9 DESCRIPTION OF THE RECOMMENDED PLANS FOR THE SUBWATERSHED AND RSA (RURAL SETTLEMENT AREA)

9.1 General

Environmental baseline conditions for the study area were described in **Chapter** 4. **Chapter** 6 outlined potential impacts from future development. **Chapter** 7 identified a suite of alternatives and selected a preferred alternative to meet subwatershed goals and objectives. Building on all of that, this chapter summarizes the overall Management Strategy for the study area. The Strategy is explained as it applies to the two portions of the study area, namely the Rural Settlement Area and the Subwatershed Area. The discussion primarily focuses on targets related to surface water, groundwater, and natural heritage plans.

9.2 Rural Settlement Area Plan

9.2.1 RSA Surface Water Plan

The previous chapter (**Chapter** 7) identified a set of preferred stormwater management alternatives to meet the identified subwatershed goals and objectives. This Section summarizes the overall water budget targets and Stormwater Management Strategy for the Rural Settlement Area, including the recommended water deficits, control measures and stormwater targets to be applied. These strategies are in conformance with Guidelines for Hydrogeological Studies and Technical Standards for Private Services (City of Hamilton, 2013).

9.2.1.1 Water Balance Targets

As noted in **Chapter** 6 **(**Impact Assessment**)**, without controls, the impervious surfaces associated with future urban development will reduce the capacity of the site to infiltrate rainfall events into the groundwater system, creating an increase in the volume of surface water runoff instead.

As reviewed in **Chapter** 4, soils in the Greensville RSA consists primarily of sand loam in the north and silty sand loam in the south, towards the Escarpment. The water balance calculations indicate that annual infiltration ranges between 197 mm (for a silt loam with moderately-rooted vegetation) and 215 mm (for a sand loam, shallow-rooted vegetation). An overall annual infiltration target of 210 mm was selected as representative of the entire RSA.

For the study area, water balance estimates (**Section 4.4.4**) indicate that, without stormwater controls, impervious surfaces associated with future development will reduce the proportion of precipitation that is capable of infiltrating to replenish groundwater. For example, if a

residential development on a 1-acre (0.4 hectare) lot reduces pervious surfaces by 15% (i.e. 600 square metres impervious surfaces on a 4,000 square metre lot), the infiltration deficit would be 31.5 mm annually (15% of 210 mm). A 15% decrease represents a loss of 127 m^3 of groundwater recharge per year on that lot, equivalent to 4 months of water demand of a family of four.

Water balance estimates for the study area indicate that in order to overcome the anticipated recharge deficit resulting from residential development within areas underlain by silt loam and sand loam soils, future infiltration measures would be required to capture and infiltrate a volume of 127 m^3 of groundwater recharge per year on a typically 1 acre residential lot under private services.

The above groundwater recharge targets can be achieved by incorporating appropriate LID source control techniques within future urban development, as recommended as part of the preferred alternative (**Section 7.9**). For example, runoff from residential roofs and rear yards may be used to maintain groundwater recharge through a variety of LID techniques. Chapter 9 includes implementation considerations in that regard.

9.2.1.2 Water Quality Targets

The MOE Stormwater Management Planning Manual (MOE, 2003) defines specific water quality control storage targets for stormwater facilities. The targets are based on:

- the type of facility (i.e., stormwater pond, infiltration facility, etc.);
- the landuse within the contributing area (in terms of an impervious component); and
- the level of control required.

Regarding the level of control required (last point), the Hamilton Conservation Authority requires that stormwater management facilities provide "Level 1" or "Enhanced" level of protection as defined in the MOE Manual (i.e., 80% long-term suspended solids removal). Regarding the type of facility (first point), both the ***preferred*** and ***alternate*** stormwater management strategies (**Section 7.9**) offer various water quality control techniques which can be used to achieve the water quality control target.

The following discussion defines water quality targets associated with stormwater management measures constituting the preferred stormwater management strategy. These measures include:

- Traditional Measures: Wet Ponds;
- Traditional Source Controls; and
- LID Source Controls

Traditional Measures - Wet Ponds

Wet ponds utilize a permanent pool of water for quality control by settling pollutants (i.e., suspended sediment) from stormwater runoff. A typical stormwater management pond was illustrated in **Figure 7.8.1**. In addition to providing water quality control, stormwater ponds may also provide temporary detention storage above the permanent pool to attenuate runoff, thereby lowering outflow rates for flood and erosion control.

