Outfall pipe

Appendix F

Flood Hazard and Scoped Stormwater Management Assessment

Flood Hazard and Scoped Stormwater Management Assessment

Aldershot GO Mobility Hub
Burlington, Ontario
Project # TPB178008

Prepared for:

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

2/19/2019

Flood Hazard and Scoped Stormwater Management Assessment

Aldershot GO Mobility Hub
Burlington, Ontario
Project # TPB178008

Prepared for:

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

Prepared by:

Wood Environment & Infrastructure Solutions
a Division of Wood Canada Limited
3450 Harvester Road, Suite 100
Burlington, ON L7N 3W5 Canada
T: 905-335-2353

2/19/2019

Table of Contents

List of Drawings

List of Figures

List of Tables

List of Appendices

1.0 Introduction

The City of Burlington is undertaking a land use planning study for four (4) Mobility Hub areas. These are areas as located around major transit hubs within the City (Appleby GO, Burlington GO, Aldershot GO, and the Downtown) where re-development and intensification are expected. In support of this planning effort (lead by Brook McIlroy Inc.), the consulting team's ecologist, Dillon Consulting Limited (Dillon), is preparing a series of Scoped Environmental Impact Studies (EIS) for each of the four (4) hubs. The purpose of the Scoped EIS is to document existing environmental conditions, and assess potential environmental impacts and mitigation strategies related to the expected development and re-development in these areas.

In support of this effort, Wood Environment & Infrastructure Solutions (Wood) is preparing a series of flood hazard and scoped stormwater management assessments for each of the four (4) hubs. These documents are intended to define existing flood hazards for areas of anticipated development, and to also develop preliminary stormwater management strategies, including reviewing drainage infrastructure service capacity, where feasible and required.

The current report is focused upon one (1) of the four (4) Mobility Hub areas, specifically the Aldershot GO Mobility Hub. Drawing 1 presents the boundaries of the Mobility Hub study area along with the area watercourses.

Ultimately, the analyses documented within the current report are intended to provide context with respect to the overall flood risk to the Aldershot GO Mobility Hub, and the potential implications to the proposed intensification development in these areas.

This report is intended to serve as a primary component of the overall Scoped EIS reporting. In addition, the current reporting also includes the Scoped Stormwater Management (SWM) criteria assessment

2.0 Hydrology

2.1 Available Modelling

The Aldershot Mobility Hub Area (Drawing 1) intersects a number of different watersheds (ref. Drawing 3). These watersheds and available sources of hydrologic modelling are summarized in Table 2.1 (as per Table B, Scoped EIS Work Plan (updated April 25, 2017).

Table 2.1 Available Hydrologic Modelling – Aldershot GO Mobility Hub

Watershed	Study Date and Reference	Modelling Platform
Grindstone Creek	Grindstone Creek Subwatershed Study (Cosburn Patterson Wardman Ltd, 1995)	GAWSER
Falcon Creek	Falcon Creek Hydrology and Hydraulics Study (Valdor, 2012)	GAWSER
West Aldershot Creek	Unavailable – new model to be created	PCSWMM
La Salle Creek Forest Glen Creek Teal Creek	Class EA for Aldershot Community Stormwater Master Plan (AMEC Environment & Infrastructure, 2013)	PCSMWM

The available modelling is a mixture of GAWSER and PCSWMM. It is noted that the Aldershot Mobility Hub is primarily intersected by Grindstone Creek and West Aldershot Creek, and to a lesser degree, Teal Creek and Falcon Creek. Although included in the Scoped EIS Work Plan, based on updated drainage area analyses (Drawing 3), the other listed watersheds (La Salle Creek, and Forest Glen Creek) do not contribute flow to the Aldershot Mobility Hub area and have therefore not been included in subsequent analyses.

2.2 Hydrologic Modelling Updates

2.2.1 Existing Land Use Parameterization

In order to develop a consistent approach to the estimation of flows under existing land use conditions, a consistent land use layer has been employed for all hydrologic models.

The City of Burlington has provided two different sources of land use mapping (Official Plan Mapping and Zoning Bylaw mapping). These mapping data have been reviewed, and ultimately the Zoning Bylaw mapping has been considered to be most representative of current conditions, and more readily useable for hydrologic modelling purposes. This mapping has been updated as required, including merging certain land use classifications, and adding separate distinctions as required (in particular, differentiating between more recent and dense detached residential areas, as opposed to older, less dense residential areas). The resulting land use mapping is presented in Drawing 2.

Imperviousness for these land use areas has been estimated using current aerial photography, with spot checks for three (3) different sub-areas for each land use classification, in order to estimate an average value. For detached residential areas, directly and indirectly connected areas have been estimated based on rooftop downspout connectivity (as evident from Google Earth™ and field review). Table 2.2 presents the resulting land use classifications and associated estimated imperviousness values.

Table 2.2 Estimated Land Use Characterization and Parameterization for Aldershot GO Mobility Hub		
Land Use Classification	**Total Imperviousness (%)**	**Directly Connected Imperviousness (%)**
Apartment Buildings	60%	60%
Low Density Detached	40%	20%
High Impervious	90%	90%
Institutional/Industrial	60%	60%
Park/Corridor	10%	10%
Semi Detached and Town Homes	60%	60%
Roadways	90%	90%
Forest	0%	0%
Other	20%	20%
Open Water	100%	100%

It should be noted that Table 2.2 includes two additional land use classifications not employed previously for other Mobility Hubs. The classification of "other" refers to open space/unvegetated areas, primarily the industrial area north of Emery Avenue, and some of the area surrounding the Aldershot GO station. The estimated imperviousness (20%) reflects the value determined from current aerial photography. The classification of "forest" refers to the forested areas of the Aldershot Mobility Hub which do not fit the estimated imperviousness of 10% which has been assigned to "Park/Corridor" in the more urbanized Downtown and Burlington GO Mobility Hubs.

Based on the above parameterization and estimated land use (Drawing 2), an average overall impervious coverage of 60% +/- results for the existing drainage areas within the Aldershot Mobility Hub Limit. The modelling updates have resulted in an increase of the impervious coverage from the original modelling (which had an average impervious coverage of approximately 36%). This likely reflects the more conservative imperviousness assumptions in current engineering practice than in more dated modelling (the previous Cosburn Patterson Wardman Ltd. Study for Grindstone Creek was completed in 1995, some 23 years previous). In addition, there is some development within the study area which has occurred since the previous study, particularly around the Aldershot GO Station itself, including two parking lot areas, as well as the recent Masonry Court Development (which has been assumed to be fully built out (both Phases 1 and 2) under existing conditions, as per "Functional Servicing and Stormwater Management Report, Adi Development (Masonry) Inc., 101 Masonry Court" (Urbantech West, October 2017).

Drawing 3 presents the drainage area boundaries for the Aldershot Mobility Hub area, and also depicts key hydrologic nodes (locations) of interest based on the flows generated from the updated hydrologic modelling.

It is noted that both GAWSER and PCSWMM are capable of undertaking continuous hydrologic simulation, as per item 6.1 c) from the Scoped EIS Work Plan (updated April 25, 2017). However, as outlined in that section, continuous simulation has not been included in the proposed work plan. As such, an event-based (design storm) approach has been employed for the current assessment, consistent with the approach employed for the other Mobility Hub areas.

Previously completed hydrologic assessments used the available IDF data of that time, which has since been superseded by more current/extensive datasets. As part of this assessment, the data from the 2004 IDF update completed by Wood (December 10, 2004) has been applied; refer to Appendix C for details. It should be noted however that the currently approved City IDF are those specified in the 1994 Storm Drainage Design Manual (based on data from 1964 to 1990). The 2004 values represent approximately a 5% increase in rainfall depths as compared to the 1994 values.

A number of different design storm distributions have been assessed to determine the most critical. Based on this analysis (completed for the Burlington GO and Downtown Mobility Hubs), the 24-Hour SCS Type II distribution has been selected based on the highest simulated flows within the receiving watercourse systems, and for consistency with the analyses completed for the other Mobility Hubs. Sensitivity analysis results have been included in Appendix C.

2.2.2 GAWSER Modelling (Grindstone and Falcon Creeks)

The Guelph All-Weather Sequential-Events Runoff (GAWSER) modelling program has been applied historically in the Grindstone Creek and Falcon Creek watersheds. The GAWSER model has multiple methods for calculating subcatchment runoff, which apply variations of main channel and off channel routing of runoff through the subcatchment. The main channel section represents the overall hydraulic routing through the subcatchment, while the off channel represents the smaller drainage paths which lead to the main channel. The Cosburn Patterson Wardman Ltd (1995) model has applied the 'Model 2' approach which requires a reference channel section for both the main channel and the off channel. For the off channel, a generic section has been applied for all subcatchments. The main channel has been modelled with a representative cross section taken from the contours form the topographic mapping. This technique has been retained in the updated modelling. The main channel is defined as a representative cross section obtained from the 2015 DEM, while the off channel remains the same as in the Cosburn Patterson Wardman Ltd (1995) model. The reference flow for the main channel (QRMC) and off channel (QROC) has been set to 0.6 and 0.05, respectively, as applied in the original model.

The baseline GAWSER model used for the Aldershot Mobility Hub is the 1995 future conditions land use model 'FU4100Q'. The model has been refined using the DEM supplied by the City of Burlington (Region of Halton, 2015) to further discretize the subcatchments between Highway #403 and the outlet to the Main Branch of Grindstone Creek. The subcatchments have been refined to allow for hydrologic input to facilitate a more discrete hydraulic modelling of structures around the Waterdown Road interchange upstream and downstream of the CN railway tracks. The schematic for the 1995 Study has been retained to the extent possible to aid in the review of the model, however due to the refinements, several flow nodes now represent different locations in the watershed. Additionally, several new areas have been added to the model including the previously unidentified Tributary 7 (subcatchment 701) and subcatchment 611 (Howard Road) which is located within the Aldershot GO Mobility Hub boundary, and drains to the Main Branch of Grindstone Creek.

The 1995 Study modelled six tributaries to the Grindstone Creek numbered from east to west, with the 100 series subcatchments representing Tributary 1 (most easterly) and the 600 series subcatchments representing Tributary 6 (most westerly - refer to 1995 study for subcatchment boundaries). The 700 series of subcatchments added by Wood was not previously included in the hydrologic models for either the Grindstone Creek watershed or the Falcon Creek watershed, and would lie to the east of Tributary 1. The runoff from subcatchment 701 is directed to a local drainage feature which travels along the east side of the Ippolito Group property and crosses Highway #403 through a culvert of unknown size, ultimately draining to the wetland feature in subcatchment 703. A review of drainage boundaries developed using the current DEM (Region of Halton, 2015) determined that subcatchments 702 and 703 would drain towards the west to the ditch system along the CN railway tracks. Subcatchment 702 was previously included in the Falcon Creek watershed due to the presence of a berm to the northeast of the wetland feature in subcatchment 703. A review of current topographic data determined that the high point to the east of subcatchment 703 is higher than the berm and therefore the runoff from subcatchment 702 contributes to the wetland. It is noted that subcatchment 702 could potentially contribute to Falcon Creek rather than Grindstone Creek; a field verification would be necessary to confirm the drainage divide. However, the assumption that the 5.7 ha drainage area contributes to Grindstone Creek provides a more conservative

estimate for the channelized area through the Aldershot GO Mobility Hub. Reference is also made to Figure 3 in the 'Draft' version of the "Grindstone and Falcon Creek Headwater Wetland Complex OWES Evaluation" (MMM Group, March 2017) which indicates that the area around subcatchment 702 should be within the Grindstone Creek watershed boundary.

The estimated existing conditions land use for hydrologic modelling (ref. Drawing 2) has been updated assuming full build out of Phase 1 and Phase 2 of the 101 Masonry Court development (Urbantech West, October 2017). The Masonry Court development is located within subcatchment 307, which has been modelled as 47 % impervious based on the areal weighting of the land use map. The "Functional Servicing and Stormwater Management Report" (Urbantech West, October 2017) refers to an existing flood storage area located at the southwest corner of the Waterdown Road overpass of the CN railway tracks. The Urbantech Report specifies that this is not considered a stormwater management facility and has undertaken analyses on the existing conditions storage volume as well as the proposed conditions storage volume. The details of the analyses are located in Appendix C of the Urbantech Report, however there is no storage-discharge relationship provided. An inactive 'dummy' reservoir has been added to the model by Wood at the outlet of subcatchment 307 to represent the flood storage area which can be updated as required in both existing and future conditions land use modelling, should a suitable rating curve ultimately become available.

The GAWSER platform simulates subcatchment runoff by calculating the amount of available runoff from a rainfall event after losses due to depression storage and infiltration through the pervious component of the subcatchment. The infiltration routines for GAWSER are explicitly calculated through two soil layers (interflow layer and groundwater storage layer). The GAWSER model allows up to eight different soil types to be specified and each requires infiltration parameters to be explicitly defined (depression storage, hydraulic conductivity, seepage rate factor, percolation rate factor, etc.). The Cosburn Patterson Wardman study (1995) applied three different soil classifications in the 1995 model and the infiltration parameters provided for these soil classifications has been retained in the updated modelling.

The runoff procedures in GAWSER utilize a subcatchment discretization method which considers the impervious area as an alternative soil type. The Cosburn Patterson Wardman model divided the soils into hydrologic soil groups 'C', 'BC' and 'A' which is typical of the SCS methodology. A review of the soils determined that the current soil mapping (MNRF's Ontario Soil Survey Complex, 2012) differs from the soil mapping used for the 1995 Study. Current surficial soil mapping (MNRF, 2012) indicates that the Grindstone Creek portion of the Study Area consists of soils with Hydrologic Soil Groups of 'A', 'B', 'C' and approximately 40 % of the area as undefined. The Hydrologic Soil Group 'B' and the undefined soil areas have been assumed to be most representative of soil type 'BC' from the 1995 Study as it represents approximately the halfway point between soil groups 'A' and 'C' in the 1995 Study. The refined and new subcatchments in the GAWSER model have been updated with the MNRF 2012 soil mapping while the external subcatchments have retained their original soil distributions. The subcatchment parameterization for the 1995 model and the updated model are presented in Table 2.3.

Table 2.3 Subcatchment Parameterization – Grindstone Creek					
Subcatchment	Area (ha)	Imperviousness (%)	Soil Class (% Adjusted for Imperviousness)		
			C	BC	A
Previous Modelling (Cosburn Paterrson Wardman Ltd, 1995)					
105	4.5	7	93	0	0
205	6.4	55	30	15	0
305	36.8	60	5	0	35
410	9.7	22	0	0	78
510	5.0	9	91	0	0
610	6.5	8	0	92	0
Total	**68.9**	**42.1**	**18.1**	**10.1**	**29.7**
Refined Subcatchment Delineation (Wood, 2018)					
GR105	5.6	27	0	73	0
GR205	3.0	40	6	54	0
GR305	2.7	51	23	26	0
GR306	5.3	70	0	17	13
GR307	12.8	47	0	1	52
GR308	9.5	51	0	48	1
GR309	3.7	21	0	79	0
GR410	5.5	39	8	53	0
GR411	4.6	26	0	74	0
GR510	2.3	31	0	59	10
GR511	1.1	10	0	90	0
GR512	0.7	68	0	32	0
GR610	4.9	31	0	69	0
Total	**61.8**	**41.5**	**2.1**	**44.0**	**12.4**
Additional Subcatchments (Wood, 2018)					
GR611[1.]	11.0	77	0	23	0
GR701	15.9	20	78	2	0
GR702	5.7	8	11	81	0
GR703	9.4	28	3	36	33
Total	**50.0**	**34.8**	**26.7**	**21.9**	**16.6**

Note: [1.] Drains directly to the main branch of Grindstone Creek rather than to the tributary

The most recent hydrologic modelling (GAWSWER) for Falcon Creek (Valdor, 2012) divided the soils into hydrologic soil groups 'D' 'C', 'B' and 'A' which is typical of the SCS methodology. The soils have been further divided into low and high vegetative cover. A review of the soils determined that the current soil mapping (MNRF's Ontario Soil Survey Complex, 2012) is sufficiently similar to the soil mapping utilized in the 2012 Valdor Study that the parent catchment soil composition has been maintained, which also ensures consistency with the original modelling.

Given that Falcon Creek lies on the periphery of the Aldershot Mobility Hub, only minor changes to the subcatchments in this area have been required. Minor boundary adjustments have been made to previous subcatchment 109, based on current topographic data. In addition, a new subcatchment (FL01) has been included on the south side of the railway tracks (north of Grove Park Drive); which, based on Wood's review, would drain easterly along the railway tracks towards Falcon Creek (ref. Drawing 3). Parameterization for the new subcatchment has been undertaken using the previously noted land use categorization, and the MNRF soil mapping (2012). The revised subcatchment parameterization for the updated hydrologic model is presented in Table 2.4.

Table 2.4 Subcatchment Parameterization – Falcon Creek						
Subcatchment	Area (ha)	Impervious (%)	Soil Class (% Adjusted for Impervious)[1]			
			D	C	B	A
FL01	8.0	35.0	0 0	0 0	0 0	42.3 22.7
109	29.3	3.7	0 0	4.7 22.2	0 6.9	36.1 26.4

Note: [1.] Soil group is separated into "High Vegetative Cover" (value above) and "Low Vegetative Cover" (value below)

2.2.3 PCSWMM Modelling (West Aldershot and Teal Creeks)

2.2.3.1 West Aldershot Creek

As per Table 2.1 (and as per the Scoped EIS Work Plan), no existing hydrologic model is available for West Aldershot Creek. A new, integrated hydrologic and hydraulic model has been developed in PCSWMM accordingly.

Subcatchment boundaries have been developed on the basis of the trunk storm sewer network (as supplied by the City of Burlington), and topographic data supplied by the City of Burlington (2015 elevation data from the Region of Halton). A total of 61 subcatchments (147 ha) have been included for the PCSWMM model, with an average drainage area of 2.4 ha +/-. Given the limits of the current study area, a greater resolution has generally been achieved for those drainage areas within the study limits, with a relatively coarser level of refinement for those subcatchments further downstream (i.e. generally south of Fairwood Place). Subcatchment boundaries for the West Aldershot Creek area are presented in Drawing 3.

The proposed drainage boundaries for West Aldershot Creek differ slightly from those presented in previous reports (most recently "Class EA for Aldershot Community Stormwater Master Plan" (AMEC Environment & Infrastructure, 2013). To the north, the drainage boundary has been revised based on the updated Grindstone Creek boundary (which reflects the assumed full build-out of the 101 Masonry Court development). No significant boundary changes have resulted along La Salle Creek and Forest Glen Creek. However, the proposed drainage area revisions are such that neither of these creeks are expected to receive flows from the Aldershot GO Mobility Hub study area. As such, no further modelling has been completed for these watersheds.

The developed subcatchment boundaries have been parameterized as per the land use described in Section 2.2.1 (Table 2.2). Based on a review of available soil mapping for the area, the majority of the West Aldershot Creek (particularly the portion within the study area) consists of Guelph Sandy Loam (SCS Soil Classification of "B"). A small portion at the north-eastern limits of the watershed consists of Winona Sandy Loam (SCS Soil Classification of "C"). A more pervious area of Springvale Sandy Loam (SCS Soil Classification of "A") is located to the north of the West Aldershot Creek watershed limits.

Selected geotechnical reports (borehole logs) available from the City of Burlington have also been reviewed to better assess area soils, as follows:

- City Report BH-156 (Fairwood Place West) – generally indicates presence of sandy silt and silty sand
- City Report BH-158 (Howard/Lemonville Road) – generally indicates presence of sand, sandy silt, and clayey silt
- City Report BH-287 (Plains Rd/Waterdown Road) – generally indicates presence of silty sand

Given the preceding overall soil mapping characterization (generally "B" soils with some "C"), and the presence of sandy silt and silty sands, a uniform SCS Soil Classification of "BC" has been more conservatively

been assumed for the watershed, with SCS Curve Numbers developed accordingly for the simulation of infiltration.

As an integrated hydrologic/hydraulic model, PCSWMM also requires that routing and conveyance elements be included explicitly. Given the urbanized nature of the West Aldershot Creek watershed, this generally includes urban drainage components (i.e. storm sewers and roadways), as well as some riverine components (open channels/creeks – however these features are located downstream of the Aldershot Mobility Hub study limit).

With respect to urban hydraulics, as per the approved April 25, 2017 Work Plan (and consistent with the approach employed for the Downtown Mobility Hub), the modelling has focused upon "trunk" storm sewers, which have been considered to be those sewers with a diameter of 600 mm or greater. It should be noted that some smaller storm sewer segments have also been included in the modelling in certain locations as required to ensure a reasonable representation of drainage conditions. The storm sewer database supplied by the City of Burlington does not contain any invert elevation information. As such, a number of plan and profile drawings have been reviewed to extract the invert elevation data (and associated maintenance hole rim elevation), and transfer this information into the PCSWMM model. In some cases, plan and profile drawings (and associated elevation data) were not available; hence alternative techniques have been employed to estimate these data, including interpolation between known elevations, use of DEM data (for rim elevations), and in other cases, assumed depths (i.e. storm sewer 2.5 m +/- below surface). In general, the plan and profile drawings supplied by the City of Burlington have been sufficient to populate the majority of the required storm sewer system elevations. Ultimately, a total of 88 storm sewer segments have been incorporated into the PCSWMM model for the West Aldershot Creek modelling.

The dual drainage creator tool within PCSWMM has been used to develop a major flow conveyance system, parallel to the storm sewer system and based on those elevations (gutter elevation assumed to be equal to the maintenance hole rim elevation). The major system has used typical roadway right-of-way sections for conveyance (both a typical 2-lane and 4-lane roadway section). Additional major system conduits have been added to the modelling to link adjacent areas as required (i.e. parallel streets with unconnected storm sewers).