To provide control for the anticipated future residential and industrial development within the Rural Settlement Area, the following target storage volumes are proposed following the recommendations of the MOE Stormwater Management Planning Manual (MOE, 2003). Level 1 of water quality control will be provided following the guidelines of the City of Hamilton Criteria and Guideline Document (City of Hamilton, 2007). Accordingly, and based on the two key land uses under future development conditions within RSA, water quality targets are:

- Residential development (approx. 50% impervious) - 105 m^3/hectare, of which:
  - 138 m^3/ha is permanent pool storage; and
  - 40 m^3/ha is extended detention, or "active" storage.

- Industrial development (approx. 80% impervious) - 145 m^3/hectare, of which:
  - 202 m^3/ha is permanent pool storage; and
  - 40 m^3/ha is extended detention, or "active" storage.

For ponds which, in addition to providing water quality control, also provide erosion and/or flood control, the "active" water quality control storage requirement can be incorporated into the larger erosion/flood control extended detention storage requirements.**Table 9.2.1** illustrates in detail the storage volumes required for permanent pool volume and extended detention.

Traditional Source Controls

For small development sites less than 5 hectares in size, the *alternate* stormwater management strategy (**Section 7.9**) recommends the use of traditional on-site controls to meet water quality targets. For example, within future industrial development, oil-grit separator devices may be used to treat stormwater runoff from parking lots and driveways where many urban pollutants tend to accumulate. These devices are also effective in trapping fuel and chemical spills that may take place in these areas.

LID Source Controls

LID source controls are recommended primarily to achieve the water balance objectives (**Section 9.2.2**). However, many of the LID source control techniques also provide water quality control benefits through the reduction of runoff volumes and/or filtration of runoff. Most substances within urban stormwater are in the form of suspended solids which can be

filtered and trapped when stormwater infiltrates through a pervious media such as sand. Therefore, the use of LID source controls which promote infiltration for groundwater recharge, will also provide additional water quality benefits. By providing some water quality treatment at the source, LID techniques will help to reduce the maintenance requirements at other downstream treatment facilities such as stormwater ponds (sites > 5 hectares) and/or oil-grit separator devices (sites < 5 hectares).

9.2.1.3 Flood and Erosion Control Targets

Several of the stream reaches located downstream of the future development lands have been classified as being susceptible to erosion and flooding (**Section 4.5** and **Section 6.2)**. Through the recommendations of the Stormwater Management Strategy, the necessary stormwater detention storage will be provided within the end-of-pipe stormwater ponds, or within traditional on-site controls for small sites less than 5 hectares (*alternate* stormwater management strategy).

The hydrological model used to estimate flow rates within the study area for existing conditions (**Chapter** 4**)**, and future conditions (i.e. new development) (**Chapter** 6) was applied to estimate storage requirements for future stormwater detention facilities. Reservoir routing was added to the model to simulate future stormwater facilities. The results of the model were as follows:

- For erosion control, outflows for the 2-year storm were controlled to pre-development rates, and outflows less than the 2-year storm were overcontrolled to minimize potential in-stream erosion from the most frequent storm events. The range of storage required for erosion control (as it varies among development areas) is between 111 and 214 m^3/ha (average = 128 m^3/ha) (**Table 9.2.1**)
- For flood control, storage volumes were increased within the model reservoirs until the runoff rates for the 100-year storm events were controlled back to pre-development rates. The range of storage required for erosion control is between 333 and 588 m^3/ha (average = 392 m^3/ha)of storage is required for flood control (**Table 9.2.1**).

Table 9.2.1 shows a summary of storage targets and volumes required for water quality, erosion, and flood control purposes. The location of the stormwater management facilities is shown in **Figure 9.2.1**. With respect to the stormwater ponds, it is noted that the illustrated locations of the ponds are conceptual in nature. Final locations will be determined in future studies (Refer to Chapter 9 for further explanation).

9.2.1.4 Stormwater Management Strategy

The Stormwater Management Strategy for the Rural Settlement Area has been formulated through consideration of the proposed future urban development, its impact on the existing

environmental resources of the area, together with input from the City, relevant agencies and the public. As outlined in the proceeding sections, the strategy consists of two key measures:

- Low Impact Development (LID) source controls;
- Wet ponds for catchment areas 5ha or more, *OR* traditional source controls for catchment areas of less than 5ha.