The minor (storm sewer) and major (roadway overland flow) systems have been linked through bottom draw orifices at junction nodes. The orifices have been sized based on the number of connected catchbasins being represented, with an assumed opening area of 0.125 m^2 per catchbasin (consistent with OPSD details for catchbasin grates). Maintenance hole lids have also been included as required (i.e. junction node linkages where no catchbasins are present).

A limited number of open channel segments have also been included in the modelling to represent flow routing within West Aldershot Creek itself. Transects for the open channel section of the West Aldershot Creek have been generated using HEC-GeoRAS using the Region of Halton's DEM (2015 – as supplied by the City of Burlington) and imported into PCSWMM model to represent the hydraulic routing of the open channel segments. The storm sewer outfalls and major systems have been connected to the open channel segment of the West Aldershot Creek. No hydraulic structures have been included for this reach, and a coarser resolution has been applied in this area given that it is beyond the current study limit.

2.2.3.2 Teal Creek

A PCSWMM model of Teal Creek was previously developed as part of the aforementioned 2013 study. That model included a single large lumped subcatchment for areas upstream of Plains Road (32.61 ha), which is the focus of the current study. This drainage area has been split and refined accordingly into a total of five (5) subcatchments, ranging in area from 0.9 to 13.4 ha. The developed subcatchment boundaries have been parameterized as per the land use described in Section 2.1.2.1 (Table 2.2).

Consistent with the rationale outlined in Section 2.2.3.1 a SCS Soil Classification of "BC" has been assumed for the watershed, with SCS Curve Numbers developed accordingly for the simulation of infiltration. It should be noted that the previous (2013) modelling employed Green-Ampt methodology for the simulation of infiltration; this has been updated to the use of SCS Curve Numbers in the current modelling.

Seven (7) storm sewer segments have been incorporated into the modelling to represent flow conveyance along Plains Road. Similar to the approach described for West Aldershot Creek, a dual drainage modelling approach (linked storm sewers and roadway segments) has been implemented accordingly.

2.3 Hydrologic Model Results

2.3.1 GAWSER Modelling (Grindstone and Falcon Creeks)

Updated simulated flows for key watercourse nodes along Grindstone Creek are presented in Tables 2.5 and 2.6 for the 100-year storm event and the Regional Storm respectively; refer to Drawing 3 for node locations. For comparison purposes, the results from the previous study (Cosburn Patterson Wardman Ltd, 1995) have been included at key nodes, for the (then) future land use condition as detailed in the preceding section.

The 1995 Grindstone Creek Study (Cosburn Patterson Wardman) used continuous simulation as well as the storm event recorded at Hamilton's Royal Botanical Garden rain gauge in August 1981 to determine the 100-year peak flows for the Grindstone Creek Tributaries. The 2012 Falcon Creek Study (Valdor) used continuous simulation as well as the 6 Hour SCS Type-II distribution for simulating the 2 to 100-year return periods. In order to maintain consistency with the previous work completed by Wood for the other Mobility Hubs (and to be consistent with the Scoped EIS Work Plan) the updated Grindstone Creek and Falcon Creek models have been executed using the 24 Hour SCS Type II distribution for the 100-year return period.

The Regional Storm Event models from the 1995 Grindstone Creek Study (FU4CREG and 4QUANREG) have been reviewed to determine how the Regional Storm was modelled previously. It has been determined that the external storage facilities were active during the Regional Storm event and therefore have been allowed to remain active during a Regional Storm event for the current refined model. The SCS Curve number methodology does not apply for Grindstone Creek or Falcon Creek and therefore the soil conditions were maintained for the Regional Storm Event. A sensitivity test was performed to determine whether the 12-hour event using zero depression storage or the 48-hour event allowing depression storage produced the greater flow at the outlet. The results of the sensitivity test indicated that the 48 hours storm event produced the higher outflow and therefore the results from this scenario have been presented for both Grindstone Creek and Falcon Creek.

Simulated results for Grindstone Creek (Table 2.5) indicate that the difference in peak flows for the 100-year storm event vary from -1.47 m^3/s to +3.62 m^3/s. Minor flow decreases are indicated primarily for smaller tributaries, whereas the flow increases are generally indicated at the most downstream limits of Grindstone Creek. This likely reflects the relative contribution of updated drainage areas from the Aldershot Mobility Hub, which would be highest at the downstream limits. In addition, it is noted that any additional drainage area (GR701 – 15.9 ha) is included in the updated modelling, which was not included in the previous (1995) modelling. Simulated results for Falcon Creek are +0.3 m^3/s +/- at the CN Railway tracks for the 100-year storm event, indicating only a nominal change in the modelling results (given the relative minor updates to the hydrology in this area).

Table 2.5 100-Year Storm Event Flows – Grindstone Creek and Falcon Creek (GAWSER)					
Node	Current Drainage Area[1] (ha)	Location	100-Year Storm[3] Peak Flow (m^3/s)		
			Original[4]	Updated[2] (Wood, 2019)	Difference
Grindstone Creek					
701	15.90	Tributary 7 at Highway #403	-	1.06	-
702	5.70	Eastern inflow to Wetland	-	0.54	-
819	21.60	Wetland	-	1.59	-
820	31.00	Tributary 7 at CNR	-	2.04	-
101	69.60	Tributary 1 at Highway #403	1.89	1.89	0
801	75.20	Tributary 1 Outlet	2.32	2.34	+0.02
201	145.20	Tributary 2 at Highway #403	2.20	2.20	0
804	220.40	Confluence of Tributary 1 and Tributary 2	-	4.47	-
810	223.40	Tributary 2 Outlet	5.09	4.75	-0.34
815	96.10	Tributary 3 at CNR	3.36	1.89	-1.47
818	319.50	Confluence of Tributary 2 and Tributary 3	-	6.64	-
822	355.80	Tributary 3 Upstream of Waterdown Road	-	9.13	-
823	368.60	Tributary 3 at Waterdown Road	-	10.20	-
826	381.80	Tributary 3 Downstream of Waterdown Road	-	11.40	-
830	38.00	Tributary 4 at CNR	1.56	1.57	+0.01
831	42.60	Tributary 4 at Outlet	-	1.80	-
832	424.40	Confluence of Tributary 3 and Tributary 4	9.48	13.0	+3.62
845	86.00	Tributary 5 at CNR	3.25	3.01	-0.24
846	87.10	Tributary 5 at Outlet	-	3.06	-
860	76.10	Tributary 6 Outlet	1.74	1.71	-0.03
850	512.20	Howard Road	12.6	14.7	+2.2
865	588.30	Outlet to Grindstone Main Creek	13.9	15.9	+2.1
611	11.00	Subcatchment to Grindstone Main Creek	-	2.17	-
Falcon Creek					
809	227	Hwy 403	12.8	12.8	0.0
811	299	CNR	15.5	15.8	+0.3

Notes:
1. Based on updated (2018) subcatchment boundaries; may differ from previous modelling
2. Includes all current modelling updates noted
3. Based on the SCS Type-II 24-hour Design Storm
4. For Grindstone Creek (CPW, 1995) and for Falcon Creek (Valdor, 2012)

Table 2.6 Regional Storm Event Flows – Grindstone Creek and Falcon Creek (GAWSER)					
Node	Current Drainage Area[1] (ha)	Location	Regional Storm Peak Flow (m^3/s)		
			Original[3]	Updated[2] (Wood, 2019)	Difference
Grindstone Creek					
701	15.90	Tributary 7 at Highway #403	-	1.88	-
702	5.70	Eastern inflow to Wetland	-	0.79	-
819	21.60	Wetland	-	2.64	-
820	31.00	Tributary 7 at CNR	-	3.77	-
101	69.60	Tributary 1 at Highway #403	6.69	6.69	0
801	75.20	Tributary 1 Outlet	7.17	7.28	+0.11
201	145.20	Tributary 2 at Highway #403	11.5	11.5	0
804	220.40	Confluence of Tributary 1 and Tributary 2	-	18.7	-
810	223.40	Tributary 2 Outlet	19.2	19	-0.2
815	96.10	Tributary 3 at CNR	11.4	7.96	-3.44
818	319.50	Confluence of Tributary 2 and Tributary 3	-	26.9	-
822	355.80	Tributary 3 Upstream of Waterdown Road	-	30.9	-
823	368.60	Tributary 3 at Waterdown Road	-	32.2	-
826	381.80	Tributary 3 Downstream of Waterdown Road	-	33.5	-
830	38.00	Tributary 4 at CNR	4.5	4.08	-0.42
831	42.60	Tributary 4 at Outlet	-	4.57	-
832	424.40	Confluence of Tributary 3 and Tributary 4	35.1	38.1	3
845	86.00	Tributary 5 at CNR	10.3	9.99	-0.31
846	87.10	Tributary 5 at Outlet	-	10.1	-
860	76.10	Tributary 6 Outlet	9.52	9.33	-0.19
850	512.20	Howard Road	44.4	47.3	+2.9
865	588.30	Outlet to Grindstone Main Creek	53	56.2	+3.2
611	11.00	Subcatchment to Grindstone Main Creek	-	1.61	-
Falcon Creek					
809	227	Hwy 403	18.6	18.6	0.0
811	299	CNR	23.9	24.2	+0.3

Notes: [1] Based on updated (2018) subcatchment boundaries; may differ from previous modelling
[2] Includes all current modelling updates noted
[3] For Grindstone Creek (CPW, 1995) and for Falcon Creek (Valdor, 2012)

Simulated results for the Regional Storm Event (Table 2.6) indicate differences in peak flows from -3.44 m^3/s to +3.20 m^3/s, with similar trends to the 100-year storm event (i.e. largest flow increases are indicated towards the downstream limits, where the highest relative contribution of drainage from updated Mobility Hub lands would result).

The largest simulated reduction in flow occurs at flow node 815. Under the revised modelling, this location has a notably reduced drainage area and revised location in the Tributary 4 watercourse. The flow node 815 was used in the 1995 Study to represent the outlet of Tributary 4 (approximately 100 m east of Howard Road). Under the updated hydrologic modelling, subcatchment 305 in the original (1995) model is now represented by subcatchments 305, 306, 307, 308 and 309. The flow node has been moved to represent the Tributary 4 flow upstream of the confluence with Tributary 5. Thus the simulated difference is considered attributable to a refinement of drainage areas and revision to the reporting node location (i.e. further upstream).

As noted previously, only a small portion of the Falcon Creek watershed is located within the Aldershot GO Mobility Hub boundary. One newly added area (FL01 – refer to Drawing 3) has been discretized and incorporated into the Falcon Creek modelling. The remaining potentially impacted area (sub-catchment 109 – refer to Drawing 3) would be minimally affected, with only 3.2 ha+/- of drainage area within the Aldershot Mobility Hub boundary. The additional drainage area to Falcon Creek and updated hydrologic modelling results in an increase in flow at the CN Railway tracks of 0.3 m3/s +/- for both the 100 year storm event and Regional Storm Event.

Consideration is also required for the potential flow inputs to the Grindstone Creek System from an identified bi-lateral spill at Falcon Creek (spill towards both Indian Creek to the east, and Grindstone Creek to the west). This is discussed further as part of the review of hydraulic modelling for the study area (Section 3.2).

2.3.2 PCSWMM Modelling (West Aldershot and Teal Creeks)

Updated simulated flows for key nodes within the West Aldershot and Teal Creek watersheds are presented in Tables 2.7 and 2.8 for the 100-year storm event and the Regional Storm respectively. Note that for simulation of the Regional Storm, Curve Numbers (CNs) have been updated to saturated (AMC-III) conditions to use the 12-hour version of Hurricane Hazel; depression storage values have also been set to zero.

The results presented in Table 2.7 indicate that the updated PCSWMM generates consistently lower peak flows for all locations for the 100-year storm event, despite a notable increase in overall imperviousness (approximately 64% for the areas within the study limit for the 2019 update, and 25% for the same area in the previous 2013 model). For the West Aldershot Creek watershed, this simulated reduction is generally considered attributable to the increased model refinement. The previous (2013) study utilized only three (3) subcatchments to the beginning of the open watercourse, whereas the updated model uses a total of 29 for the same area. The increased model refinement has also included additional conveyance elements (storm sewer and overland flow) which would tend to further attenuate flows, particularly peaky flows as would result from a design storm distribution of this magnitude. Further, it is noted that the locations presented in Table 2.7 do not precisely match due to the coarse level of discretization in the 2013 study, and that different infiltration routines were used for the two models (Green-Ampt in the original 2013 study, SCS Curve Number in the current update). This last point in particular is significant as there is a notable difference in the peak infiltration rate for the 100-year storm event. For Teal Creek as an example, the peak infiltration rate from the previous (2013) modelling using Green-Ampt is approximately 7 mm/hr, while for the current modelling (SCS Curve Number) it is approximately 26 mm/hr, which occurs coincidentally with peak rainfall, which would be expected to reduce peak flows.

Table 2.7 100-Year Storm Event Flows – West Aldershot and Teak Creeks (PCSWMM)						
Watershed	Current Drainage Area[1] (ha)	Location and Node	100-Year Storm Event Peak Flow (m^3/s)			
			Original[3] 6H SCS (AMEC, 2013)	Updated[2] 6H SCS (Wood, 2019)	Updated[2] 24H SCS (Wood, 2019)	Difference (6H SCS)
West Aldershot Creek	16.9	Plains Rd west of Emery Ave (4048)	4.54	3.35	3.32	-1.19
	25.1	Plains Rd at Waterdown Rd (4003)	10.86	4.57	4.45	-6.29
	50.2	South of Fairwood Pl and West of Aldershot School (J665.0624)	12.68	7.06	7.04	-5.62
Teal Creek	33.6	Plains Rd and Filmandale Rd (OF1 and OF3)	11.02	6.30	6.40	-4.62

Notes:
1. Based on updated (2018) subcatchment boundaries; this may differ slightly from previous modelling
2. Includes all current modelling updates noted
3. As per "Class EA for Aldershot Community Stormwater Master Plan" (AMEC Environment & Infrastructure, 2013)

Table 2.8 Regional Storm Event Flows – West Aldershot and Teak Creeks (PCSWMM)					
Watershed	Current Drainage Area[1] (ha)	Location and Node	Regional Storm Event Peak Flow (m^3/s)		
			Original[3]	Updated[2]	Difference
West Aldershot Creek	16.9	Plains Rd west of Emery Ave (4048)	2.44	1.83	-0.61
	25.1	Plains Rd at Waterdown Rd (4003)	4.95	2.28	-2.67
	50.2	South of Fairwood Pl and West of Aldershot School (J665.0624)	7.33	5.16	-2.17
Teal Creek	33.6	Plains Rd and Filmandale Rd (OF1 and OF3)	4.49	4.71	+0.22

Notes:
1. Based on updated (2018) subcatchment boundaries; this may differ slightly from previous modelling
2. Includes all current modelling updates noted. Uses 12-hour version of Hurricane Hazel and AMC-III (saturated) conditions with SCS Curve Number method for infiltration
3. Uses 48-hour version of Hurricane Hazel and AMC-II (normal) conditions due to Green-Ampt infiltration methodology.

The simulated difference in peak flows for Teal Creek is considered to be attributable to similar reasons; increased subcatchment resolution (five (5) subcatchments in the current modelling as compared to one (1) subcatchment in the 2013 modelling) and increased conveyance/routing elements, as well as the difference in infiltration methodology. For Teal Creek as an example, the peak infiltration rate from the previous (2013) modelling is approximately 7 mm/hr, while for the current modelling (SCS Curve Number) it is approximately 26 mm/hr, which occurs coincidentally with peak rainfall, which would be expected to reduce peak flows. As noted, additional hydraulic flow routing elements may also attenuate and reduce peaks.

For the Regional Storm Event (Table 2.8), simulated decreases in peak flows are again indicated throughout for West Aldershot Creek. It is considered that the reasons discussed previously with respect to the 100-year storm event would again apply. However, it is notable that a slight increase in the Regional Storm peak flow is indicated for the Teal Creek outlet. This may reflect the lower intensity (less peaked) rainfall and flow response for this storm event.

3.0 Hydraulics

3.1 Available Hydraulic Modelling

As noted previously, the Aldershot Mobility Hub Area (Drawing 1) intersects a number of different watersheds (Drawing 3). Notwithstanding, only one (1) open creek system is directly within the Aldershot Mobility Hub area: Grindstone Creek. The other watersheds within the study area (West Aldershot Creek and Teal Creek) consist of urban conveyance systems (i.e. storm sewers and roadways). Sources of hydraulic modelling are summarized in Table 3.1 (as per the Scoped EIS Work Plan (updated April 25, 2017 – ref. Table C).

Table 3.1 Available Hydraulic Modelling – Aldershot GO Mobility Hub

Watershed	Study Date and Reference	Modelling Platform
Grindstone Creek	Grindstone Creek Subwatershed Study (Cosburn Patterson Wardman Ltd, 1995)	HEC-2
	Detailed Design of Waterdown Road/Highway 403 Interchange – Stormwater Management Design Brief (Philips Engineering Limited, October 2008)	HEC-RAS
	Functional Servicing and Stormwater Management Report – 101 Masonry Court (Urbantech West, October 2017)	HEC-RAS

3.2 Hydraulic Modelling Updates

3.2.1 HEC-RAS Modelling (Grindstone and Falcon Creek)

3.2.1.1 Grindstone Creek

As per the Scoped EIS Work Plan (updated April 25, 2017 – ref. Table C), a HEC-2 hydraulic model for the tributary branch which runs through the Aldershot Mobility Hub was previously completed as part of the Grindstone Creek Subwatershed Study (Cosburn Patterson Wardman Ltd., 1995). An updated HEC-RAS model of the lower portion of Grindstone Creek (i.e. below Highway 403), was developed as part of previous studies; in particular, the Waterdown Road Interchange design work (Detailed design of Waterdown Road/Highway 403 Interchange Stormwater Management Design Brief, Philips Engineering Limited, October, 2008), and the recent residential development on Masonry Court (ref. Functional Servicing and Stormwater Management Report, ADI Development (Masonry) Inc., 101 Masonry Court – Urbantech West, October 2017). Based on Wood's review of the two (2) models, it was considered that the HEC-RAS modelling developed for the Waterdown Road interchange (and subsequently verified in May 2015 as part of the City-Wide Flooding study) was more current for the area upstream of the railway tracks than the HEC-RAS modelling for the 101 Masonry Court Development. Therefore, as part of the current work, Wood has combined relevant updates from both models which reflects the most current portions of each (i.e. revised watercourse alignment from the Waterdown Road interchange work upstream, and revised watercourse alignment from the 101 Masonry Court development downstream). Through a review of the City's 2015 DEM it was determined that the cross sections between ID 0.50 and 0.32 in the received modeling for 101 Masonry Court (immediately upstream of the railway tracks) do not match the existing topography. The relevant sections have been extended and updated from the City's 2015 DEM. These updated hydraulic modelling cross-sections are presented on Drawings 4b and 4d.

The currently available HEC-RAS modelling cross-sections extend only slightly downstream of Waterdown Road; no cross-sections are available for the section between Waterdown Road and the confluence with the main branch of Grindstone Creek. Older hydraulic modelling and cross-sections are available from the original HEC-2 model (Cosburn Patterson Wardman Ltd, 1995). However, this modelling is not considered appropriate for the current study given the vintage of the topography data, and the spacing and locations of the hydraulic cross-sections, which are sparse in many locations, particularly between culvert crossings. As such, the Grindstone Creek tributaries west of Waterdown Road have been modeled as part of a new HEC-GeoRAS model, with new cross-sections which have been cut using the current DEM (Region of Halton, 2015). Hydraulic structure (culvert) details from the original HEC-2 modelling been incorporated accordingly into the new modelling. A suitable boundary condition for the main branch of Grindstone Creek has been determined by referring to the Flood Damage Reduction Program (FDRP) of the Main Branch of the Grindstone Creek prepared by Philips Planning + Engineering Limited (1982). The water surface elevation for the cross sections (1018 and 1019 in the FDRP) bounding the outlet of the Tributaries of Grindstone Creek to the Main Branch (near Lemonville Road) were applied in the hydraulic modelling. Cross Section 1019 has been utilized as the boundary condition since it produced the higher water surface elevation, and therefore the more conservative constraints, for both the 100-year storm event (91.22 m) and the Regional Storm Event (92.07 m).

In order to ensure continuity between the newly developed HEC-GeoRAS modelling to the west of Waterdown Road, and the updated HEC-RAS modelling to the east of Waterdown Road, the most downstream modelling (HEC-GeoRAS) has been run first. The resulting simulated water surface elevations at the downstream face of Waterdown Road have then been used as fixed water surface elevation boundary conditions within the second HEC-RAS model.

3.2.1.2 Bi-Lateral Spills (Falcon Creek)

Previous studies have identified the existence of a bi-lateral spill from Falcon Creek towards both Indian Creek to the east and Grindstone Creek to the west. The Falcon Creek Hydrology and Hydraulic Study by Valdor Engineering (2012) identifies a bi-lateral spill at the CNR tracks, however the spill is not quantified. The King Road/CNR Grade Separation Drainage Works Design Brief prepared for the City of Burlington (Philips Engineering Limited, 2006) also identified a bi-lateral spill at the CNR tracks. The Philips Study quantified the spill to Indian Creek, however the spill to Grindstone Creek was not quantified as the focus of the study was on Indian Creek.

For the current assessment, the Valdor (2012) hydraulic model (HEC-RAS) has been modified to include a lateral structure to the west of the upstream face of the CNR Tracks at the estimated high point spill elevation of 103.08 m (based on current topography data – 2015 Region of Halton DEM) to simulate the spill from Falcon Creek into the CNR ditch system westerly towards Grindstone Creek. The spill occurs approximately 800 m to the west along the northside of the CNR tracks at the boundary between subcatchment 109 (Falcon Creek) and subcatchment GR702 (Grindstone Creek) as shown on Drawing 3.