Table 9.2.2 outlines the respective environmental benefits and stormwater targets for each of these measures. Specific details related to stormwater management targets are articulated in **Table 9.2.2**, with a summary of the preliminary sizing characteristics of the stormwater ponds. The ultimate location and size of any stormwater ponds will be dependent upon several factors to be examined during the future stages of development, including:

- Development phasing / timing;
- Land ownership;
- Topography and proposed subdivision grading;
- Road layouts / grades;
- Storm sewer outlets and elevations; and
- Stream corridor definition through future top-of-bank surveys and setbacks.

Table 9.2.1: Summary of Location and Sizing of the Proposed Stormwater Management Ponds within the Rural Settlement Area

SWM Facility*	Catchment Name	Catchment Area (ha)	New Development	Permanent Pool Storage for Water Quality (m^3)	Extended Detention for Water Quality (m^3)	100 Year Flood Control Storage (m3)	Active Flood/Erosion Control Storage (m^3)	Total Pond Volume (m3)	Erosion Control Unit Storage (m3/ha)	Flood Control Unit Storage (m3/ha)
1-1	1	10.9	1	1497.6	434.1	3910	4344	5842	111	360
1-2	1	6.4	2	879.2	254.8	2310	2565	3444	111	363
2-2	2	10.9	1	1499.2	434.5	3930	4365	5864	111	362
2-3	2	8.3	3	1670.7	330.8	4860	5191	6862	214	588
2-4	2	4.6	9	633.4	183.6	2230	2414	3047	113	364
6-1	6	5.7	6	786.8	228.1	2140	2368	3155	121	375
7-1	7	6.1	7	841.8	244.0	2030	2274	3116	115	333

* Refer to **Figure 9.2.1**for conceptual SWM Pond locations.

Table 9.2.2: Summary of Stormwater Management Strategy Components for the New Development

Components:	**Groundwater Resources**	**Water Quality**	**Erosion/Flood Control**	**Aquatic/Terrestrial Resources**
Low Impact Development (LID) Source Controls:				
Targets:	*In order to overcome the anticipated recharge deficit resulting from residential development within areas underlain by silt loam and sand loam soils, future infiltration measures would be required to capture and infiltrate a volume of 127 m^3 of groundwater recharge per year on a typically 1 acre residential lot;*			
Benefits:	- maintain groundwater recharge rates;	- improved water quality through removal of suspended contaminants	- moderate reductions in stormwater runoff	- protect stream baseflows and improved water quality
Wet Ponds (catchment area > 5ha) and Traditional Source Controls (catchment area <5ha)				
Targets:		- Level 1 (normal) water quality control - residential landuses (50%impervious): 138 m^3/ha permanent pool, 40 m^3/ha active storage - industrial landuses (80%impervious): 202 m^3/ha permanent pool, 40 m^3/ha active storage	- overcontrol of events up to 2-year storm for erosion control: ranging from 111 to 214 m^3/ha (average = 128 m^3/ha) active storage (**Table 9.2.1**); - post-to-pre runoff control for flooding: ranging between 333 and 588 m^3/ha (average = 392 m^3/ha) active storage (**Table 9.2.1**)	
Benefits:		- improved water quality through settling and capture of suspended contaminants	- prevent increases in runoff rates which could otherwise worsen existing downstream erosion and flooding	- improved water quality

Mid-Spencer Creek / Greenville Rural Settlement Area Subwatershed Study

Legend

- Watercourses
- Floodline
- Catchment

Catchment Area for Development

- Catchment Area >5ha (Wet Pond)
- Catchment Area <5ha (Traditional Source Controls)
- 1-1 Stormwater management Pond (quality and quantity control)

Note: Final location of SWM facilities to be defined upon completion of Functional Servicing Study. Facilities must be located outside of any environmentally significant areas as defined by City, HCA, MNRF or other policy.

FIGURE 9.2.1

Stormwater Management Facilites for Water Quality /Erosion and Flood Control

Aquafor Beech Limited

9.2.2 Rural Sttlement Area Groundwater Plan

Groundwater is the sole source of drinking water within the Greensville RSA. The reliability and sustainability of groundwater quantity and quality are the dominant concerns for both the Middle Spencer Creek Subwatershed and the Greensville RSA in particular.