The current hydraulic model (HEC-RAS) has also been modified to include a lateral structure to the east of the upstream face of the CNR Tracks at the estimated high point spill elevation of 104.11 m (to Indian Creek). The spill occurs within 50 m of the CNR crossing of Falcon Creek. The spill is conveyed easterly along the CNR tracks to the Indian Creek crossing of King Road.

Additional cross sections (based on current topography data – 2015 Region of Halton DEM) have been added to the Valdor hydraulic model upstream of the CNR Tracks to represent the sections which spill to Grindstone Creek and to Indian Creek.

For comparison purposes, both the with and without flow optimization routines have been employed. Notwithstanding, the with flow optimization routine is considered the more realistic approach, as has been

discussed and presented previously for the Burlington and Downtown Mobility Hubs (with respect to spills from the Hager-Rambo Diversion Channel), namely that spills necessarily result in loss of flow and a corresponding reduction in water surface elevation within the main channel, and the use of a full flow main channel water surface elevation yields unrealistically high spill flows. As per comments from Conservation Halton (CH – Comment 4 c, April 20, 2018), it is understood that CH's primary concern with flow optimization is any removal of flows from the source watercourse, such that downstream capacity is preserved in the event the spills can be mitigated in the future. CH further indicated (comment 4 b, April 20, 2018) that they would potentially be supportive of spill flow optimization subject to the collection of more detailed topographic information, and CH review of the associated hydraulic modelling. Further topographic data collection is considered beyond the scope of the current study, thus the previously noted spill sections have been developed based on the best currently available date, namely the Region of Halton's 2015 DEM.

Table 3.2 Comparison of Estimated Falcon Creek Spill (HEC-RAS) – 100 Year Storm Event

Scenario	Study	Drainage Area (ha)	WSE[1] (m)	Peak Flow (m^3/s)					
				Total Flow U/S of CNR	U/S of CNR	D/S of CNR	CNR Weir Flow	Spill to Indian Creek	Spill to Grindstone Creek
No Flow Optimization	Philips (2006)[2]	271.4	103.71	17.30	17.30	17.70	7.29	59.92	-
	Valdor (2012)[3]	291.3	104.44	19.51	19.51	20.57	11.36	-	-
	Wood (2019)	292.9	105.24	15.80	15.80	15.80	5.78	8.33	7.97
Single Flow Optimization (Indian Creek)	Philips (2006)[2]	271.4	102.61	17.30	6.59	6.99	0	10.73	-
	Wood (2019)	292.9	105.05	15.80	10.39	10.26	0.31	5.50	6.36
Single Flow Optimization (Grindstone Creek)	Wood (2019)	292.9	104.98	15.80	9.98	9.98	0	4.63	5.80
Dual Flow Optimization	Wood (2019)	292.9	104.78	15.80	9.67	9.60	0	2.69	4.41

Notes:
1. Water Surface Elevation (WSE) is defined as the elevation at the CNR crossing.
2. Philips 2006 hydraulic model has been simulated using HEC-RAS model version 3.1.3 to maintain consistency with previous reporting
3. Valdor 2012 hydraulic model does not simulate spill flows although the reporting recognizes the existence of the spill condition

Table 3.3 Comparison of Estimated Falcon Creek Spill (HEC-RAS) – Regional Storm Event									
Scenario	Study	Drainage Area (ha)	WSE[1] (m)	Peak Flow (m^3/s)					
				Total Flow U/S of CNR	U/S of CNR	D/S of CNR	CNR Weir Flow	Spill to Indian Creek	Spill to Grindstone Creek
No Flow Optimization	Philips (2006) [2.]	271.4	-	-	-	-	-	-	-
	Valdor (2012)[3.]	291.3	104.49	23.88	23.88	25.35	15.81	-	-
	Wood (2019)	292.9	105.35	24.20	24.20	24.20	14.04	10.31	8.99
Single Flow Optimization (Indian Creek)	Philips (2006) [2.]	271.4	-	-	-	-	-	-	-
	Wood (2019)	292.9	105.24	24.20	15.99	15.82	5.90	8.36	7.99
Single Flow Optimization (Grindstone Creek)	Wood (2019)	292.9	105.24	24.20	16.21	16.17	6.00	8.39	8.00
Dual Flow Optimization	Wood (2019)	292.9	105.11	24.20	11.15	11.00	1.03	6.28	6.83

Notes:
1. Water Surface Elevation (WSE) is defined as the elevation at the CNR crossing.
2. Philips 2006 hydraulic model has been simulated using HEC-RAS model version 3.1.3 to maintain consistency with previous reporting
3. Valdor 2012 hydraulic model does not simulate spill flows although the reporting recognizes the existence of the spill condition

The 2006 Philips Study determined that approximately 10.7 m^3/s of flow would spill towards Indian Creek at a water surface elevation of 102.61 m for the 100-year design event (using flow optimization). However, it should be noted that the 2006 Philips Study applied a 3-hour Chicago distribution. Furthermore, the 2006 Philips Study did not consider the Regional Storm Event. The unrealistic nature of the no flow optimization scenario is evident from the results presented in Table 3.2 for the Philips (2006) model for spills to Indian Creek.

The results of Wood's (2019) updated modelling are consistent with the Philips (2006) report text which indicates that the spill flow to Grindstone Creek is larger than the spill flow to Indian Creek. The lateral structures for the updated spill flow assessment have been modeled such that they terminate prior to the CNR culvert crossing and therefore reduce the flow which the culvert receives. The resulting spill flows with dual optimization (spills occurring both to Indian Creek and Grindstone Creek, as would realistically be expected to occur) reduce the water level such that the CNR crossing is not overtopped during a 100 year storm event.

The results presented in Table 3.3 and Tables 3.4 provide the peak flows from the dual optimization scenario (4.41 m^3/s for 100 year storm event and 6.83 m^3/s for the Regional Storm Event) which are considered the most realistic/representative spill flows given available information. These steady state flows have been incorporated into the HEC-RAS modelling for Grindstone Creek (refer to Section 3.3.1) through a direct peak flow addition upstream of Waterdown Road. It has been conservatively assumed that the spill from Falcon Creek would be conveyed westerly along or adjacent to the railside ditch north of the CNR Tracks. The spill flow would then enter a piped system between the existing Aldershot GO north parking lot and the CNR Tracks. The hydraulics of conveying the Falcon Creek spill flow to the Grindstone Creek tributaries has not been assessed in further detail. It is considered unlikely that the spill from Falcon Creek would have a coincident peak with the Grindstone Creek tributaries, therefore the addition of the peak flows to the Grindstone Creek flow nodes provides a level of conservatism to the resulting floodplains depicted on Drawings 4c and 4d.

3.2.2 PCSWMM Modelling (West Aldershot and Teal Creeks)

Only minor updates to the hydraulics within the existing Teal Creek modelling have been undertaken as part of the current assessment. Specifically, sections of trunk storm sewer along Plains Road have been incorporated into the modelling, along with a corresponding length of linked major system conduits. In addition, the major system linkages within the Teal Creek watershed modelling have been connected to those of the newly created West Aldershot Creek modelling, in the event of overflows or inter-watershed spills.

3.3 Hydraulic Modelling Results

3.3.1 Grindstone Creek (HEC-RAS)

As noted in 2.3.1 (Tables 2.5 and 2.6), in general the 100-Year Storm and Regional Storm Event flows (without Falcon Creek spill flows) have increased slightly compared to the original modelling for the Grindstone Creek watershed through the study area. The simulated flooding extents for the 100-year storm event and the Regional Storm Event based on the updated hydrologic and hydraulic modelling (without spills) are depicted in Drawings 4a (west of Waterdown Road – Tributaries 6 to 4) and 4b (east of Waterdown Road – Tributaries 3 to 1 and Tributary 7).

In addition to the preceding, the simulated floodplain extents with the addition of spill flows from Falcon Creek are presented in Drawings 4c (west of Waterdown Road – Tributaries 6 to 4) and 4d (east of Waterdown Road – Tributaries 3 to 1 and Tributary 7). Although discussed in further detail within this section, the floodplain mapping with the Falcon Creek spill condition depicted on Drawings 4c and 4d are generally consistent with the floodplains without the Falcon Creek spill. This is attributed to the high slopes within the valley system.

The floodplain mapping of Grindstone Creek west of Waterdown Road has identified several reaches with wide riverine floodplains during the Regional Storm Event. These areas are visible on Drawings 4a (without spills) and 4c (with spills), and are limited to:

- Between the Highway #403 and CNR tracks for Tributaries 4, 5 and 6
- Immediately upstream of Howard Road.
- 1160 Waterdown Road (Pro Concrete & Paving)

The culverts underneath the railway tracks for Tributaries 4, 5 and 6 are considered to be undersized for the Regional Storm Event, which causes a backwater area between Highway #403 and the railway tracks. The backwater from the railway culverts causes Tributaries 5 and 6 to spill into each other for a Regional Storm

Event, i.e. each tributary spills towards the others and effectively creates one combined floodplain. During the 100-year design event only Tributaries 4 and 6 would spill towards Tributary 5, while Tributary 5 would be contained to the channel. It is anticipated that the 100-year floodplain for Tributary 5 would be wider if the resulting spill flows were considered. Ultimately, based on the preliminary concept plans for the Aldershot Mobility Hub, there is no re-development proposed between Highway 403 and the railway tracks west of Waterdown Road. As such, flooding extents in this area would not be expected to impact development potential. The estimated floodplain for Tributary 5 downstream of the railway tracks (i.e. upstream of Howard Road) could potentially be underestimated due to the exclusion of the aforementioned spill flows, however based upon the steep slopes in the Tributary 5 valley it is considered unlikely that an increase in flow would significantly impact the extents of the floodplain. Further, the preliminary concept plans for this area do not indicate any re-development (proposed Hidden Valley Park land).

Based on the simulated results, the hydraulic structure (culvert) at Howard Road is overtopped during the 100-year design event and Regional Storm Event. Howard Road also would be overtopped by Tributary 5, which runs parallel to the road and would spill over the road during the Regional Storm Event.

The HEC-GeoRAS modelling simulates a slight encroachment onto the property of 1160 Waterdown Road during a Regional Storm Event (Drawing 4a), in particular the section furthest upstream, immediately downstream of Railway Road. This floodplain impact is worsened when spill flows from Falcon Creek are included (Drawing 4c) as would be expected. The identified floodplain limits would also occur at the driveway entrance to the property, which would limit safe ingress/egress from the site.

The property in question is slated for potential re-development ("Aldershot GO Central") on the Draft Precinct Plan for this area (May 2018 – refer to Appendix A). Based on CH policies, any development within the regulated area (plus a 15 m setback limit, given that Grindstone Creek and its tributaries are classified as a major valley system) would be precluded. Although the delineated floodplain is confined to the channel along the south limit (1140 Waterdown Road), this property would also be affected by the required 15 m setback limit.

Notwithstanding the preceding, the identified floodplain encroachment at 1160 Waterdown Road could be managed through channel widening and re-grading, including a cut/fill balance to ensure that there is no loss of floodplain storage and no impact to downstream areas. This would potentially permit safe ingress/egress to the site and increase the development potential of the site, while still ensuring CH requirements are met. It is recommended that further discussions with CH staff be arranged accordingly, to discuss the acceptability of this approach.

For the area east of Waterdown Road (Tributaries 3 to 1 and Tributary 7 - refer to Drawing 4b), the presented hydraulic modelling indicates an overtopping of the railway tracks immediately east of Waterdown Road during the Regional Storm Event. A review of current topographic data (2015 DEM) and simulated water surface elevations confirms that spill would likely occur across the tracks at this location. The full extents of the spill have not been delineated beyond this point; this spill would potentially impact the 101 Masonry Court development to the south, which is currently under construction. The spill, and the estimated floodplain through this area have not been delineated, as indicated on Drawing 4b. As this area is currently under construction, the current topography data (2015 DEM) would not be able to accurately present floodplain extents. Reference is rather made to the supporting analyses completed for that development (Urbantech, 2017). As part of the development, a flood storage facility is to be constructed between the railway tracks and Waterdown Road. Any potential spill across the railway tracks would therefore potentially be captured by the flood storage facility, and ultimately back to Grindstone Creek. A note has been added to Drawing 4b deferring floodplain mapping for the Masonry Court development to the supporting study for that development (Urbantech, 2017).

The 100-year design event and Regional Storm Event floodplain mapping for Tributaries 3 to 1 depicted on Drawing 4b (without spills) and 4d (with spills) demonstrate that the Grindstone Creek tributaries east of Waterdown Road are primarily contained to the channel block. The exceptions would be the area immediately upstream of the CNR, and the most easterly portion of the Grindstone Creek channel (Tributary 1).

Upstream of the CNR, the Regional Floodplain is generally consistent for the with and without Falcon Creek Spill flow scenarios, and is bound by the Aldershot GO Parking area and roadway (with overtopping of the CNR tracks as noted previously). For the 100-year storm event floodplain, greater differences are noted, given that this location is where spill flows from Falcon Creek first enter the Grindstone Creek system.

The most easterly portion of the channel has a large floodplain, however based on discussions from the January 25, 2018 TAC meeting it is understood that no re-development of this area is being contemplated as part of the current study and that this area is subject to the outcomes of a separate study for that parcel of land (1200 King Road).

It should be again noted that the flow path of spill flows from Falcon Creek have not been assessed or delineated; this should be considered further in future studies or detailed assessment of upstream lands (potentially including 1200 King Road). Similarly, spill flows over the CNR (which would impact 101 Masonry Court and adjacent lands) have also not been assessed as part of the current study; further hydraulic modelling and review may be warranted as part of future land use planning for these lands.

3.3.2 West Aldershot and Teal Creeks (PCSWMM)

3.3.2.1 Storm Sewers

The developed PCSWMM hydraulic modelling has been used to characterize the conveyance capacity of the existing trunk storm sewer system (i.e. those elements included in the modelling). The following characterization has been employed based on the simulated hydraulic gradeline (HGL – maximum expected water surface elevation) characterization for individual storm sewer segments:

- Unsurcharged - HGL is below pipe obverts at both upstream and downstream ends
- Surcharged – HGL is above pipe obvert at either or both of the upstream and downstream ends, but below the ground surface
- Flooded – HGL is above the ground surface at either or both of the upstream and downstream ends

Results have been generated for the 5-year storm event, as this is the City of Burlington's design standard for storm sewers. The 24-hour SCS Type-II Design Storm Distribution has been employed, consistent with the distribution employed for the assessment of the 100-year storm event. Results are presented graphically in Drawing 7.

The simulated results indicate variable results with respect to storm sewer capacity with the Mobility Hub limit. Sections along Plains Road west of Emery Lane are indicated as being unsurcharged or slightly surcharged. A more constrained section is indicated east of Waterdown Road at Plains Road, including along Plains Road itself (indicated as flooded) and upstream along Cooke Boulevard. Storm sewer surcharging is also indicated at the eastern limits of the study area, generally east of White Oak Drive. Based on the preceding, the section in the vicinity of Waterdown Road/Plains Road appears to have the greatest constraint and simulated capacity deficiencies, and may warrant further consideration and upsizing.

3.3.2.2 Overland Flow (Roadways)

Hydraulic modelling results for the urban drainage area (i.e. roadway overland flow routes) within West Aldershot Creek and Teal Creek have also been assessed as part of the current summary. In order to characterize areas of higher overland flow depths, the following characterization has been employed:

- Maximum depth between 0.15 m and 0.30 m (i.e. above curb height, but within the roadway right-of-way)
- Greater than 0.30 m (i.e. outside the limits of the right-of-way)

Actual street cross-sections could be used to better refine the preceding generic assumptions on right-of-way depths. Notwithstanding, for the current assessment the preceding assumptions are considered reasonable.

The results have been generated for both the 100-year storm event (Drawing 5) as well as the Regional Storm Event (Drawing 6). Both drawings also indicate the locations of identified roadway sag points.

For the 100-year storm event, right-of-way flooding is indicated in several different locations within the Aldershot GO Mobility Hub boundary:

- Waterdown Road and Plains Road, as well as Cooke Boulevard and Plains Road
- Clearview Avenue and Plains Road
- Plains Road (White Oak Drive to Flimandale Road)

The simulated results indicate potential overland flow depths well in excess of 0.30 m for the 100-year storm event (e.g. up to 1.1 m near Plains Road / Waterdown Road and up to 0.8 m for the eastern limits of Plains Road), which could impact emergency service access, as well as result in flooding of private properties (including potential re-development areas). As a major intersection, the simulated flooding in the vicinity of Waterdown Road and Plains Road (including Cooke Boulevard) is of particular note. This appears to be partially attributable to the number of roadway sag points in this area (i.e. lack of defined overland flow route). Simulated flooding at the sag point along Clearview Avenue is likely caused by a similar grading constraint.

Simulated flooding depths along Plains Road (White Oak Drive to Filmandale Road) may be somewhat overestimated, due to the omission of a potential overland spill relief path along Shadeland Avenue in the current modelling. Notwithstanding, simulated 100-year overland flow depths in this area are still well in excess of 0.30 m (e.g. 0.8 to 1.1 m as noted previously).

Given that the simulated overland flow depths exceed 0.30 m (and thus the limits of the public roadway right-of-way) potential spill pathways and depths cannot be further assessed in a 1-dimensional (1D) model. While a 2-dimensional (2D) model could potentially assess this further, this is beyond the scope of the current assessment. Notwithstanding, this should potentially be considered further as part of the overall SWM strategy for this area.

Simulated flooding depths and locations for the Regional Storm Event (Drawing 6) shows similar patterns to the 100-year results, albeit generally lower depths. Urban flooding in excess of 0.30 m continues to be indicated at the intersection of Waterdown Road and Plains Road (including Cooke Boulevard), as well as the sag point on Clearview Avenue. Simulated flooding depths along Plains Road east of White Oak Drive are however indicated as being contained within the roadway right-of-way (i.e. between 0.15 m and 0.30 m).

4.0 Stormwater Management

4.1 Planned Development

The currently proposed land use plans for the Aldershot GO Mobility Hub are included in Appendix A. A precinct plan has been developed (May 2018), which separates the overall Aldershot GO Mobility Hub into several sub-areas with common features. The majority of the proposed development areas are focused on residential land use types, along with some mixed commercial/residential along the "Aldershot Main Street" district (Plains Road East and Waterdown Road between Plains Road and Masonry Court), "Emery/Cooke Commons" precinct (generally located between Plains Road and Masonry Court), and the "Aldershot GO Central" precinct.

The preceding development would be expected to primarily alter land use to the west of Waterdown Road, given the existing industrial land use – primarily the paving/asphalt plant area, but other adjacent properties as well. These areas are proposed to be converted to residential and mixed commercial/residential uses. Other areas to the east would be expected to experience some intensification but remain primarily residential, with some associated commercial land usage. Notwithstanding, from a hydrologic perspective, significant changes to impervious coverage would not be expected; it is assumed that the paving/asphalt plant area is already highly impervious, although the existing ground coverage is difficult to verify given the site usage.

Figure 4.1 presents the identified remaining greenspace/undeveloped areas [(>0.5 ha +/-) within the Aldershot GO Mobility Hub not including creek corridors and parks (Hidden Valley, Grove and Aldershot), which would not be expected to change based on the precinct plan]. The ongoing development at 101 Masonry Court has also been excluded from this area identification. Likewise, the lands forming 1200 King Road are understood to be under assessment through a separate study, and are not considered as part of the current review.

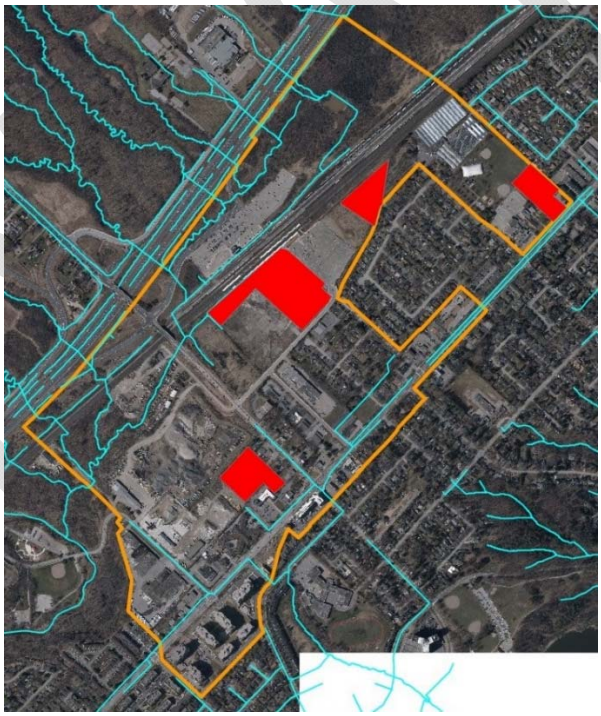


Figure 4.1: Aldershot GO Mobility Hub and Existing Pervious Areas

Based on the preceding, a total of 8.61 ha of such currently pervious/undeveloped areas has been identified (out of the total Aldershot GO Mobiity Hub area of 138.7 ha).

- 1021 Emery Avenue (1.68 ha)
- 121 Masonry Court (4.23 ha and 1.36 ha)
- 287 Plains Road East (1.34 ha)

The first parcel (1021 Emery Avenue) represents an undeveloped parcel of land. 121 Masonry Court appears to be owned by Metrolinx, and would form part of the Aldershot GO Station property. Plans included with the Functional Servicing and Stormwater Management Report for 101 Masonry Court (Urbantech West, October 2017) indicate that the majority of the western area (4.23 ha) is planned for a future parking lot expansion, however the plans are indicated as conceptual only. The area to the east (1.36 ha) may be planned for a similar expansion, however this is unknown. The property at 287 Plains Road East is part of the Holy Rosary Catholic Church and Elementary school and is identified as "Public Service" in the proposed precinct plan.

From a hydrologic perspective, the identified areas represent only a small percentage of the total area, and as indicated, it is unclear how all of these areas may (or may not) develop. Further, as per Drawing 2, the areas at 1021 Emery Avenue and the western portion of 121 Masonry Court have been assessed at a higher rate of imperviousness ("Other" – 20%), while the pervious area at 287 Plains Road East has been considered as part of an overall institutional/industrial land use. The eastern portion of 121 Masonry Court (1.36 ha) is noted however as Park – Natural Corridor in Drawing 2.

Notwithstanding the preceding, expected changes in land coverage should be considered as part of the proposed stormwater management (SWM) strategy, as discussed further in Section 4.4.

4.2 Floodplain and Spill Impacts

Riverine Floodplain Limits for Grindstone Creek are presented in Drawings 4a – 4b (without spills) and 4c – 4d (with spills) respectively. Only one primary property (1160 Waterdown Road) has been identified which is slated for re-development, but would have existing floodplain impacts (Section 3.3.1). As noted in Section 3.3.1, further discussion with CH staff is warranted to assess whether remedial channel modifications could be undertaken within the regulated area to increase channel capacity and adjust the associated floodplain limit to support future development.

A spill (overtopping) of the CNR tracks has been noted east of Waterdown Road. Similarly, spill flows from an adjacent watercourse (Falcon Creek) are expected to have an impact on the Grindstone Creek system. Neither of these spills has been assessed in further detail as part of the current study; further hydraulic modelling and assessment of these areas may be warranted as part of future land use planning.

A distinction must be made between flood risk due to a riverine floodplain (i.e. floodplain directly along/adjacent to the watercourse) and due to spills (i.e. excess flow draining in an uncontrolled manner, potentially no longer following the path of the watercourse). The former (riverine floodplains) are regulated by Conservation Authorities, and prevent any development within the floodplain limits (plus a 15 m buffer in the case of Grindstone Creek and its tributaries, given its classification as a Major Valley System), unless a Special Policy Area or other exception applies. Floodplain limits in these cases could potentially be reduced through infrastructure improvements (i.e. channel widening, re-grading, or more likely hydraulic structure (culvert) improvements where appropriate) to reduce floodplain extents, as discussed in Section 4.3. Beyond such measures, development would be restricted to the extents noted. It should also be re-iterated that any such works within a regulated area would require a permit and approval from CH.

Spills are also not considered to be regulated (refer to Section 4.2.5 of Policies and Guidelines for the Administration of Ontario Regulation 162/06, Conservation Halton, Amended November 26, 2015). The two (2) spill areas noted previously have not been assessed further as part of the current study.

Generally, for locations subject to spill impacts (where other mitigation measures are not feasible), it is recommended that appropriate flood mitigation and management strategies be employed. This would primarily include floodproofing of buildings. Passive floodproofing (i.e. floodproofing that does not require human intervention) is preferred, which would be expected to focus on grading of both the site and building, to ensure that openings are greater than spill elevations (typically a 0.30 m freeboard is applied). Active floodproofing (measures that require human intervention) may be warranted in locations where passive floodproofing cannot reasonably be achieved. In conjunction with the preceding, site grading should allow for the safe conveyance and routing of flood spill flows, and consider the safe ingress and egress of vehicles from the site. Site grading in these locations should also work towards achieving a cut/fill balance, in order to avoid the potential for off-site impacts. This should be more strongly enforced for riverine floodplain areas, where a cut/fill can more easily be achieved. For re-developments in spill areas where filling is unavoidable, other compensatory measures may be warranted. Further hydraulic modelling (beyond the scope of the current study) is considered required to better assess and map spill flow impacts. Such hydraulic modelling could also be applied to better determine the potential impacts of any future developments and the most appropriate floodproofing/flood mitigation strategies.

It should again be noted that the hydrologic modelling applied for Grindstone Creek, while technically sound and appropriate, has not been calibrated (i.e. adjusted to reflect actual observed responses to storm events). Typically, uncalibrated hydrologic models are considered conservative (i.e. over-predict flows and volumes as compared to existing conditions). Thus, further study could potentially result in a reduction in the predicted flood risk. In the absence of such information, the results generated by the current study are considered to be the best available data.

In addition to the preceding, it should be noted that the riverine (open channel) hydraulic modelling downstream of Waterdown Road has been developed using a digital elevation model (DEM) from the Region of Halton (2015). Hydraulic structures have been included based on elevations from this source, along with corrections from record drawings, and data from field observations/measurements. Notwithstanding, a further validation should be considered in the future using topographic survey data, to better confirm precise floodplain limits. It is expected that this may occur as specific sites (particularly those identified as being within the floodplain) re-develop and proponents design appropriate mitigation measures. The results generated by the current study are however still considered appropriate for the estimation of floodplain risk.

4.3 Potential Infrastructure Improvements

As noted in Section 4.2, one potential strategy for areas with riverine floodplain impacts is to review the feasibility of infrastructure improvements, which would most likely take the form of hydraulic structure (culvert) improvements. Based on the results presented in Drawings 4a to 4d, hydraulic structure upgrades should be considered for the following locations:

- Grindstone Creek
  - CNR (existing 1950 mm diameter circular CSP)
  - Waterdown Road (existing 2100 mm diameter circular concrete and 1.84 m x 1.33 m rectangular concrete box culvert)

- Falcon Creek
  - CNR (existing 1800 mm diameter circular CSP)

With respect to Grindstone Creek, a spill/overtopping of the CNR has been identified for the Regional Storm Event, which could potentially impact downstream properties. As noted previously, the impacts of these spill flows have not been assessed further as part of the current study; reference is made to the ongoing development at 101 Masonry Court. The CNR hydraulic structure is notably smaller than the hydraulic structures at Waterdown Road. The capacity of these features has similarly not been assessed as part of the current study, thus the necessity of a hydraulic structure upgrade in this case is unknown. Based on the existing structure sizes however, the CNR crossing appears to have a greater deficiency.

With respect to Falcon Creek, a spill has been identified which has the potential to impact the Grindstone Creek watershed through the conveyance of these spill flows, as well as increased downstream floodplain limits (1160 Waterdown Road in particular). The CNR is also indicated as being overtopped at this location for the 100-year storm event (without flow optimization/spills) and for the Regional Storm event (both with and without flow optimization/spills). As such, a hydraulic structure upgrade in this location would benefit the current study area. In conjunction with such an upgrade, potential grading modifications to overbank areas to contain spill flows to the Falcon Creek system could also be considered.

In addition to the preceding, as noted in Section 4.2 and 3.3.1, there would be value in undertaking channel widening works for the section of Grindstone Creek immediately downstream of Railway Road, in order to reduce floodplain impacts to the property to the north (1160 Waterdown Road).

It should again be noted that all of the preceding works would occur within CH Regulated areas, and thus would require a permit application and permission from CH prior to implementation.

Trunk storm sewer sections with deficient hydraulic capacity (i.e. less than the 5-year storm event) have been identified previously. These sections should therefore be considered for capacity upgrades where feasible, in conjunction with the City of Burlington's existing capital planning for road reconstructions.

4.4 Stormwater Management Strategy

As discussed in Section 4.1, the proposed re-development within the study area is not expected to result in large overall changes in impervious coverage, given the existing urbanized/developed nature of the study area. Notwithstanding, some potential re-development sites do include larger sections of existing pervious land, and increased impervious coverage would potentially still be expected in some areas. As such, a general strategy for quantity control is still required.

Large park areas are currently proposed for Emery Avenue/Masonry Court and Cooke Boulevard north of Plains Road East. These areas could potentially be used to provide stormwater management (SWM) controls for adjacent developments, through the implementation of properly landscaped and designed features, including LID BMPs. Notwithstanding, given the complexities of shared-use agreements, on site controls for these areas may be preferred. None of the existing park areas (Hidden Valley, Grove, Aldershot) appear directly amenable to incorporating SWM measures for future development given their respective locations and nature.

The majority of the re-development areas in the Aldershot GO Mobility Hub would be expected to discharge to adjacent storm sewer systems, with the exception of development north of the proposed Masonry Court extension and west of Waterdown Road, which may potentially outlet directly to Grindstone Creek. Consistent with current City practices for quantity control, it is recommended that requirements distinguish between these two types of outlets.

Where sites have an existing approved outfall directly to a watercourse system, post-development to pre-development peak flow for the 2 through 100 year storm events are generally considered sufficient. Given the relatively minor change in land use in the area, and the location (towards the downstream limits of the watershed) it is considered unlikely that further overcontrol to reduce any downstream riverine impacts would be of any benefit, and may in fact result in an adverse synchronizing of peak flows.

It is recommended that the City of Burlington's current informal policy of over-control (100-year post-development peak flow controlled to the 5-year pre-development peak flow) be applied as a minimum criteria for those sites connecting to the City's storm sewer system unless the receiver can be demonstrated to have a greater capacity, in which case that identified capacity would govern. This policy ensures that discharges are adequately controlled to the conveyance capacity of the interim drainage system receiver (i.e. the storm sewer) and no overland flow impacts would result from the conversion of area land uses. Further, those areas outletting to trunk storm sewers with identified capacity constraints (refer to Drawing 7) should potentially require further over-control to the simulated capacity of the storm sewer receiver. The modelling tools developed as part of the current study may be applied to further assess and validate quantity control measures and storm sewer capacity in these areas.

Given the fragmented nature of the pervious areas within the study area, and the study areas location towards the downstream limits of watercourse systems, erosion control requirements are not considered as critical as in more undeveloped, greenfield areas. Notwithstanding, consistent with the City's current approach to site developments, erosion control should be implemented through the 24-hour extended detention of the 4-hour 25 mm storm event. This could potentially also be achieved through the provision of LID BMPs, as part of the overall site SWM strategy (including quality control). In cases where the proponent can demonstrate that the preceding requirement cannot be reasonably achieved for the site, best efforts should be implemented.

As re-developments proceed within the study, area there is also an opportunity to holistically improve stormwater quality of discharges to the receiving system. The City of Burlington's current informal policy is to require "Enhanced" Water Quality treatment (80% average annual removal of Total Suspended Solids). This requirement accounts for the entire proposed impervious coverage, not only the "new" impervious coverage. It is recommended that this policy continue to be applied for re-developments within the study area, given the retroactive stormwater quality improvement to receivers.

It should be noted that the City of Burlington is currently in the process of reviewing and updating its Stormwater Management Design Policies and Guidelines, thus additional stormwater management requirements, particularly with respect to climate change, erosion control, and water balance/infiltration may also result for future developments, beyond the basic quantity and quality requirements noted previously.

In addition to the preceding, the currently proposed land use plan for the Aldershot GO Mobility Hub (Draft Precinct Plan – May 2018) indicates the use of "Green Streets" for area roadways. Green Streets provide the opportunity to incorporate Low Impact Development Best Management Practices (LID BMPs) 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.

5.0 Conclusions and Recommendations

The land use plans prepared for the Aldershot GO Mobility Hubs indicate that re-development and intensification are expected in this area. This report has been prepared in support of this planning effort, in order to summarize the expected flood hazard limits for the Mobility Hub. Existing hydrologic and hydraulic models have been refined in order to assess expected flood hazards, due to riverine floodplain extents, and potential spill areas.

Conventional 1-dimensional (1D) hydraulic modelling has been prepared for the area watercourses to confirm the riverine floodplain limits, and those locations where floodplain extents would limit any potential re-development.

A general floodplain management strategy has been proposed, which necessarily distinguishes between riverine floodplain extents (regulated by Conservation Halton) and spills (not regulated). Recommendations for potential hydraulic structure and channel upgrades have been proposed in areas which may assist in reducing currently estimated floodplain extents. An overall stormwater management (SWM) strategy has also been proposed, including quantity, quality, and erosion control measures to mitigate the impacts of future development. A summary of the proposed measures for the Aldershot GO Mobility Hub is outlined in Table 5.1.

The current study provides a basis for the estimation of existing flood hazards and a proposed SWM strategy for the Aldershot GO Mobility Hub. As noted, further study may be warranted as future refined land use planning and development studies. The following additional recommendations are noted in this regard:

- The City of Burlington may wish to consider undertaking further field monitoring and data collection efforts to support hydrologic model calibration, which will allow for a more informed estimate of flood risk. An updated to the 1995 GAWSER modelling for Grindstone Creek to a more current hydrologic modelling platform may also be considered as part of this effort.
- Further field verification and topographic survey is also recommended in certain locations, including affected floodplain areas (1160 Waterdown Road), and spill locations (spill section from Falcon Creek to Grindstone Creek).

Table 5.1	Summary of Flood Hazard and SWM Strategies for Aldershot GO Mobility Hub	
Management Area	**Consideration**	**Recommendation**
Development Area Flood Management	Riverine floodplain encroachment onto development sites	• No development can occur within 15 m buffer of identified floodplain extents (Grindstone Creek and its tributaries are identified as a Major Valley System) • Consider opportunities to reduce floodplain extents through hydraulic structure upgrades or channel improvements where feasible (1160 Waterdown Road) subject to CH approval
	Flood spills onto development sites	• Development can proceed subject to suitable flood management strategy on affected development sites. • Focus on passive floodproofing (re-grading of land and buildings to 0.30 m above identified flood level); consider active floodproofing (measures that require human intervention) where passive floodproofing not feasible. Confirm safe ingress/egress from site. • Attempt to achieve a cut/fill balance for flood storage volume to avoid off-site impacts. • Assess proposed site management strategies through application of developed modelling tools to confirm no off-site impacts and safe conveyance of spill flows.

Area Infrastructure Improvements	Hydraulic Structures (Culverts) and Channel Works	• Consider benefit of hydraulic structure upgrades to reduce spills to potential development lands (subject to CH permitting/approval):
		  • CNR (Grindstone Creek)
		  • CNR (Falcon Creek) – combine with potential grading modifications to prevent spill flows to Grindstone Creek
		• Consider channel widening and re-grading at 1160 Waterdown Road to reduce floodplain extents and ensure safe ingress/egress (subject to discussions with CH staff and permitting approval)

	Storm Sewers	• Consider capacity upgrades for identified deficient trunk storm sewers (those with surcharging or flooding for the 5-year storm event)
	Overland Flow Pathways	• Review opportunities for improvements in areas where 100-year and Regional Storm accumulation depths are > 0.30 m
	SWM Facilities	• Consider implementation of SWM facilities (for local or external lands) within proposed future park areas (Emery Ave/Masonry Court and Cooke Blvd) as part of future re-development plans, however these may not ultimately be feasible.
Stormwater Management Criteria	Quantity Control	• 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 or demonstrated capacity) of peak flows for areas connecting to storm sewers or where major system is constrained. Additional over-control may also be warranted where modelling results indicate storm sewer capacity is less than 5-year storm event standard.

Table 5.1 Summary of Flood Hazard and SWM Strategies for Aldershot GO Mobility Hub		
Management Area	**Consideration**	**Recommendation**
		• 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 to be considered where it can be demonstrated that the above cannot be reasonably be achieved.
	Quality Control	• Enhanced (80% average annual TSS for all impervious areas • Review opportunities for synergies with other studies and road reconstruction projects in particular ("Green Streets")

The current study should also be considered in conjunction with other ongoing City of Burlington initiatives within the study area. For the Mobility Hub assessed herein, updated direction from the City's revised Stormwater Management Policies and Design Guidelines should be taken into account in the development of future SWM strategies for re-developments.

Respectfully submitted,

Wood Environment & Infrastructure Solutions,
a division of Wood Canada Limited

DRAFT

Per: Ron Scheckenberger, M.Eng., P.Eng.
Principal, Water Resources

DRAFT

Per: Michael Penney, E.I.T.
Water Resources Analyst

DRAFT

Per: Allison Zhang, Ph.D., E.I.T.
Water Resources Analyst

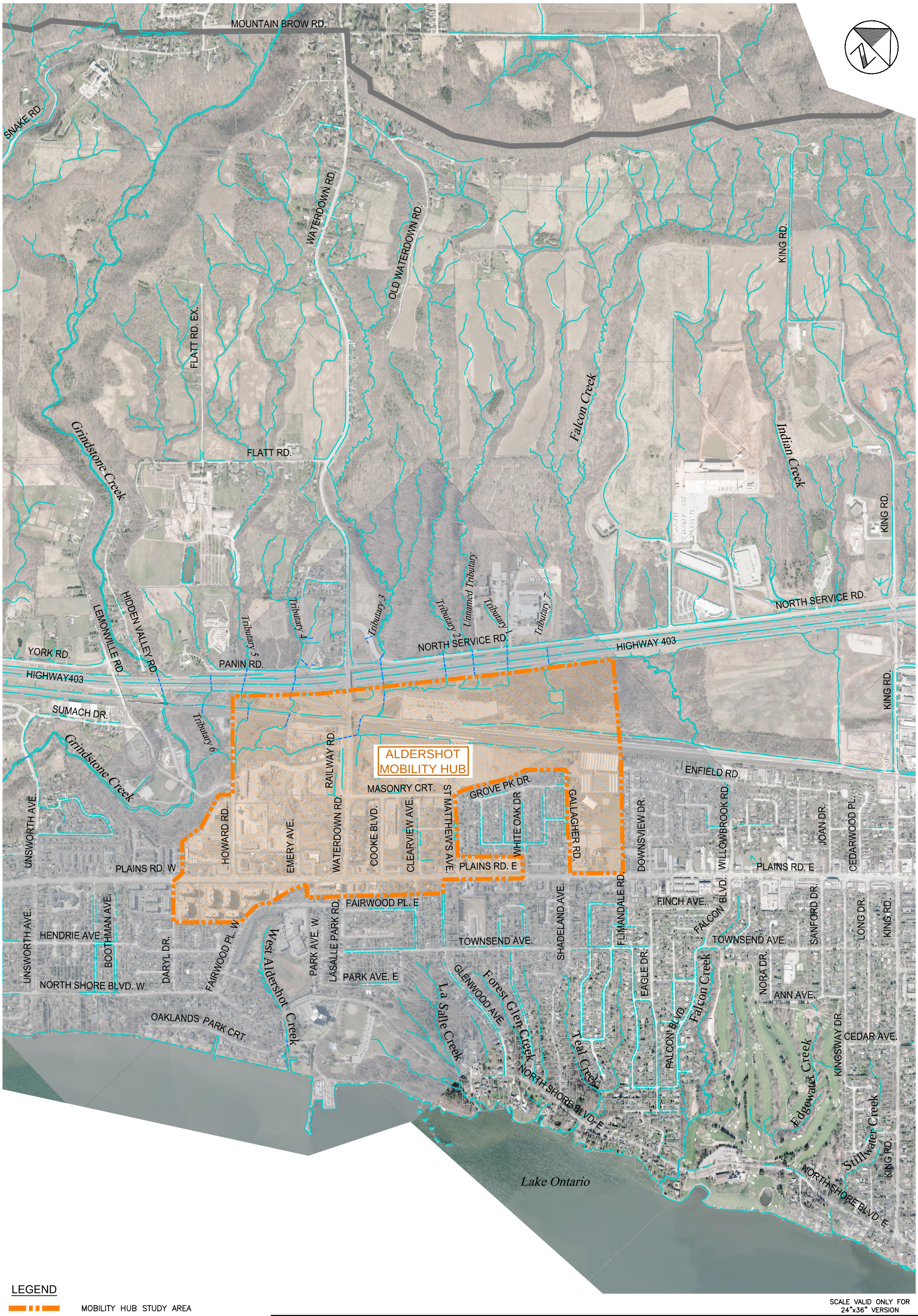
DRAFT

Per: Matthew Senior, M.A.Sc., P. Eng.
Senior Water Resources Engineer

DRAFT

Per: Priyantha Hunukumbura, Ph.D., E.I.T.
Water Resources Analyst

MJS/cc



LEGEND

- MOBILITY HUB STUDY AREA
- MUNICIPAL BOUNDARY
- WATERCOURSE
- PARCEL FABRIC
- CULVERT LOCATION

SCALE VALID ONLY FOR 24"x36" VERSION

MOBILITY HUB PLANNING STUDY

CITY OF BURLINGTON

STUDY AREA PLAN (ALDERSHOT AREA)

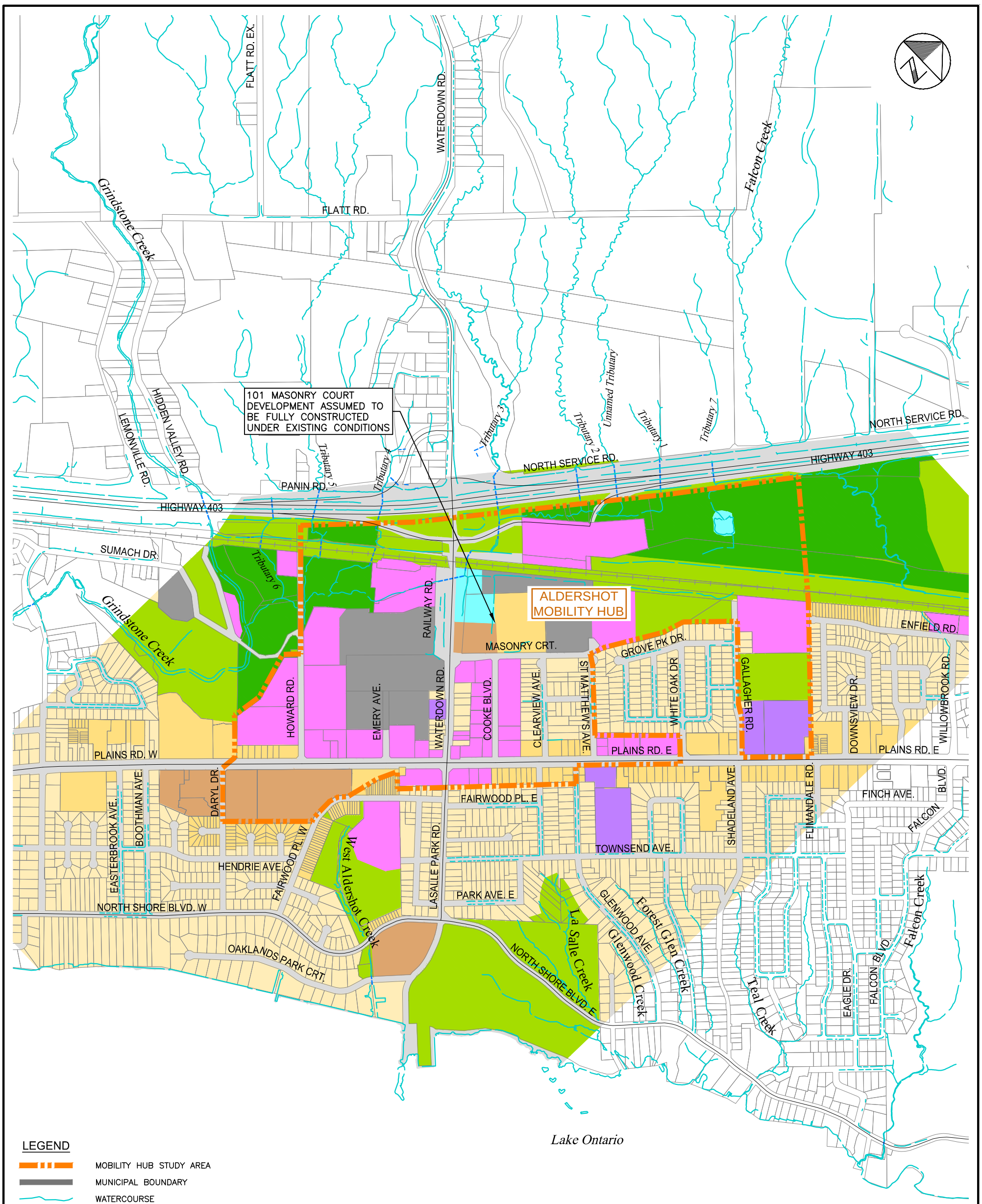
wood.