From **Chapter 4**, it was determined that more than 60% of groundwater recharge occurs when precipitation infiltrates through the soils to the water table, with the remainder from groundwater flow across the RSA towards the Escarpment. The amount of groundwater recharge depends on the permeability of the soils.

As reviewed in **Chapter 4**, soils in the Greensville RSA consists primarily of sand loam in the north and silty sand loam in the south, towards the Escarpment. The water balance calculations indicate that annual infiltration ranges between 197 mm (for a silt loam with moderately-rooted vegetation) and 215 mm (for a sand loam, shallow-rooted vegetation). An overall annual infiltration target of 210 mm was selected as representative of the entire RSA.

Without controls, impervious surfaces associated with future development will reduce the proportion of precipitation that is capable of infiltrating to replenish groundwater. For example, if a residential development on a 1-acre (0.4 hectare) lot reduces pervious surfaces by 15% (i.e. 600 square metres impervious surfaces on a 4,000 square metre lot), the infiltration deficit would be 31.5 mm annually (115% of 210 mm). A 15% decrease represents a loss of 127 m^3 of groundwater recharge per acre on that lot, equivalent to almost 4 months of water demand of a family of four.

Groundwater withdrawals in the RSA were based on an average urban consumption of 285/person/day (1171.5 litres/day for a family of four). Existing and build-out water demands are shown in **Table 9.2.3**. Total demand is 24% of the infiltration under existing conditions, rising to 36% under build-out conditions.

Table 9.2.3: Water Demand in the Greensville RSA under Existing and Build-Out Conditions (No Controls)

Water Demand – Existing Conditions for 2,525 residents (m3/year)	Demand as a % of Infiltration from Precipitation Alone	Demand as a % of All Groundwater Recharge	Water Demand – Build-out Conditions 1267 wells and 3,793 residents* (m3/year)	Demand as a % of Precipitation Infiltration alone	Demand as a % of All Groundwater Recharge
262,663	24	14	394,567	36	21

*From Earthfx (2010b), based on a family of 4 per new well

Steady-state groundwater modeling by Earthfx (2010b) demonstrated that under existing and full build-out conditions, drawdowns were generally less than one metre and concluded that full build-out conditions (an additional 317 wells) would be sustainable under normal climate conditions.

The addition of another 317 individual Class 4 septic systems (septic tank & tile bed) will have an impact on groundwater quality, which is considered here for nitrates alone. A properly functioning septic system processes 40 grams of nitrate per day and an additional 317 septic system would increase the input of nitrate by 12 kg/day overall, sufficient to raise the average nitrate concentration in groundwater by approximately 2 mg/L (**Figure 9.2.2**). The effect decreases as the infiltration rate increases. Lot sizing and low-impact development will mitigate the impact of nitrates.