Scale 1:7500 (0, 75, 150, 300)

Consultant File No. TP178008S

Drawing No. 1

Last Saved: 2019-02-19 Last Saved By: richard.bartolo Plotted: 2019-02-19 Plotted By: richard.bartolo Path: P:\2017\Projects\TPB178008S – Mobility Hub Planning Consulting Services\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJ\2019-02(Ald)\Dwg1 StudyArea(AL).dwg



LEGEND

- MOBILITY HUB STUDY AREA
- MUNICIPAL BOUNDARY
- WATERCOURSE
- PRIMARY ROADWAY
- PARCEL FABRIC
- CULVERT LOCATION

LAND USE

- INSTITUTIONAL – INDUSTRIAL
- APARTMENT BUILDINGS
- LOW DENSITY DETACHED
- SEMI–DETACHED AND TOWNHOMES
- HIGH IMPERVIOUS
- ROAD
- PARK – NATURAL CORRIDOR
- FOREST
- OPEN WATER
- OTHER

SCALE VALID ONLY FOR 24"x36" VERSION

MOBILITY HUB PLANNING STUDY

CITY OF BURLINGTON

EXISTING LAND USE PLAN FOR HYDROLOGIC MODELLING

(ALDERSHOT AREA)

wood.

Scale 1:6000
0 75 150 300

Consultant File No.
TP178008S

Drawing No.
2

Path: P:\2017\Projects\TPB178008S – Mobility Hub Planning Consulting Services\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PRO\2019-02(Ald)\Dwg2 Landuse(AL).dwg
Last Saved: 2019-02-19 Last Saved By: richard.bartolo Plotted: 2019-02-19 Plotted By: richard.bartolo

NOTE:
FOR SUBCATCHMENTS REFER TO 'GRINDSTONE CREEK SUBWATERSHED STUDY' (COSBURN PATTERSON WARDMAN LTD., JAN. 1995)

NOTE:
FALCON CREEK SUBCATCHMENTS FOR EXTERNAL AREAS FROM 'FALCON CREEK HYDROLOGY AND HYDRAULIC STUDY' (VALDOR ENGINEERING INC., DEC. 2012)

NOTE:
AREA NOT INCLUDED IN PREVIOUS STUDY

ALDERSHOT MOBILITY HUB

GRINDSTONE CREEK

FALCON CREEK

WEST ALDERSHOT CREEK

LA SALLE CREEK

FOREST GLEN CREEK

TEAL CREEK

GLENWOOD CREEK

Lake Ontario

LEGEND

- MOBILITY HUB STUDY AREA
- WATERCOURSE
- CONTOUR (1m)
- PRIMARY ROADWAY
- PARCEL FABRIC
- CULVERT LOCATION
- STORM SEWER SYSTEM
- WATERSHED BOUNDARY
- SUBCATCHMENT BOUNDARY
- 100 / 25.0ha — SUBCATCHMENT ID# / SUBCATCHMENT AREA
- A805 — FLOW NODE

SCALE VALID ONLY FOR 24"x36" VERSION

MOBILITY HUB PLANNING STUDY CITY OF BURLINGTON	SUBCATCHMENT BOUNDARY PLAN (ALDERSHOT AREA)	wood.	Scale 1:6000 (0, 75, 150, 300) Consultant File No. TP178008S Drawing No. 3

Path: P:\2017\Projects\TPB178008S – Mobility Hub Planning Consulting Services\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJ\2019-02-19_Subcatchment(Hub-AL).dwg
Plotted By: richard.bartolo
Plotted: 2019-02-19
Last Saved By: richard.bartolo
Last Saved: 2019-02-19

PANIN RD.

HIGHWAY 403

HIGHWAY 403

WATERDOWN RD.

Tributary 3

SPILL

SPILL

Tributary 5

Tributary 6

Tributary 4

Grindstone Creek

LEMONVILLE RD.

HIDDEN VALLEY RD.

RAILWAY RD.

HOWARD RD.

WATERDOWN RD.

MASONRY CRT.

COOKE BLVD.

ALDERSHOT MOBILITY HUB

335,899 104.38 103.18
324,951 104.38 102.77
307,458 104.38 102.27
247,472 104.37 101.45
238,686 104.38 101.30
306,783 104.37 103.84
295,941 104.38 103.84
280,203 104.38 103.84
251,675 104.38 103.84
239,446 104.38 103.78
190,698 101.92 100.40
187,998 100.77 99.97
185,199 97.99 97.60
186,794 99.73 98.64
67,323 98.43 98.18
89,009 99.31 99.18
115,655 99.71 99.58
133,621 97.05 95.77
156,201 100.34 99.77
119,948 99.75 99.12
92,778 95.95 95.49
71,060 96.72 96.34
35,625 94.27 93.69
335,467 104.43 104.40
329,270 104.43 104.40
321,971 104.43 104.40
306,478 104.43 104.40
289,842 104.43 104.40
283,677 104.43 104.40
193,708 102.00 101.20
188,786 100.56 100.37
151,412 100.02 99.86
78,877 94.67 94.09
113,233 94.81 94.23
95,799 96.18 95.26
117,112 96.19 95.28
43,240 94.69 94.10
35,222 96.15 95.23
95,294 94.54 94.04
89,757 94.52 94.04
89,118 93.61 92.63
66,510 93.21 92.01
24,781 93.14 91.95
134,170 92.41 91.31
112,168 92.02 91.20
93,747 91.70 91.14
53,852 92.07 91.22
132,385 96.40 95.43
185,979 99.88 99.06
249,672 100.71 99.79
299,141 100.97 99.97
360,646 100.83 99.95
382,691 101.28 100.13
376,081 101.24 100.05
367,009 100.92 100.01

LEGEND

- MOBILITY HUB STUDY AREA
- WATERCOURSE
- CONTOUR (1m)
- PARCEL FABRIC
- CULVERT LOCATION
- STORM SEWER SYSTEM
- CROSS SECTION NUMBER
- REGIONAL STORM FLOOD ELEVATION (m)
- CROSS SECTION LOCATION
- 100 YEAR STORM FLOOD ELEVATION (m)
- REGIONAL STORM FLOODPLAIN
- 100 YEAR STORM FLOODPLAIN
- SPILL LOCATION
- PLANNED RE-DEVELOPMENT PARCELS WITH POSSIBLE RIVERINE FLOODING IMPACT

SCALE VALID ONLY FOR 24"x36" VERSION

MOBILITY HUB PLANNING STUDY

CITY OF BURLINGTON

FLOODPLAIN MAPPING WITHOUT FALCON CREEK SPILL

(GRINDSTONE CREEK WEST OF WATERDOWN RD)

wood.

Scale 1:1500 (0 15 30 60)

Consultant File No. TP178008S

Drawing No. 4a

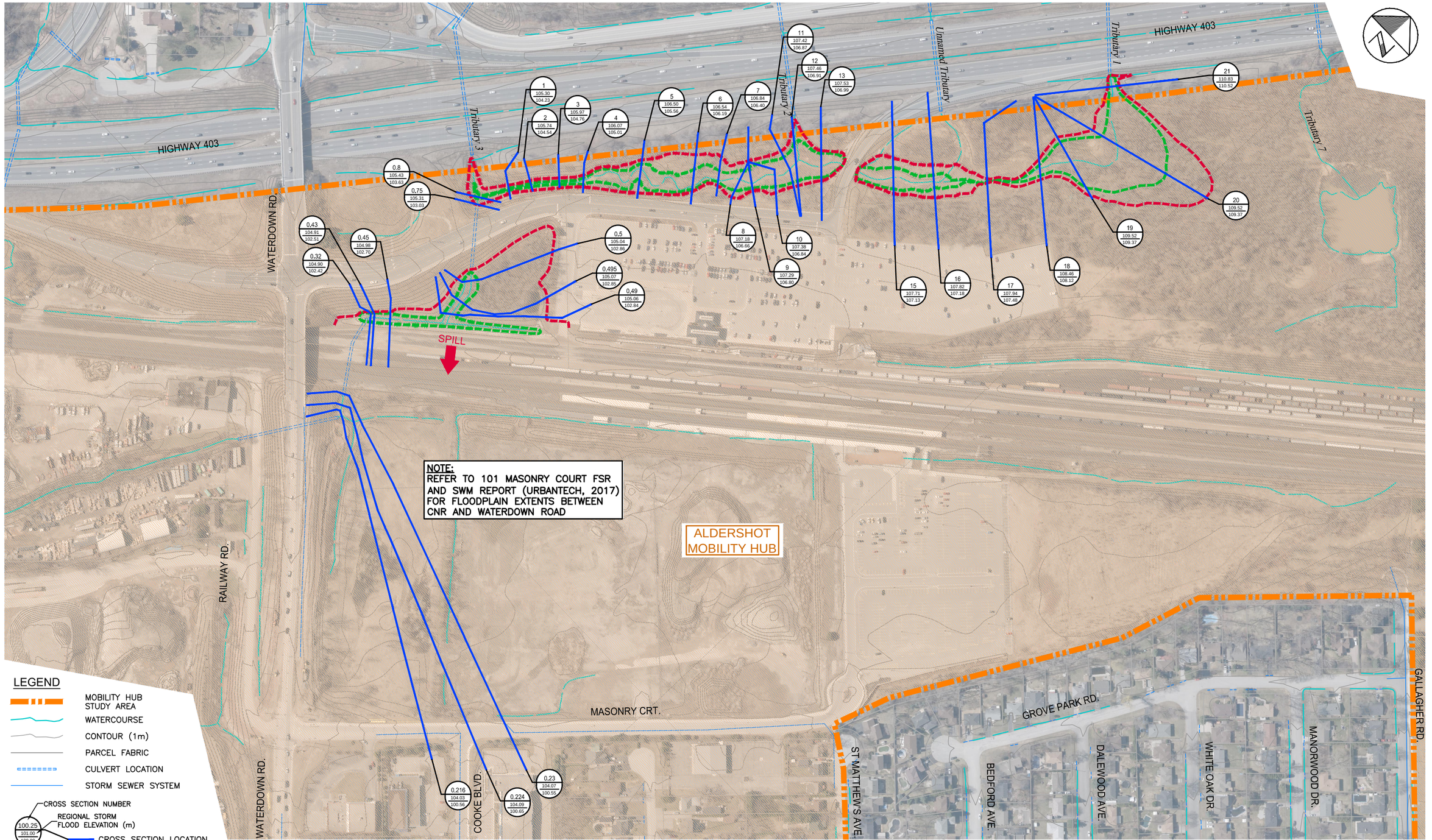
Path: P:\2017\Projects\TPB178008S - Mobility Hub Planning Consulting Services\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJ\2019-02(Ad)\Dwg4ab FloodlineNSP(Hub-AL).dwg

Plotted By: richard.bartolo

Last Saved By: richard.bartolo

Plotted: 2019-02-19

Last Saved: 2019-02-19



SCALE VALID ONLY FOR 24"x36" VERSION

MOBILITY HUB PLANNING STUDY

CITY OF BURLINGTON

FLOODPLAIN MAPPING WITHOUT FALCON CREEK SPILL

(GRINDSTONE CREEK EAST OF WATERDOWN RD)

wood.

Scale 1:1500
0 15 30 60

Consultant File No.
TP178008S

Drawing No.
4b

Plotted: 2019-02-19
Last Saved: 2019-02-19
Plotted By: richard.bartolo
Last Saved By: richard.bartolo
Path: P:\2017\Projects\TP178008S - Mobility Hub Planning Consulting Services\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJ\2019-02(Ald)\Dwg4ab FloodlineNSP(Hub-AL).dwg

PANIN RD.

HIGHWAY 403

HIGHWAY 403

WATERDOWN RD.

Tributary 3

SPILL

SPILL

Tributary 5

Tributary 6

Tributary 4

Grindstone Creek

LEMONVILLE RD.

HIDDEN VALLEY RD.

RAILWAY RD.

HOWARD RD.

WATERDOWN RD.

MASONRY CRT.

COOKE BLVD.

ALDERSHOT MOBILITY HUB

335,899 104.38 103.18
324,951 104.38 102.77
307,458 104.38 102.27
247,472 104.37 101.45
238,686 104.38 101.30
306,783 104.37 103.84
295,941 104.38 103.84
280,203 104.38 103.84
251,675 104.38 103.84
239,446 104.38 103.78
190,698 101.92 100.40
187,998 100.77 99.97
185,199 97.99 97.60
186,794 99.73 98.64
67,323 98.43 98.18
89,009 99.31 99.18
115,655 99.71 99.58
133,621 97.05 96.77
156,201 100.34 99.77
119,948 99.75 99.12
92,778 95.95 95.49
71,060 96.72 96.34
35,625 94.27 93.68
335,467 104.43 104.40
329,270 104.43 104.40
321,971 104.43 104.40
306,478 104.43 104.40
289,842 104.43 104.40
283,677 104.43 104.40
193,708 102.00 101.20
188,786 100.56 100.37
151,412 100.02 99.86
78,877 94.76 94.27
43,240 94.78 94.27
113,233 94.92 94.36
35,222 96.35 95.45
95,799 96.37 95.48
117,112 96.38 95.50
95,294 94.62 94.21
88,757 94.61 94.21
69,118 93.61 92.96
66,510 93.32 92.22
24,781 93.27 92.16
134,170 92.55 91.42
112,168 92.06 91.20
93,747 91.88 91.06
53,852 92.07 91.22
132,385 96.60 95.67
185,979 100.06 99.28
249,672 100.91 100.02
299,141 101.18 100.23
360,646 101.21 100.18
382,691 101.32 100.43
376,081 101.26 100.32
367,009 101.24 100.24

LEGEND

- MOBILITY HUB STUDY AREA
- WATERCOURSE
- CONTOUR (1m)
- PARCEL FABRIC
- CULVERT LOCATION
- STORM SEWER SYSTEM
- CROSS SECTION NUMBER
- REGIONAL STORM FLOOD ELEVATION (m)
- CROSS SECTION LOCATION
- 100 YEAR STORM FLOOD ELEVATION (m)
- REGIONAL STORM FLOODPLAIN
- 100 YEAR STORM FLOODPLAIN
- SPILL LOCATION
- PLANNED RE-DEVELOPMENT PARCELS WITH POSSIBLE RIVERINE FLOODING IMPACT

SCALE VALID ONLY FOR 24"x36" VERSION

MOBILITY HUB PLANNING STUDY

CITY OF BURLINGTON

FLOODPLAIN MAPPING WITH FALCON CREEK SPILL

(GRINDSTONE CREEK WEST OF WATERDOWN RD)

wood.

Scale 1:1500 (0 15 30 60)

Consultant File No. TP178008S

Drawing No. 4c

Path: P:\2017\Projects\TPB178008S - Mobility Hub Planning Consulting Services\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJ\2019-02(Ald)\Dwg4cd FloodlineWSP(Hub-AL).dwg

Plotted By: richard.bartolo
Last Saved By: richard.bartolo

Plotted: 2019-02-19
Last Saved: 2019-02-19

HIGHWAY 403

WATERDOWN RD.

RAILWAY RD.

Tributary 3

Tributary 2

Unnamed Tributary

Tributary 1

Tributary 7

1 105.88 104.23
2 105.96 104.54
3 106.10 104.79
4 106.18 105.01
5 106.54 105.55
6 106.57 106.19
7 106.84 106.40
8 107.18 106.66
9 107.29 106.80
10 107.38 106.84
11 107.42 106.87
12 107.51 106.93
13 107.50 106.94
15 107.69 107.11
16 107.80 107.17
17 107.94 107.48
18 108.46 108.12
19 109.52 109.37
20 109.52 109.37
21 110.83 110.52

0.8 106.04 103.77
0.75 105.95 103.79
0.43 105.57 103.68
0.45 105.59 103.73
0.32 105.56 103.68
0.5 105.62 103.79
0.495 105.65 103.79
0.49 105.65 103.79
0.216 105.55 101.06
0.224 105.61 101.16
0.23 105.61 101.08

SPILL

FALCON CREEK SPILL

FALCON CREEK SPILL

FALCON CREEK SPILL

NOTE:
REFER TO 101 MASONRY COURT FSR AND SWM REPORT (URBANTECH, 2017) FOR FLOODPLAIN EXTENTS BETWEEN CNR AND WATERDOWN ROAD

ALDERSHOT MOBILITY HUB

MASONRY CRT.

COOKE BLVD.

GROVE PARK RD.

ST MATTHEW'S AVE.

BEDFORD AVE.

DALEWOOD AVE.

WHITE OAK DR.

MANORWOOD DR.

GALLAGHER RD.

LEGEND

- MOBILITY HUB STUDY AREA
- WATERCOURSE
- CONTOUR (1m)
- PARCEL FABRIC
- CULVERT LOCATION
- STORM SEWER SYSTEM
- CROSS SECTION NUMBER
- REGIONAL STORM FLOOD ELEVATION (m) (100.25 / 101.00)
- CROSS SECTION LOCATION
- 100 YEAR STORM FLOOD ELEVATION (m) (100.00)
- REGIONAL STORM FLOODPLAIN
- 100 YEAR STORM FLOODPLAIN
- SPILL LOCATION

SCALE VALID ONLY FOR 24"x36" VERSION

MOBILITY HUB PLANNING STUDY

CITY OF BURLINGTON

FLOODPLAIN MAPPING WITH FALCON CREEK SPILL

(GRINDSTONE CREEK EAST OF WATERDOWN RD)

wood.

Scale 1:1500
0 15 30 60

Consultant File No.
TP178008S

Drawing No.
4d

NOTE:
RESULTS AREA PRESENTED FOR PCSWMM MODELLING ONLY (WEST ALDERSHOT CREEK AND TEAL CREEK)

LEGEND

- MOBILITY HUB STUDY AREA
- WATERCOURSE
- CONTOUR (1m)
- PARCEL FABRIC
- CULVERT LOCATION
- STORM SEWER SYSTEM
- SAG POINT
- OVERLAND FLOW NODE (DEPTH 150mm–300mm)
- OVERLAND FLOW NODE (DEPTH GREATER THAN 300mm)

SCALE VALID ONLY FOR 24"x36" VERSION

MOBILITY HUB PLANNING STUDY

CITY OF BURLINGTON

URBAN FLOODING PLAN 100 YEAR STORM (ALDERSHOT AREA)

wood.

Scale 1:6000
0 75 150 300

Consultant File No.
TP178008S

Drawing No.
5

Path: P:\2017\Projects\TPB178008S – Mobility Hub Planning Consulting Services\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJ\2019-02(Ald)\Dwg5-6 UrbanFlooding(AL).dwg
Last Saved: 2019-02-19 Last Saved By: richard.bartolo Plotted: 2019-02-19 Plotted By: richard.bartolo

NOTE:
RESULTS AREA PRESENTED FOR PCSWMM MODELLING ONLY (WEST ALDERSHOT CREEK AND TEAL CREEK)

LEGEND

- MOBILITY HUB STUDY AREA
- WATERCOURSE
- CONTOUR (1m)
- PARCEL FABRIC
- CULVERT LOCATION
- STORM SEWER SYSTEM
- SAG POINT
- OVERLAND FLOW NODE (DEPTH 150mm–300mm)
- OVERLAND FLOW NODE (DEPTH GREATER THAN 300mm)

SCALE VALID ONLY FOR 24"x36" VERSION

MOBILITY HUB PLANNING STUDY

CITY OF BURLINGTON

URBAN FLOODING PLAN REGIONAL STORM (ALDERSHOT AREA)

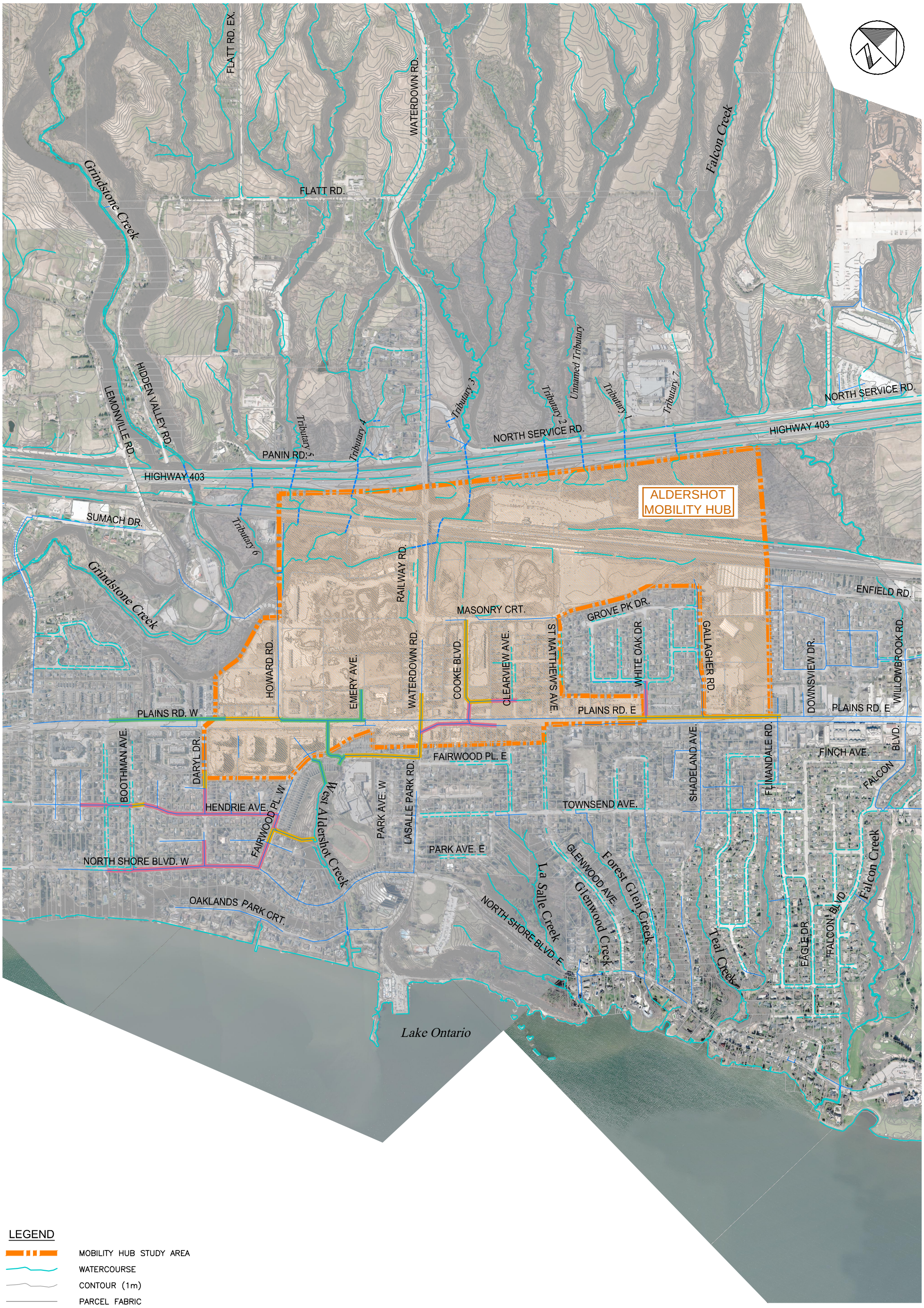
wood.

Scale 1:6000
0 75 150 300

Consultant File No.
TP178008S

Drawing No.
6

Path: P:\2017\Projects\TPB178008S – Mobility Hub Planning Consulting Services\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJ\2019-02(Ald)\Dwg5-6 UrbanFlooding(AL).dwg
Last Saved: 2019-02-19 Last Saved By: richard.bartolo Plotted: 2019-02-19 Plotted By: richard.bartolo



LEGEND

- MOBILITY HUB STUDY AREA
- WATERCOURSE
- CONTOUR (1m)
- PARCEL FABRIC
- CULVERT LOCATION
- STORM SEWER SYSTEM
- STORM SEWER SYSTEM NOT SURCHARGED
- STORM SEWER SYSTEM SURCHARGED
- STORM SEWER SYSTEM FLOODED

SCALE VALID ONLY FOR 24"x36" VERSION

MOBILITY HUB PLANNING STUDY

CITY OF BURLINGTON

STORM SEWER CAPACITY 5 YEAR STORM (ALDERSHOT AREA)

wood.

Scale 1:6000 (0 75 150 300)

Consultant File No. TP178008S

Drawing No. 7

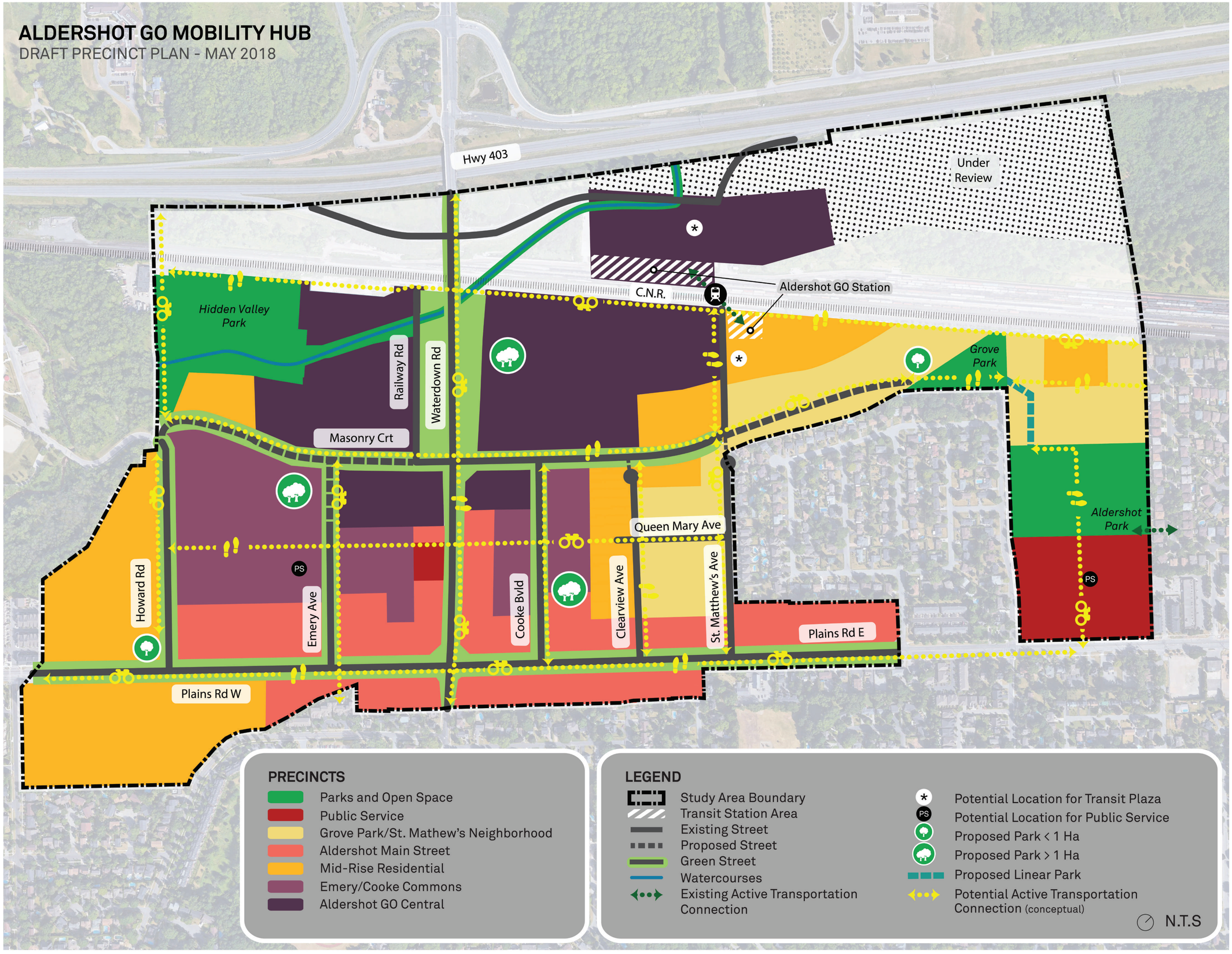
Path: P:\2017\Projects\TPB178008S – Mobility Hub Planning Consulting Services\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJ\2019-02(Ald)\Dwg7 StormSewer5yrCap(AL).dwg
Last Saved: 2019-02-19 Last Saved By: richard.bartolo Plotted: 2019-02-19 Plotted By: richard.bartolo

Appendix A

Mobility Hub Land Use Plans

ALDERSHOT GO MOBILITY HUB

DRAFT PRECINCT PLAN - MAY 2018



PRECINCTS

- Parks and Open Space
- Public Service
- Grove Park/St. Mathew's Neighborhood
- Aldershot Main Street
- Mid-Rise Residential
- Emery/Cooke Commons
- Aldershot GO Central

LEGEND

- Study Area Boundary
- Transit Station Area
- Existing Street
- Proposed Street
- Green Street
- Watercourses
- Existing Active Transportation Connection
- Potential Location for Transit Plaza
- Potential Location for Public Service
- Proposed Park < 1 Ha
- Proposed Park > 1 Ha
- Proposed Linear Park
- Potential Active Transportation Connection (conceptual)

N.T.S

GROW BOLD

CITY OF Burlington

Please note that the draft precinct plan, precinct boundaries, associated intention statements and key directions are preliminary and subject to change as a result of on-going technical studies and community and stakeholder feedback.

Appendix B

Background Information and Correspondence (Conservation Halton)

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:

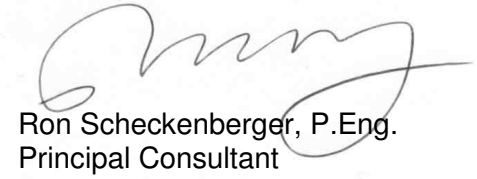
1. Page 6 of PDF (5.0 - Table A) – Aldershot has been revised to a "Yes*", based on the qualifiers and conditions outlined under the "*".
2. Page 10 of PDF (5.0 – Water Quality/Benthic Invertebrates) – Asteriks added for Burlington and Appleby Line.
3. Page 11 of PDF (5.0 – Stream/Drainage Corridor and 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) Indian Creek Grade Separation Design (AMEC 2013) 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 4th, 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. • 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. • Include all data sheets (e.g., soils, disturbance, etc.). • Mapping should clearly differentiate between the polygons.
☐	Wetland Evaluation and Delineation	• Evaluation: variety of seasons to ensure the full evaluation occurs as per OWES • 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. • Ensure sufficient time for MNRF to process. *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 • Details on species including level of invasiveness, CoC, CoW, species rarity etc., should be recorded	Species rarity to be based on: • Species at Risk in Ontario list (MNRF) • S-Rank using the Natural Heritage Information Centre species lists • 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: • Ontario Breeding Bird Atlas protocols	• Point counts required for monitoring. • 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) • 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). • 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. • If sampling in urban areas, point counts longer than three minutes may be recommended *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 • Late Summer/Fall: Late August to October for migration or congregating species • Weather dependent	• Species and habitat dependent • May include cover board surveys, spring emergence surveys etc. • 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 • July (peak) • Weather dependent	• Species and habitat dependent • Consultation recommended ahead of work	*Note: potential significant wildlife habitat for migratory butterflies to be confirmed through ELC surveys.*
☐	Dragonflies and damselflies	• June – August • July (peak) • Weather dependent	• Species and habitat dependent • 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 • 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 • SAR Bats require different surveys than SWH bats. • MNRF Guidelines, where applicable • 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 • 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 *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

Conservation Halton

905.336.1158
Fax: 905.336.7014
2596 Britannia Road West
Burlington, Ontario L7P 0G3
conservationhalton.ca

Protecting the Natural Environment from Lake to Escarpment

July 7, 2017

BY EMAIL AND MAIL

Phil Caldwell
City of Burlington
Planning and Building Department
426 Brant Street, P.O. Box 5013
Burlington, Ontario L7R 3Z6

Dear Mr. Caldwell:

Re: Mobility Hubs Project – Final Work Plan
City of Burlington
CH File: MPR 653

Conservation Halton (CH) staff has reviewed the City of Burlington's Mobility Hubs Final Work Plan dated updated April 25th 2017 and Agreement dated March 9, 2017 and offer the following comments:

- The level of study provided for the Appleby and Aldershot Hubs will generally identify flooding and erosion hazards and is sufficient to support the Area Specific Plans. Additional technical studies will be required to support redevelopment and intensification at the site-specific level. Some of these studies require holistic evaluation on a subwatershed basis, and should be completed in advance of any Site Specific Application, while others can be included as part of a Site Specific Application (Table 1 summarizes study gaps and recommended timing for these submissions). The Area Specific Plan should specify the types, levels, and timing of studies required and who would be responsible for funding and undertaking these studies.

- The level of study for the Downtown and Burlington Hubs is insufficient to determine the general nature and extent of the flooding and erosion hazards. Identification of areas where redevelopment and intensification is appropriate is not possible. **Conservation Halton recommends that the City undertakes additional required comprehensive studies, outlined below, prior to the completion of the Area Specific Plans to determine the general nature and extent of the flooding hazard and to develop appropriate land use policies to minimize risk to life and property through redevelopment and**

intensification in keeping with Section 3.0 – Protecting Public Health and Safety of the Provincial Policy Statement (PPS) (Conservation Halton has delegated responsibility for commenting on Sections 3.1.1-3.1.7 of the PPS under the one-window approach).

Should the City proceed with finalizing the Area Specific Plan (ASP) for the Burlington and Downtown Hubs without this additional analysis and decision making, the ASP should clearly indicate that comprehensive studies to determine the nature and extent of the hazards are required, in conjunction with additional subwatershed level studies, before site-specific applications for redevelopment and intensification could be accepted. The ASP should specify that a Terms of Reference for these comprehensive studies would have to be completed to the satisfaction of the City and Conservation Halton and indicate who would be responsible for undertaking and funding the studies. The policy framework developed for the ASP should implement measure(s) to restrict advancement of development or re-development proposals within the entire Study Area before completion of all additional comprehensive studies and subsequent site specific studies (Table 1 summarizes study gaps and recommended timing for these submissions).

Conservation Halton prefers that the City complete the required technical studies rather than deferring them to a latter stage of the planning process, as this would provide certainty to residents and developers in the Burlington and Downtown Mobility Hubs. Further discussion regarding the preferred approach is requested by CH prior to signing the Agreement.

The technical studies required and the rationale for requesting these studies are outlined below.

Additional Work Needed to Support Identification of the Flood Hazard at an Area Specific Plan Level for the Downtown and Burlington Mobility Hubs:

As acknowledged in the Disclaimer associated with AMECFW's updated April 25, 2017 Work Plan, *"To generate a level of accuracy that can be reasonably relied upon to guide development and establish related polices ... would require detailed hydraulic modelling... Clearly the detailed analysis that would be required cannot be accommodated by the current Work Plan."* The proposed studies do not fully characterize and define the limits of natural hazards associated with the Downtown and Burlington Hubs. Determining the extent of the flooding hazard impacting these Hubs is reliant upon an understanding of potential spill associated with the upstream Hager Rambo Diversion Channel. This is further complicated for the Downtown Hub by the need to understand how potential spills from the diversion channel impact the flood and erosion risks associated with the remnant lower Hager and lower Rambo channels. While a precise delineation of the flood hazard is not necessary at this time, it would be prudent for the City and Conservation Halton to understand the general extent of the flood hazard to establish a basic understanding of the lands available for intensification.

The extent of spill from the Hager Rambo Diversion channel is dependent upon how flow attenuation associated with the upstream Freeman, West Hager and East Rambo ponds are credited in the calculation of the flood hazard. Since Conservation Halton, the City, and the

Province jointly constructed the above-mentioned flood control reservoirs the hazard management approach for this area has credited these facilities in the past. However, current MNRF Guidelines do not support crediting any attenuation associated with on-line flood control reservoirs. As such, existing Approximate Regulation Limit mapping within the Downtown and Burlington Hubs should not be relied upon to determine constraints for intensification. To finalize the floodplain delineation associated with the Burlington and Downtown Mobility Hubs, a decision must be made on whether, it is appropriate to continue to credit the Freeman Pond, West Hager and East Rambo ponds.

Per discussions with the City of Burlington (June 5th, 2017 involving Allan Magi, Cary Clark, Barb Veale, Janelle Weppler, Janette Brenner), the City committed to reviewing their files for historical documentation on the flood control reservoirs. This information is to be reviewed prior to further consultation on this issue. Key information the City was to look for included:

- written documentation regarding the decision(s) made by the City, Conservation Halton and the Province to credit attenuation within the SWM facilities,
- final design and construction details (embankment height, inclusion of design safety factors incorporated into the design, etc.), and,
- ownership and management information.

As the City, Region and Conservation Halton will be potentially accepting additional risk/liability should there be a decision to continue crediting these ponds, additional attributes that contribute to the level of risk, must also be considered, including:

- potential future changes in flow contributing to these ponds due to climate change or development,
- consistency in floodplain mapping approaches relative to other flood control facilities in Conservation Halton's jurisdiction, i.e., dams, regional control ponds, etc.,
- future management requirements for the structures (i.e., Do the ponds need to be managed as dams in future? How will this impact the required frequency of maintenance and inspection? Are remedial works required to meet safety standards?), and,
- other relevant factors as determined through ongoing discussions.

Once a decision on crediting attenuation within the upstream ponds is made, the hydraulic analysis associated with the diversion channel must:

a) be revised based on any flow change,
b) determine whether spills are significant (and cannot be eliminated), and,
c) how any significant spill is credited in reducing downstream flows within the diversion channel.

Should significant spills from the Diversion Channel be recognized and credited, a corresponding analysis determining how spill from the Diversion Channel impacts the flood hazard associated with any watercourse or drainage system receiving the spill flows will be required. The updated April 25, 2017 Work Plan commits the Mobility Hub Consulting Team and TAC to identifying study gaps as early as possible.

A joint decision on crediting the existing flood control reservoirs must be made before land use concept plans and the technical studies supporting the ASP are finalized for the Burlington and Downtown Hubs, as the limit of the Floodplain Hazard will determine which areas may intensify. While this decision making process is understood to be separate from the Mobility Hub Study, the final decision may rely, to some extent, on the findings of the modelling proposed as part of the Mobility Hub Work Plan.

The updated April 25, 2017 Work Plan addresses modeling related to the on-line flood control reservoirs and associated spill, but only in a preliminary way, including the following items:

- estimation of the order of magnitude of the spill from the diversion channel under attenuated and unattenuated peak flow conditions;
- review of potential pond breach spill paths to provide a preliminary understanding of spill path routes through the Burlington and Downtown Mobility Hubs.

This approach will allow only a coarse estimate of the potential flood impact. Insufficient detail will be available to fully characterize the flood hazard. The level of analysis will be less rigorous than the analysis completed for the Appleby and Aldershot Hubs. To achieve a similar level of analysis, the quantification of the spills, their locations and their flow paths would be required as well as a decision on the use of attenuated or unattenuated flows.

Additional Technical Studies Recommended for all Four ASPs Prior to Site Specific Development Applications:

Should the City proceed with Area Specific Plans, additional holistic subwatershed scale technical studies should be completed to support development. In drafting the original ToR for the Mobility Hub Study, Conservation Halton staff accepted the limitations of the Council-driven timelines and access issues associated with fractured property ownership, and scoped several elements typically required to support an Area Specific Plan out of the agreed ToR. This was based on an understanding that these elements would be further assessed through later studies that would holistically address subwatershed impacts. The original requirements of the ToR were further scoped through the Work Plan presented by the City's consultants. Following development of the consultant's Work Plan, the City identified an expectation that development would advance directly from the Area Specific Plan to individual site specific development applications. Conservation Halton staff are very concerned with the proposal to advance directly to individual site specific development applications.

The following technical deficiencies, while not required for the completion of an Area Specific Plan, are better suited to a higher level study rather than a site specific application:

- *Hydrologic Model Review*: The Work Plan included a review of hydrologic model parameterization, but noted watershed wide re-parameterization (outside of the Mobility Hubs) was not included. There is also no requirement for the models to be calibrated and validated. Watershed conditions associated with the planned development, particularly as

described in the older hydrology studies (dated 1997 for Shoreacres, Appleby and the upper Hager Rambo Diversion System), may not fully correspond with actual development. Each Hydrologic model must be calibrated and validated following a watershed wide review, to ensure proposed stormwater management targets appropriately protect downstream residents from increased runoff generated by intensification. Following refinement of the existing condition model, the impact of the anticipated stormwater management controls should be tested to ensure that the shifted hydrographs associated with flow control will not negatively impact flooding or erosion when evaluated cumulatively.

- *Detailed Spill Assessment and 2-Dimensional Modelling:* The 1- Dimensional steady state modelling being created or refined may not be sufficient to assess the developed urban floodplain and/or the Falcon Creek Spill. 2-Dimensional modelling may be required to fully assess the flooding risks for site specific applications in some areas, such as the Downtown Hub, Aldershot Hub, and potentially the Burlington Hub.

- *Dam Break Analysis:* A dam break analysis is recommended to inform risk and for the purposes of emergency planning, downstream of the on-line ponds associated with the Hager Rambo Diversion Channel. (Note: Current MNRF Technical Guidelines recommends regulatory flows be assessed based on peak flow from a dam break conditions wherever public safety is the issue, but identifies a preferred approach of using unregulated flows to identify the flood hazard downstream of dams.) While it is not anticipated that the Dam Break Scenario would be used in establishing regulation limits, it is recommended that this work be completed to identify the level of risk posed by the upstream facilities. This would impact the Downtown and Burlington Hubs.

The current Work Plan is not sufficient for Conservation Halton to support site specific development applications or development adjacent to natural hazards without completion of the above technical studies. Completion of these studies as part of individual site development applications will not allow for comprehensive mitigation measures and will result in substantially more complex and costly submissions and delays. It is recommended that these studies be prepared by the City in advance of site development applications. Alternatively, a less preferable option could include identification within the policies of the Area Specific Plan that the above studies will need to be completed for the entire subwatershed area, by the first developer to advance redevelopment or intensification within each catchment area.