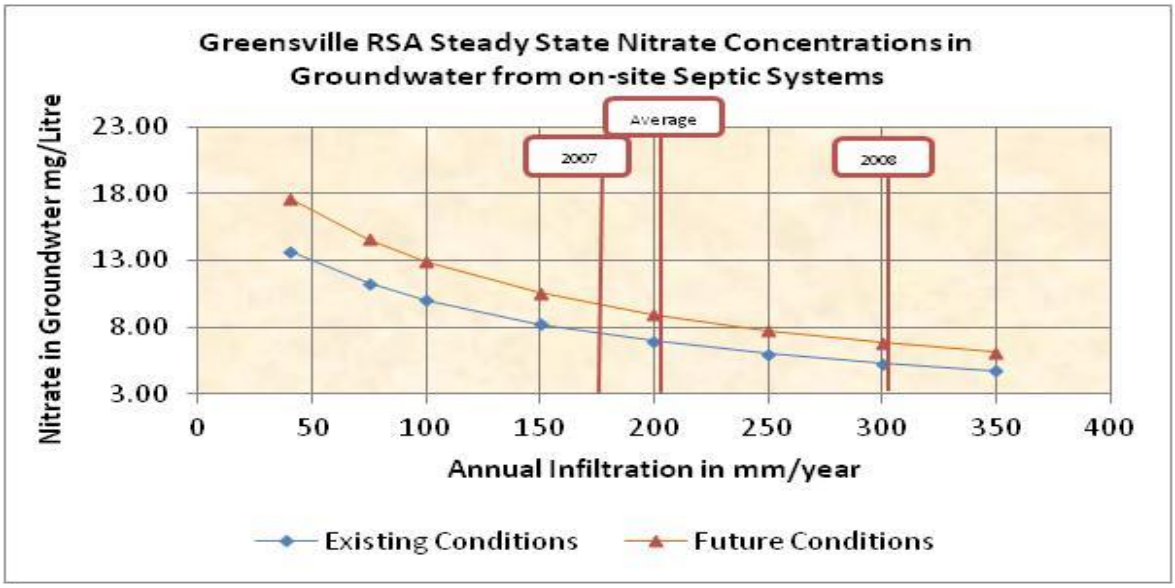


Figure 9.2.2: Greensville RSA Steady State Nitrate Input from Septic Systems under Existing and Future Conditions with Infiltration Rates shown for an Average Year, for 2007 (dry year) and 2008 (wet year).

It is important to emphasize that in a 2004 survey, 53% of Greensville residents indicated that their septic systems were between 25 years and 50 years old and 3% of the systems are more than 50 years old. Failing septic systems was identified as a problem 20 years ago.

The well head protection area (WHPA) for the Greensville municipal well (**Figure 4.4.21**) extends north through the Meldrum/Wesite development (*circa* 1955) and the Village Green development (*circa* 1975) and west across Brock Road/Moxley Road. Development controls will be required to protect the well from contamination.

9.2.3 Rural Settlement Area Natural Heritage Plan

The Revised Natural Heritage System within the RSA is comprised of a preliminary Natural Heritage System (NHS) as provided by the City of Hamilton, and additional Natural Heritage Features outside of the preliminary NHS as identified by Aquafor Beech Limited. Natural heritage features outside of the preliminary NHS were identified in accordance with the definitions provided in the City of Hamilton Official Rural and Urban Plans, as appropriate. Together, these natural heritage features are refered to as the *Revised Natural Heritage System*. The process for defining the Revised Natural Heritage System within the Greensville RSA is discussed above in **Section 4.7.** The following section briefly outlines the definitions Aquafor Beech Limited used to identify components (i.e. natural heritage features) of the NHS. Implementation is discussed in **Chapter 7,** above.

To briefly summarize what was detailed in **Section 4.7**, the Greensville Natural Heritage System is comprised of *Core Natural Areas* and *Linkages*. Definitions for Core Natural Areas and Linkages are found in (**Table 9.2.4**) and (**Table 9.2.5**):

Table 9.2.4: Core Natural Areas

1. Key Natural Heritage Features	2. Key Hydrologic Features	3. Local Natural Areas
a) Significant habitat of endangered, threatened, and special concern species	a) Permanent and intermittent streams	a) Environmentally Significant Areas (ESAs), as defined by the City of Hamilton
b) Fish Habitat	b) Lakes (and their littoral zones)	b) Unevaluated Wetlands
c) Life Science ANSIs	c) Seepage areas and springs	c) Earth Science ANSIs
d) Wetlands	d) Wetlands	
e) Significant Valleylands		
f) Significant Woodlands		
g) Significant Wildlife Habitat		
h) Sand barrens, savannahs, and tallgrass prairies		
i) Alvars		

Table 9.2.5: Linkages

	1. Streams and watercourses that connect core areas	2. Woodland linkages	3. Other natural vegetation types
Rural OP	All.	Any natural or planted wooded area of any size or composition that either connects or lies within 100 m of a Core Area.	Any meadow, thicket, or old field that connects Core Areas or is situated within 100 m of a Core Area.
Urban OP	All.	Any natural or planted wooded area of any size or composition of 0.5 ha or more in size that either connects or lies within 100 m of a Core Area.	Any meadow, thicket, or old field at least 0.5 ha in size that connects Core Areas or is situated within 100 m of a Core Area.

As previously mentioned, per the Mid-Spencer Subwatershed Study Terms of Reference particular attention was paid to the Greensville RSA because the RSA is the only area of development interest within the subwatershed. Detailed fieldwork, spanning multiple years, was conducted in order to characterize the Natural Heritage Features within the RSA. The baseline subwatershed conditions assessment and NHS characterization process are described in **Section 4.6** and **Section 4.7**, respectively.