Work Required to Support Site Specific Development Applications:

Upon completion of the above studies, further site specific technical studies will be required to properly define and characterize natural hazards and features in order to satisfy Conservation Halton's regulatory requirements for future site specific development applications. Table 1 provides a summary of items required for site specific applications.

Summary of Future Works Required

Table 1 summarizes the studies required at different stages in the planning process. Additional comments related to individual study components are outlined in Appendix A. This list is not exhaustive and requirements may vary based on the individual sites.

Conservation Halton staff look forward to continue working with the City of Burlington through the review process for this Mobility Hubs Study. Further discussion regarding the points mentioned in this correspondence is recommended. If you have any questions please contact the undersigned at extension 2266.

Yours truly,

Barbara Veale

for Leah Chishimba, MAES
Environmental Planner

Cc: Jonathan Pounder, Conservation Halton, email
Rosa Bustamante, City of Burlington, email
Richard Clark, Region of Halton, email
Jason Elliot, Region of Halton, email
Mary Lou Tanner, City of Burlington, email
Allan Magi, City of Burlington, email
Cary Clark, City of Burlington, email

Table 1: Summary of Tasks/Analysis Requirements

Required Tasks/Analysis	Downtown	Aldershot	Burlington	Appleby
Tasks/Studies Preferably Completed Prior to Finalizing the ASP*				
Completion of all supporting studies identified in the Work Plan	✓	✓	✓	✓
Identification of future study requirements	✓	✓	✓	✓
Discussion and decision making on crediting attenuation associated with the Freeman, West Hager and East Rambo Ponds	✓		✓	
Quantification of spill flows and spill locations related to the Hager Rambo Diversion Channel	✓		✓	
Quantification of downstream flow paths from the Diversion Channel to the remnant channels (2-Dimensional modeling may be required)	✓		✓	
Studies Preferably Completed Prior to Site Specific Development Applications**				
Watershed-wide review and update to the hydrologic model, including calibration and validation	✓	✓	✓	✓
Watershed wide update to the hydraulic model, based on refined hydrology	✓	✓	✓	✓
Evaluate spill impacts associated with Falcon Creek		✓		
Dam break analysis is recommended to inform emergency planning and risk	✓		✓	
Detailed analysis of erosion potential and mitigation for all high risk watercourses	✓	✓	✓	✓
Re-evaluation of the proposed stormwater management strategy with due consideration for implications of timing of anticipated controls	✓	✓	✓	✓
Establish a monitoring framework	✓	✓	✓	✓
Note: Given the importance of assessing cumulative impacts, the above studies should be completed holistically, considering full future build out of catchment, including all development sites within the Mobility Hub.				
Studies Completed as Part of Site Specific Development Applications				
Flooding Hazard Assessment:				
Update hydraulic model based on detailed, accurate, site specific topographic information and map the regulated flooding hazard	✓	✓	✓	✓
Erosion Hazard Assessment:				
Determine and map the erosion hazard associated with confined valley systems and/or refine the unconfined hazard limit. Map the regulated erosion hazard.	✓	✓	✓	✓
Shoreline Hazard Assessment:				
Refine and map the flooding and erosion hazards associated with Lake Ontario	✓			
Stormwater Management (SWM) Assessment:				
Demonstration that all SWM Criteria (enhanced level of quality control, erosion and quantity control, water balance, etc.) required to mitigate development impacts is achieved in accordance with current guidelines.	✓	✓	✓	✓
Terrestrial and Aquatic:				
Additional field work may be required to address data gaps and uncertainties within the characterization of terrestrial and aquatic environments and hydrologic setting.	✓	✓	✓	✓
Hydrologic/hydrogeologic evaluation and water balance for wetlands (where applicable)	✓	✓	✓	✓
Monitoring	✓	✓	✓	✓

* These studies must be completed before acceptance of Site Specific Development Applications

** If these studies are deferred to a site specific development application, the first development to go forward would need to assess impacts associated with all development in the watershed within and adjacent to the Mobility Hub, similar to an EIR/FSS or SIS/EIR process applied in adjacent municipalities.

Detailed Requirements for Site Specific Development Applications for all the Mobility Hubs

APPENDIX A

1. Erosion Hazard:

The Mobility Hub Study Work Plan proposes to assess the extent of hazard associated with Confined Valley Systems through a desk top exercise considering conservative stable slope inclinations and toe erosion setbacks, based on available information. Future development applications on properties located adjacent to or containing a confined valley system will be required to complete the following:

- Top of bank staking in the field by Conservation Halton with an Ontario Land Surveyor (OLS);
- A Fluvial Geomorphic Assessment that assesses toe erosion (considering both current and anticipated future conditions);
- A slope stability assessment in accordance with current MNRF Guidelines, to the satisfaction of Conservation Halton. It is expected that the Geotechnical Assessment will require completion of site specific boreholes and survey of the slope.

Please note that for unconfined valley systems, the tasks associated with the work plan should be sufficient to assess the existing erosion hazard, however, additional works to clarify the extent of the development constraint associated with the meander belt component of the erosion hazard will be required for systems impacted by mitigation strategies (i.e., systems that may be 'day lighted' or otherwise altered), and for systems undergoing significant changes in hydrologic regime.

2. Shoreline Erosion Hazard:

For properties within the Downtown Hub impacted by the shoreline hazard the following will be required:

- A detailed topographic survey and geotechnical borehole analysis.
- Delineation of the erosion hazard and associated development setbacks.
- Assessment of shoreline protection works to ensure they meet current standards. The repair/ replacement/ reconstruction of shoreline protection works will be required if they do not meet current standards.
- A CH permit for the shoreline protection works.

Please note that Conservation Halton requires that the shoreline protection works meet current standards to ensure the erosion hazard is addressed, and to reduce development setbacks.

It is also recommended that pre-consultation be undertaken, as setbacks associated for Lake

Ontario can be significant and there are properties along this stretch where development would be restricted to replacement of no more than what currently exists.

3. **Floodplain Hazard:**

While the Area Specific Plan will provide some rough delineation of floodplain hazards, further refinement will be required in support of any site specific applications. The following analysis 'gaps' and associated study requirements will apply to each property containing or located adjacent to the floodplain hazard:

- The hydrologic and hydraulic models need to be validated through comparison with the measured and observed precipitation, runoff response, flows, and water levels. The validation process may trigger the need for further model calibration and refinement. Model sensitivity should also be assessed through this process.
- The available topographic data utilized in the hydraulic models is not sufficient for site specific property applications, and as such the model must be refined on the basis of detailed topographic survey or LiDAR data (of appropriate quality) to support individual property developments.
- Given the limited feasibility of eliminating the spill from Falcon Creek to the Grindstone Creek and Indian Creek Systems, detailed evaluation of the spill will be required to confirm appropriate downstream flood flows for each of the above listed watersheds. This will need to be assessed prior to any site specific development within the Grindstone Creek system.
- The 1- Dimensional steady-state modelling being refined and created may not be sufficient to assess the developed urban floodplain. 2-Dimensional modelling may be required to fully assess the flooding risks for site specific applications within the Aldershot, Burlington and Downtown Hubs (not anticipated for the Appleby Hub).
- While a preliminary investigation of potential downstream spill pathways has been considered, a full dam breach assessment has not been considered downstream of the Freeman and Triple Ponds or other on-line controls. Additional assessment may need to be undertaken pending the outcomes of the Mobility Hub Study's initial assessment

The above limitations will need to be addressed individually as each application advances, and will require additional effort to ensure data consistency. Gaps should be considered cumulatively and holistically for the entire development catchment to the extent feasible, by the first development to advance within each hub.

4. **Hydrologic Impacts to a Wetland:**

Specific hydrologic impacts to wetlands will need to be evaluated at a site specific stage as the existing models are not integrated groundwater/surface water models and the stormwater management strategies being advanced will be high level. To support development adjacent to a wetland, the following will be required:

- A hydrologic evaluation that demonstrates at minimum that there will be no negative

impact to the hydrologic functions of the wetland as result of the proposed development.

5. **Stormwater Management Criteria:**

Significant gaps are noted with respect to the establishment of Stormwater Management Criteria for the subject lands:

- The hydrologic modeling work relies on a variety of existing models, resulting in the establishment of stormwater management criteria based on numerous different modelling platforms of various degrees of currency. The models are to be updated relative to each of the hubs, but a watershed wide update is not considered within the Work Plan. Therefore, the stormwater management requirements associated with each watershed may not be as 'equitable' as if they were modeled using a consistent modeling platform. It is possible that watershed conditions associated with the planned development, particularly as described in the older hydrology studies (dated 1997 for Shoreacres, Appleby and the upper Hager Rambo Diversion System), may not fully correspond with actual development.
- The Work Plan does not include a requirement to calibrate or validate models using existing information nor does it include requirements to collect and calibrate or validate the existing models utilizing new calibration data. Conservation Halton staff had previously indicated through our comments on the ToR the need for validation of each hydrologic model as part of a subsequent phase of the study. Where validation results in a significant revision to flows, the stormwater management strategy must be reassessed to confirm that the required extent of mitigation is maintained.
- The hydrologic modeling work does not require continuous modeling or the determination of a critical erosion threshold, resulting in less robust analysis tools to assess channel erosion impacts and effectiveness of the mitigation strategy. Where the potential for 'high' erosion risk is identified, more detailed analysis (that considers cumulative impacts associated with full build out of the Mobility Hub) will be required to support a site specific mitigation strategy at the site plan stage.
- The Stormwater Management Strategy is being defined based on the 2003 MOE Stormwater Management Planning and Design Guide. It is anticipated that the MOECC's forthcoming LID Design Guide may significantly alter stormwater management practices, and may require re-assessment or significant revision to the SWM Strategy, when this Design Guide comes into effect.
- The Stormwater Management Strategy is based on an expectation that planning policies will protect against increases in impervious coverage over and above the maximum allowable under current and proposed zoning. At the site specific development stage, updated hydrologic modelling may be required should intensification increase impervious coverage beyond what was considered at the time of the Mobility Hub Study.
- Fractured ownership within each of the hub areas are anticipated to result in a series of

on-site controls, as opposed to development of communal, municipally controlled infrastructure. Timing impacts associated with the development of numerous site specific controls will not be fully assessed through the Mobility Hub Study. Development of a municipal site control strategy to address intensification concerns regarding ensuring maintenance of on-site stormwater management controls is also recommended.

Given the importance of assessing cumulative impacts, additional study prior to initiation of development is to be completed holistically, and have due consideration for the full future build out of the watercourse catchment, including other sites within the Mobility Hub. This assessment may be submitted as part of an enhanced Stormwater Management Design Brief.

6. **Monitoring:**

Monitoring, such as detailed geomorphic monitoring, has not been included in the work plan. Determination and completion of necessary pre and post-construction monitoring has been deferred to future study, and therefore may result in the delay of future site specific development while the pre-construction monitoring program is confirmed and sufficient baseline monitoring is completed.

7. **Terrestrial and Aquatic:**

Once, initial characterization work is completed, and more is known in terms of proposed land uses and potential impacts, additional field work may be required to address data gaps and uncertainties within the characterization of terrestrial and aquatic environments and hydrologic setting.

Conservation Halton

905.336.1158
Fax: 905.336.7014
2596 Britannia Road West
Burlington, Ontario L7P 0G3
conservationhalton.ca

Protecting the Natural Environment from Lake to Escarpment

April 20, 2018

BY EMAIL AND MAIL

Phil Caldwell
City of Burlington, Planning and Building Department
426 Brant Street, P.O. Box 5013
Burlington, Ontario L7R 3Z6

Dear Mr. Caldwell:

Re: Aldershot and Appleby Mobility Hubs – Flood Hazard Assessment Scoped Environmental Impact Study and Scoped SWM Assessment
Mobility Hubs - City of Burlington
CH File: MPR 653

Conservation Halton has reviewed the following report submitted to support the Mobility Hub Study in the Aldershot and Appleby Hubs:

- Amec Foster Wheeler's February 21, 2018 Memo Re: Aldershot and Appleby Mobility Hubs – Flood Hazard Assessment – Scoped EIS, City of Burlington.

Inclusion of file documentation including the creation of readme files documenting modelled changes are greatly appreciated, and strengthen the future utility of the models, report and analysis,

General Comments

There are three key comments that require further discussion with Conservation Halton to resolve. More detailed technical comments are provided in Appendix A:

1. **Flood Risk Analysis** – As noted in ***Section 2.2.1 Bi-Lateral Spills (Falcon Creek)***, there is a bi-lateral spill from Falcon Creek towards Indian Creek to the east and Grindstone Creek to the west. This has the potential to impact the extent of development potential within the Aldershot Hub. However, the spill from Falcon Creek has not been incorporated in the Flood Risk analysis for Grindstone Creek. The spill should be considered when evaluating flood risk and determining the extent of the regulatory floodplain in the Aldershot Hub study area, until such time that the spill is mitigated.
2. **Stormwater Management Ponds** – In past discussions regarding the Downtown and Burlington Mobility Hubs, Conservation Halton has requested that the hydrologic and hydraulic models incorporate scenarios with and without upstream infrastructure, in light of the unique circumstances surrounding the diversion system. The extent of the regulatory storm floodplain shown in Drawing 11 (Appleby Creek) is based on the crediting of upstream stormwater management facilities located north of the QEW. For the purposes of the Appleby Mobility Hub, the standard approach, based on Provincial Guidelines, should be used to define the regulatory storm floodplain.

3. **Redevelopment and Intensification within the Regulatory Floodplain** – The concept plan shows some redevelopment and intensification within the regulatory floodplain within the Aldershot and Appleby Mobility Hubs. Consideration for this type of development runs counter to Provincial Policy Statement policies (Section 3.1) and is not supported by Conservation Halton's Board-approved policies. Any redevelopment within regulated areas will require permission from Conservation Halton. We recommend that all concepts to facilitate intensification and redevelopment, including potential floodplain modifications, be aligned with Conservation Halton's planning and regulatory policies to ensure that permits can be supported.

Next Steps

For subsequent submissions, the inclusion of a detailed response matrix would facilitate a quicker review. We appreciate the opportunity to comment on the Mobility Hub Study and would welcome further dialogue to resolve the above issues. If you require additional information or have any questions please contact the undersigned at extension 2231.

Yours truly,

Heather Dearlove, B.Sc.
Environmental Planner

Cc: Ron Scheckenberger, Amec Foster Wheeler, email
Jonathan Pounder, Conservation Halton, email
Barb Veale, Conservation Halton, email
Hassaan Basit, Conservation Halton, email
Rosa Bustamante, City of Burlington, email

Appendix A: Detail Comments

Detailed Comments from the Review of the February 21, 2018 Memo

1. ***2.1.2.2 GAWSER Modelling (Grindstone and Falcon Creeks):***
   a. OMAFRA Soil mapping would appear to indicate great similarity between catchments GR 308 and GR307. The predominate use of a BC soil type for pervious portions of catchment GR308 (as indicated in Table 2.3) should be reviewed and clarified.
   b. The receiving outlet for catchment FL01 should be reviewed in greater detail. Conservation Halton's 2002 DEM confirms that catchment FL01 drains north to the hydrologic connection adjacent to the rail line, but indicates that this catchment drains westerly to Grindstone Creek as opposed to easterly to Falcon Creek. Review of the 2017 aerial photo indicates that the hydrologic connection is piped for approximately 250 m between the southern parking lot and railway until a point along the railway co-incident with the extension of Clearview Avenue. The ultimate receiver for FL01 should be reviewed in greater detail and the report updated accordingly.
   c. The analysis completed by Amec Foster Wheeler indicates that LaSalle Creek and Forest Glen Creek are not expected to receive drainage from the Aldershot Mobility Hub. Please confirm whether this statement is intended to apply to both major and minor system drainage, and provide supporting information (Based on Conservation Halton's topographic information, there appears to be limited gradient defining the watershed divide between Forest Glen and Teal Creeks, increasing potential for major system outflows from the Aldershot Mobility Hub to drain to Forest Glen Creek). Please review this potential, and update the report accordingly.

2. ***2.1.2.3 PCSWMM Modelling (West Aldershot Creek and adjacent Creeks):***
   a. Additional justification for the proposed SCS Soil Classification of BC for all catchments within the West Aldershot Creek is requested to be included within the report. Available OMAFRA mapping indicates the soil to be a Guelph Loam, which has a hydrologic soil classification of B. The Guelph Loam is surrounded by Grimsby Sandy Loam and Springvale Sandy Loam, both having a hydrologic soil classification of A.
   b. Additional justification for the proposed SCS Soil Classification of BC for the Teal Creek is requested to be included within the report. Available OMAFRA mapping indicates the soils within catchments S6, S7, S15, S19, and S74 to be either a Guelph Loam, which has a hydrologic soil classification of B or a Winnona Sandy Loam which has a hydrologic soil classification of AB.
   c. It is recommended that the final EIS contain Subcatchment Parameterization Tables for West Aldershot and Teal Creeks, as was done for Grindstone Creek and Falcon Creek.
   d. Flagging potential issues arising from direct application of the modeling from the 1995 Grindstone Creek Study by Cosburn, Patterson, and Wardman is appreciated. As the on-line ponds included in the Future Conditions Grindstone Creek model service areas that have not yet developed, and as flow rates indicated in Table 3.4 Appendix E of the 1995 Subwatershed Study indicate future condition regulatory flows will continue to exceed existing condition regulatory flows, Conservation Halton is supportive of directly applying the 1995 model to determine external flow contributions.

3. ***2.1.3.1 GAWSER Modelling (Grindstone and Flacon Creeks):***
   a. The tributary numbering convention from Grindstone Creek Subwatershed study (and described in Section 2.1.2.2 of the report) has not been followed in the drainage node location descriptors

included in Tables 2.5 and 2.6. The location descriptors should be revised to ensure consistency with the upper level study.

b. Conservation Halton has substantially different catchment areas associated with influent areas at Nodes G815 and G804 as compared to the values reported in Table 2.5. Conservation Halton's data indicates that Grindstone Creek Tributary 3 (Node G815) has an upstream drainage area of approximately 180 ha (as compared to the modelled drainage area of 96 ha), while node G804 identified in our GIS as having a contributing drainage area of 140 ha, as opposed to the modelled as 220 ha drainage area. Conservation Halton recommends that the drainage area contributions upstream of the two culverts be reviewed and updated in the report.

   Alternately, provided there is no development proposed between the tributary reach in question (between Nodes G815 and G804) and the QEW, and recognizing the current study approach represents the most conservative scenario, the potential discrepancy in drainage areas may be referenced in the report as an item that may require future investigation to support infrastructure or other future works within Grindstone Creek Tributaries 2 and 3 north of the Aldershot Mobility Hub.

4. ***2.2.1 Bi-Lateral Spills (Falcon Creek):***
   a. Given the significance of the high point elevation in the spill assessment, additional documentation confirming the noted high point spill elevation of 102.80 m will need to be included in the report.
   b. In regards to spill flow optimization, Conservation Halton would normally be supportive of advancing the assessment of flow to Grindstone Creek on the basis of full optimization of flows from Falcon Creek (i.e. allowing for concurrent spills to Indian Creek to reduce Falcon Creek flows, impacting spills to Grindstone). As there are discrepancies between the Falcon Creek spill to Indian Creek considered in the detailed design of the adjacent King Road Grade Separation and the optimized and non-optimized flows presented in Table 2.9, Conservation Halton is supportive of Amec Foster Wheeler's analysis approach, which advances consideration of Falcon Creek spills to Grindstone Creek independently of spill to Indian Creek within this higher level study. Conservation Halton would be in a position to support flood risk analysis in Grindstone Creek being based on flow optimization values presented in Table 2.9 following receipt and review of the Amec Foster Wheeler's 2018 hydraulic model assessing the extent of lateral spill.

      The optional future work analyzing spill to Grindstone Creek based on optimization of Falcon Creek flows to both Grindstone and Indian Creeks concurrently should only be undertaken in conjunction with the collection of more detailed topographic information.
   c. Text within Section 2.2.1 appears to indicate confusion over Conservation Halton's expectations related to flow optimization and spills. As a point of clarification, Conservation Halton looks to have non-optimized flows utilized for the 'spilling' watercourse (in this case Falcon Creek) to protect downstream capacity within the system should grades be adjusted to eliminate spills in future, i.e. spill flows out of a system should not be recognized as reducing flows downstream within the same system. Conservation Halton does not require spill assessments within the watersheds receiving spills (in this case Indian Creek and Grindstone Creek) to be based on non-optimized flow conditions, recognizing that under non-optimized flow conditions, spills would be prevented and not occur.

5. ***3.1.2.2 GAWSER Modelling (Shoreacres & Appleby Creeks), page 23:***
   a. Additional discussion and examples are required to clarify Amec Foster Wheeler's approach of maintaining the parent catchment's length and width parameter ratios for the additional

catchments further discretized from the parent catchment. While the goal of maintaining a consistent lumped catchment response is appreciated, the concept of application of an area based weighting to parameterize routing within re-discretized subcatchments is not a standard practice. Additional discussion is required before Conservation Halton will be in a position to support this approach as part of the Mobility Hub Study. A greater understanding of the following is required:

i. Which catchments were altered and how?
ii. How closely do area averaged routing parameters represent the actual routing for the re-discretized catchments?
iii. What limitations does the use of this approach place on future use of this model? How sensitive is the outcome of the Mobility Study and future studies to flows calculated internal to the original subcatchments, i.e. what is the impact of the approach, are there any foreseeable model uses that would rely on accurate model representation at a point internal to the parent catchment?

b. The regional conditions Appleby Creek model maintains route reservoir functions associated with the Rotary Pond, while the regional conditions Shoreacres model maintains route reservoir commands for a number of reservoirs. To ensure the extent of the regulatory floodplain is characterized in accordance with MNRF Technical Guidelines, a regional model run for Appleby Creek should be completed without the Route Reservoir command for the Rotary Pond. Similar adjustments to the updated Shoreacres models are not required, as the regulated floodplain associated with Shoreacres Creek does not intersect the Appleby Mobility Hub. Please update the model and report accordingly.

c. The proposed approach of scaling pervious area characteristics on the basis of extent of pervious cover in the initial subcatchment can be supported where the current impervious coverage is understood to have been representative of the extent of impervious coverage at the time of the initial model. The scaling approach applied is not expected to be reflective of potential changes in the proportion of pervious coverage parameters where new impervious areas have been introduced in catchments with multiple pervious characteristics. While the work completed for the Mobility Hub study is accepted as sufficient for the purposes of Secondary Planning, this approach is not generally supported for future projects. For future studies, pervious coverage parameterization should be modelled based on the best available information. No changes to the analysis is required.

d. Table 3.7 shows a decrease in anticipated impervious coverage for parent catchment A5 (a catchment located south of the QEW within a built up area). Please review the ortho photography for this area and confirm the appropriateness of the proposed modelled impervious coverages. Please review and update the report accordingly.

6. ***3.1.3.1 GAWSER Modelling (Shoreacres & Appleby Creeks):***

a. The 1:100 year flow reported at node 6101 (in Table 3.9) is significantly higher than expected given the reported drainage area. The model and table should be reviewed more closely and updated as required.

b. The 135 ha increase in drainage area between nodes 651 and 607 is not clear based on the information presented in Drawing 9. Please review and update as required.

c. While sufficiently outside of the detailed study area, such that additional model refinements are not anticipated, additional consideration may be warranted as to why Table 3.9 indicates a disproportionate flow increase between nodes 601 and 641. Additional clarification is required.

7. ***3.2.3.1 Appleby Creek, page 36:*** 2-D modelling is indicated as required to more definitively confirm spill extent upstream of the railway crossing and east and west of the Appleby GO station. From a regulatory development constraint perspective, 2-D modelling will not be required. The recommended approach from a regulatory perspective would be to define the spill point (based on the topographic location where flow is no longer directed towards Appleby Creek), and mitigate the spill through a combination of grading outside of the regulated limit and/or infrastructure improvements (larger culverts/twinned culverts, etc.).

8. ***3.1.3.2 HSP-F Modelling (Sheldon Creek), page 34:*** Tables 3.11 and 3.12 refer to the location of Node 105.1 as Mainway. The nodal description should be updated to be reflective of the location indicated in Drawing 10.

9. ***Drawing 1 – Study Area Plan (Aldershot Area):*** Drawing 1 excludes several culvert crossings under the CN tracks which are identified in Conservation Halton's mapping and appear to be supported by the downstream channel formations visible in the Halton Region's orthophoto imagery – including two crossings west of Waterdown Road within the study area and one downstream. It is also noted that there is a culvert connection across the QEW connecting Tributary 4 to the downstream feature. For clarity it is recommended that all culverts or pipes be included within the stream flow network to ensure flow pathways are clarified. Please update the drawing to include all culvert or pipe connections within the study area.

10. ***Drawing 3 – Subcatchment Boundary Plan:***
    a. The inclusion of specific study references for external drainage areas is appreciated. For completeness, please provide a copy of the catchment plans associated with referenced reports within an appendix of the final report as this will increase future report utility.
    b. The boundary plan does not include all nodes identified in Table 2.5 and 2.6. Please update the drawing for completeness.

11. ***Drawing 4b Preliminary Floodplain Mapping (Grindstone Creek – East of Waterdown Road):*** The regulatory floodplain elevation provided hydraulic cross sections 19, 0.800, and 0.750 is slightly greater than what has been modelled. Please update the drawing accordingly.

12. ***Drawing 9 Subcatchment Boundary Plan (External Drainage Areas):*** Please review and revise for clarity the letter assigned to node 601, and the placement of node S641

13. ***Drawing 11 Preliminary Floodplain Mapping (Appleby Creek):*** The provided hydraulic cross section identification labels associated with Reach 2 should be revised for consistency with the hydraulic model.

14. ***Grindstone Creek Hydraulic Model – Upstream of Waterdown Road and Grindstone Creek Hydraulic Model – Downstream of Waterdown Road:*** Neither of the two Grindstone Creek hydraulic models incorporates the calculated spill flows from Falcon Creek. To support the analysis of future development potential, the flood risk from this spill must be considered, and the floodplain limits updated accordingly.

15. ***Grindstone Creek Hydraulic Model – Upstream of Waterdown Road:*** The following minor issues/concerns related to the Grindstone Creek Hydraulic Model – Upstream of Waterdown Road need to be clarified or resolved as part of future studies, but <u>are not</u> anticipated to significantly impact the extent of the floodplain to the point where these issues need to be addressed as part of the City's Secondary Planning Study:
    a. Hydraulic cross sections 20 and 0.15 needed to be extended unless they can be shown to relate to a spill.

b. Standard conventions for modelling expansion and contraction and Manning's n associated with the Parking Lot/403 on-ramp at approximate hydraulic cross section 14 do not appear to have been followed. Please review and revise bounding hydraulic cross sections accordingly.

c. The hydraulic cross section spacing adjacent to the Waterdown Road culvert and CNR crossings may not have properly accounted for the full expansion and contraction zones around the structures, as the distance to up and downstream cross sections was reported to be less than the culvert opening.

d. The ineffective flow station elevations applied to upstream and downstream hydraulic cross sections bounding structure 0.25 are greater than the minimum top of road elevation modelled. Ineffective flow stations should be adjusted as per conventions or justification provided.

e. Bank station widths should be adjusted to be more representative of existing conditions.

f. Flow stations should be updated to ensure consistency with final models. Minor discrepancies were noted related to the flow change at Hydraulic Cross Sections 1, 0.45, and 0.224. Updates for consistency will be required as part of future site specific studies.

16. ***Grindstone Creek Hydraulic Model – Upstream of Waterdown Road:*** The following minor issues/concerns related to the Grindstone Creek Hydraulic Model - Downstream of Waterdown Road need to be clarified or resolved as part of future studies, but <u>are not</u> anticipated to significantly impact the extent of the floodplain to the point where these issues need to be addressed as part of the City's Secondary Planning Study:

    a. Main channel widths must be updated relative to existing site conditions.

    b. Overbank Manning's n values in the lower portion of reach M4 should be updated to reflect naturalized conditions.

    c. Levees or ineffective flow areas should be added to cross sections within the upper reach of M4.

    d. Flow stations should be updated to ensure consistency with final models. Minor discrepancies were noted related to the majority of flow change stations for the Regional model. Updates for consistency will be required as part of future site specific studies.

17. ***Appleby Creek Hydraulic Model:*** The following concerns are expected to have impactful changes to the modelled regulatory water surface elevation and <u>are</u> to be addressed as part of the Mobility Hub Study:

    a. Main channel bankfull stations must be reviewed and updated as necessary to be representative of existing conditions within the Mobility Hub area and the relevant hydraulic distance extending beyond the Mobility Hub boundary.

    b. Justification for selected main channel and overbank Manning's n values in River 1 Reach 2 is required where the values selected differ from the provided Table (see the last page of Appendix A) or the model should be adjusted to apply more standardized overbank and main channel Manning's n values within the limit of hydraulic relevance to the Mobility Hub.

    c. The expansion and contraction zones around crossing structures do not appear to have been modelled in accordance with recommended HEC RAS conventions. Review and refinement of the modelled expansion and contraction zones around the following hydraulic crossings is required: 2710, 2825, and 3460.

    d. Model stability within the majority of the Mobility Hub study area should be reviewed, and refinements made as the hydraulic model repeatedly defaults to critical depth across multiple sequential cross sections. Adjust the model and update accordingly.

18. ***Sheldon Creek Hydraulic Model:*** The following concerns are expected to have impactful changes to the modelled regulatory water surface elevation and are to be addressed as part of the Mobility Hub Study:
    a. Flow change nodes have been applied downstream of crossing structures, despite catchment mapping from previous studies indicating flow contributions would be based on catchments located upstream of crossing structures. Please update the flow change locations or provide justification supporting the proposed flow change location.
    b. Please ensure that non-calibrated flows have been incorporated for the entire portion of the downstream study area and a hydraulically significant upstream distance.
    c. Model stability within the majority of the Mobility Hub study area should be reviewed, and refinements made as the hydraulic model repeatedly defaults to critical depth across multiple sequential cross sections.
    d. Main channel bankfull stations must be reviewed and updated as necessary to be representative of existing conditions within the Mobility Hub area and the relevant hydraulic distance extending beyond the Mobility Hub boundary.
    e. Justification for selected main channel Manning's n value of 0.03 is required. There are also opportunities to adjust overbank Manning's n values, outside of the municipal creek corridor to be more reflective of existing conditions, should the above changes increase the extent of flooding.
19. **Sheldon Creek Hydraulic Model:** Additional concerns with the Sheldon Creek Hydraulic model have been expressed in Conservation Halton's letter of related to the City's Floodplain Modelling Update for Sheldon Creek. Conservation Halton will require further refinement of the Sheldon Creek model (relative to several of the issues flagged in the letter), as part of future study updates in support of specific development applications.
20. It may be beneficial to explore accuracy of available topographic mapping sources, as Aquafor Beech has been retained by the City of Burlington to explore flood risk and mitigation potential within Appleby Creek downstream of the Fairview Road. Preliminary modelling and mapping prepared by Aquafor Beech has indicated higher flood elevations within the Bridelwood neighborhood, but despite the increased modelled water surface elevation determined by the Aquafor Beech model, their floodplain mapping does not show the regulatory floodplain extending beyond or substantially into any of the residences along Bridlewood Crescent.

Recommended Overbank Manning's n Values:

In reviewing potential standards to be applied as part of internal watershed wide floodplain mapping efforts, Conservation Halton staff are considering the following criteria. While Conservation Halton staff do not require modelling to be updated to reflect values in the below table, justification within the report is required should the Engineer choose to select alternate Manning's n values as more representative for a given land use. Please note that for publicly owned channel corridors, it is expected that a Manning's n value of 0.08 be applied for the entire overbank corridor width. Alternate values may be accepted where publicly owned lands extend within the regulated floodplain but are outside of the 'channel corridor', i.e. for sports fields, manicured parks, etc.

Recommended Overbank Manning's n Values		
	Existing Condition	**Manning's 'n'**
Channel	Concrete	0.015
	Armourstone or gabions	0.025

	Vegetated or Natural Rock	0.035
Floodplain	Asphalt/Concrete	0.02
	Manicured Grass/Lawns – rural, within 30 m of watercourse*	0.08
	Manicured Grass/Lawns – urban, within 30 m of watercourse and in public ownership or large estate lots*	0.08
	Manicured Grass/Lawns, Other	0.045
	Pasture – within 30 m of watercourse*	0.08
	Pasture – other	0.045
	Crop – within 30 m of watercourse*	0.08
	Crop – other	0.045
	Field/Meadow – within 30 m of watercourse*	0.08
	Field/Meadow – other	0.055
	Brush and Wooded	0.08

Appendix C

Hydrologic Modelling Files

Appendix D

Hydraulic Modelling Files

wood.

Appendix G

Stream Rehabilitation Opportunities

MEMO

GeoProcess RESEARCH ASSOCIATES
Knowledge Research Consulting

October 20, 2021

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

Re: Burlington Mobility Hub
Stream Rehabilitation Opportunities – Appleby and Aldershot Mobility Hubs

Dear Mr. Bourassa:

GeoProcess Research Associates Inc. (GRA) was retained by Dillon Consulting Limited (Dillon) in 2017 to complete a preliminary geomorphic assessment of several watercourses to identify potential geomorphic constraints as part of Environmental Impact Studies for the future development of four Mobility Hubs in the City of Burlington. Based on Agency comments, it was requested that additional details be provided on the potential watercourse rehabilitation opportunities for the Appleby and Aldershot Mobility Hubs. This memo outlines watercourse rehabilitation options to be considered during the site-specific development phases. The recommendations are classified by reach, per the 2017 assessment (for consistency and ease of comparison). These opportunities were informed by the 2017 field assessment data and, as such, should be verified in future phases of the project due to the actively adjusting watercourse conditions documented in many of the assessed reaches. Two accompanying maps illustrate the 2017 reach delineations and provide representative photos of the field conditions and rehabilitation opportunities.

1. Appleby Mobility Hub

Reach	Rehabilitation Opportunities
SHC01	SHC01 was previously rehabilitated with cobble bed and bank material for erosion protection. The reach was stable at the time of the 2017 field assessment and no rehabilitation measures,m are recommended based on the 2017 conditions.
SHC02	SHC02 is within a confined valley having approximately 20 m of available floodplain. The 2017 field assessment indicated active widening of the shale banks as the dominant mode of adjustment, with some locations of valley toe contact. Despite the indicators of adjustment, it is expected that the bedrock banks will be more resilient than the sandy till bank material in the downstream reaches. Potential rehabilitation opportunities include assessing locations of valley toe contact and mitigating toe erosion risk, should it

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

	be deemed a threat to infrastructure. The benefit of rehabilitation here will need to be weighed against potential impacts associated with access and riparian removal within the confined, well-vegetated valley.
SHC03	SHC03 exhibited some signs of widening during the 2017 assessment. However, coarse cobbles and boulders were present and providing erosion protection in many areas. This reach is more constrained than the upstream reaches with less available floodplain. As such, rehabilitation opportunities are limited to modifications to the bankfull channel (e.g. width-depth improvements and naturalized erosion protection) and the removal of woody debris present throughout the reach. Also, the feasibility of removing the channel spanning weir at the downstream end of the reach should be investigated.
SHC04	SHC04 had a similar level of valley confinement and erosion protection (toe stones) as SHC03. As such, rehabilitation opportunities are limited to improvements within the bankfull channel, similar to SHC03. There was a 0.5 m headcut present at the approximate midpoint of the reach, with the channel downcutting downstream of this feature. This local instability should be stabilized to mitigate further instabilities propagating upstream towards the Harvester Road culvert.
SHC05	SCH05 exhibited indicators of channel instability during the 2017 field assessment. Given the greater floodplain availability and construction access potential (leveraging the public trails) within SHC05, there are opportunities to provide naturalized erosion protection at locations where rapid bank erosion is occurring. Floodplain benches can be added to reconnect the frequent flow regime to the floodplain, providing additional energy dissipation to further reduce erosive forces.
APC01A	APC01A was found to be unstable with remnants of failed, legacy erosion protection measures throughout the reach. Rehabilitation opportunities consist of a reach-scale design incorporating naturalized erosion protection of the bed and banks and removing the existing gabions and riprap. The downstream portion of the reach has opportunities to promote additional energy dissipation employing floodplain benches given the less confined valley.
APC01B	There were instances of woody debris accumulation within APC01B that were causing localized instabilities (e.g. a small headcut at the approximate midpoint of the reach). Rehabilitation opportunities include the strategic removal of woody debris and select locations where existing erosion protection has failed. Concurrent with these removals should be the evaluation of localized naturalized erosion protection measures should they be deemed necessary.
APC02	APC02 was in a state of adjustment with instances of failed erosion protection throughout the reach. Rehabilitation opportunities include rehabilitating the concrete spillway at the upstream end to a series of steps and pools for increased energy dissipation. Additionally, the removal of all failed concrete grade control structures and gabion baskets can be replaced with naturalized erosion protection measures.
APC03	APC03 was a trapezoidal channel having several failed concrete grade control structures. Rehabilitation opportunities consist of revegetation of the corridor in concert with the replacement of the concrete grade control structures with more naturalized erosion protection such as armourstone or boulder steps. The feasibility of maintaining the trapezoidal channel lining while integrating the rehabilitation measures should be further investigated.
APC04	APC04 is in a confined valley with commercial and residential buildings close to the valley wall. The erosion protection was found to be degrading. As such, rehabilitation opportunities include the removal of existing gabion bank protection bring replaced with naturalized bed and bank protection (e.g. vegetated buttresses and riffle-pool morphology bed features).

2. Aldershot Mobility Hub

Reach	Rehabilitation Opportunities
GST01	GST01 was depositional due to vegetation encroachment within the bankfull channel. Despite the deposition, the previously realigned reach is well-vegetated with available floodplain access. As such, rehabilitation efforts should be focused on downstream reaches.
GST02	GST02 was in adjustment, exhibiting signs of downcutting and widening. This reach is in a natural woodlot with more confinement than GST01. Rehabilitation opportunities include bankfull channel modifications (e.g. width-depth improvements and naturalized erosion protection measures). However, any rehabilitation measures within this reach require additional feasibility assessment to balance construction impacts (i.e. the removal of mature trees within the woodlot) with potential improvements gained through the rehabilitation efforts.
GST03	GST03 was a channelized reach lined with concrete matting. The matting was generally stable with limited degradation. This reach should be monitored as future degradation of the existing erosion protection measures may result in reach-scale instabilities given the valley confinement throughout the reach. It should be noted that since the 2017 assessment, a portion of this reach immediately upstream of Waterdown Road has been reconstructed to accommodate the construction of a stormwater management facility.
GST04	GST04 is in a confined valley and the 2017 field assessment revealed frequent valley toe contact and erosion. Rehabilitation opportunities should consider assessing the erosion risk associated with the valley wall contact and associated stability of the valley slopes. If erosion risks are present, integrated bed and bank (valley toe) protection can be implemented.
GST05	GST05 had an abundance of construction debris resulting in localized erosion of the valley toe. Rehabilitation opportunities include removing the debris and replacing with a naturalized grade control and valley toe protection. These efforts can be integrated with potential opportunities discussed for GST04.
GST06	GST06 is in a less confined valley with more floodplain access than the upstream reaches. While indicators of instability were noted in the 2017 field assessment, rehabilitation opportunities should be focused in the more confined, erosion-prone reaches.
GST06i	Despite GST06i being assessed as unstable, the reach is situated in a mature woodlot and thus potential rehabilitation opportunities (removal of debris and failed concrete structures) should be weighed against potential impacts due to the rehabilitation (impacts to the woodlot).
GST07	GST07 was found to have an enlarged cross-section due to both downcutting and widening. However, it was suggested that adjustments have occurred at slower rates owing to the more resilient bed and bank material. Rehabilitation opportunities in this reach should focus on further determining the resiliency and, if warranted, increasing the floodplain connectivity through the implementation of bankfull benches.

Rehabilitation opportunities should be prioritized based on erosion risk to existing infrastructure and potential degradation to the aquatic environment. Some of these opportunities also overlap with existing planned watershed activities and should consider recommendations and phasing outlined in those studies (for example the 2020 Appleby Creek Erosion Control EA). Based on the 2017 field assessment, reaches with the most valley confinement and toe erosion (e.g. APC1-4, GST4-5) should be subject to further study to evaluate existing and future erosion risk. Based on the site-specific erosion risk, rehabilitation solutions can be refined and prioritized. Please do not hesitate to contact the undersigned should you have any questions about the information contained in this memo.

Regards,

GEOPROCESS RESEARCH ASSOCIATES INC

Jeff Hirvonen, MASc
Principal

Ben Plumb, PhD, P.Eng.
River Engineer

600000
600500
601000
4804500
4804000
4803500

SHC01
SHC02
SHC03
SHC04
SHC05
QEW
Harvester Road
APC01B
APC01A
APC02
APC03
APC04
Appleby Line












Legend

- Study Area
- Watercourses
- Reach Breaks
- Contours (1 m)

N

0 100 200 300 metres

GeoProcess RESEARCH ASSOCIATES

CREATED BY:	BDP	PROJECT NO.:	P2017-237
CHECKED BY:	JPH	DATE:	Oct 19, 2021

Coordinate System: NAD83 - UTM Zone 17N

NOTE: Refer to accompanying memo for description of rehabilitation opportunities. Information based on 2017 field assessment and should be verified at future project phases.

APPLEBY MOBILITY HUB

GEOMORPHIC REHABILITATION OPPORTUNITIES

592500
593000
593500
4796000
4795500




GCT01
GCT02
GCT03
GCT04
GCT05
GCT06
GTC06i
GCT07

QEW
Waterdown Road
Plains Road E
Plains Road W

Legend

- Study Area
- Watercourses
- Reach Breaks
- Contours (1 m)

N

0 100 200 300 metres

GeoProcess RESEARCH ASSOCIATES

CREATED BY:	BDP	PROJECT NO.:	P2017-237
CHECKED BY:	JPH	DATE:	Oct 19, 2021

Coordinate System: NAD83 - UTM Zone 17N

NOTE: Refer to accompanying memo for description of rehabilitation opportunities. Information based on 2017 field assessment and should be verified at future project phases.

ALDERSHOT MOBILITY HUB

GEOMORPHIC REHABILITATION OPPORTUNITIES

References

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

Borisko, J. 2002. Water Quality Monitoring with Benthic Macroinvertebrates. Citizen's Environment Watch. Toronto.

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.

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. 2013. Long Term Environmental Monitoring Program Grindstone Creek, Sixteen Mile Creek and Supplemental Monitoring for 2011. Conservation Halton, Burlington, ON. 177 pgs.

CH. 2013. Conservation Halton Fisheries Database.

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 Creek 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.

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.

Jones, C., K. Somers, B. Craig and T. Reynoldson, 2005. Ontario Benthos Biomonitoring

Network Protocol Manual v. 1.0. Ontario Ministry of Environment, Environmental Monitoring and Reporting Branch, Dorset, Ontario.

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.

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

Ontario 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.

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

Ontario Ministry of Natural Resources and Forestry (MNRF). 2015. Significant Wildlife Habitat Criteria Schedules for Ecoregion 6E.

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

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

Ontario 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.

Savanta Inc. 2015 1200 King Road Environmental Impact Assessment (EIA). January 6, 2015. 96 pgs.

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