A brief summary of the Natural Heritage Features within the RSA is provided below:

- A total of twelve (12) woodlands were identified outside of the preliminary NHS (see **Figure 4.7.5**). Of these, eight (8) meet the City of Hamilton's criteria for Significant Woodlands, and one (1) met other criteria for inclusion as a Core Natural Area. Two (2) woodlands did not meet the criteria for Core Natural Areas, and were included in the revised NHS as Linkages.
- A total of nine (9) wetlands were identified outside of the preliminary NHS (see

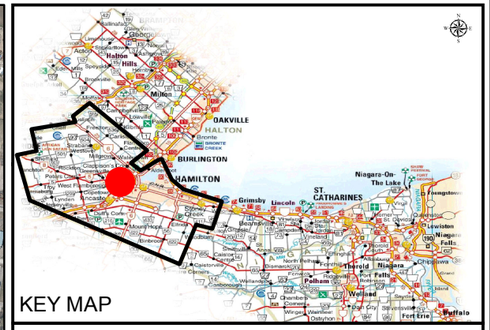
- **Figure 4.7.4**). All were included in the Revised NHS as Core Natural Areas.
- A number of permanent and intermittent streams are present throughout the RSA. All watercourses within and adjacent to the RSA are considered direct or indirect (contributing) fish habitat.
- Outside of the preliminary NHS, the following Core Natural Heritage Features are not present:
    - ANSIs;
    - Significant valleylands;
    - Lakes;
    - Seepage areas and springs;Sand barrens, savannahs, tallgrass prairies; and
    - Alvars.
- Aside from watercourses, within the RSA Linkages are comprised of five (5) woodlands and ten (10) other natural vegetation types.

Elements of the Revised Natural Heritage System for the RSA

In order to provide further context to the Revised NHS, the Key Natural Heritage Features and Key Hydrologic Features that make up Core Natural Heritage Features within the RSA are illustrated on one map along with Linkages (**Figure 9.2.3**, below).

Preliminary minimum Vegetation Protection Zones (VPZs), discussed in **Section 4.7.5**, are included within the Revised NHS. However, inclusion of these VPZs would render the map difficult to read. As such, VPZs are included in the final Opportunities and Constraints mapping, located in **Section 4.8**.

Per the request of the City of Hamilton, Core Natural Heritage Features and Linkages within the Revised NHS within the RSA are illustrated separately rather than as one single layer: Core Natural Heritage Features are illustrated in red and Linkages are illustrated in yellow. Also per the City's request, hazard lands (e.g. floodplain) are also illustrated on these maps (**Figure 9.2.3).**



KEY MAP

LEGEND:

- Mid-Spencer Creek Subwatershed Boundary
- Rural Settlement Area
- Parks
- Wetland
- Preliminary Natural Heritage System
- Significant Woodland
- Floodplain
- Significant Wildlife Habitat and/or SAR Habitat

Resvised Natural Heritage System

- Core Areas
- Linkages
- Hedgerow

FishHabitat

- Direct Fish Habitat
- Indirect (Contributing) Fish Habitat

NOTES:

* Status to be confirmed through future study

0 125 250 500

Meters

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GREENSVILLE SUBWATERSHED STUDY

Details of the Revised Natural Heritage System Within The Rural Settlement Area

FIGURE: 9.2.3

DATE: February 2016

9.3 Subwatershed Plan

9.3.1 Subwatershed Surface Water Plan

The recommendations of the Stewardship Action Plan for the Middle Spencer Creek Subwatershed (HCA, 2011) reveal that stormwater management is a priority within the Middle Spencer Creek watershed. The recommendations of the Action Plan include the following:

- Efforts should be made to implement measures as recommended in the City of Hamilton Stormwater Master Plan;
- The guidelines of the City of Hamilton's Greensville Community Subwatershed Study should be followed;
- Aquatic habitat restoration is needed where on-line ponds act as barriers and fragment aquatic habitat;
- Habitat restoration may involve removing or retrofitting on-line ponds;
- Sediment and nutrient loading is an issue within the watershed. Two sites responsible for non-point sediment sources were assigned high priority:
    - One site of active erosion behind the properties along Newton Avenue;
    - Potential for sediment release when Crooks Hollow dam is removed (now completed)

As part of discussing opportunities to alleviate stresses related to water quality and flooding issues, the Action Plan recommends the following stewardship actions:

Stormwater Management

- Identify opportunities for restoration as recommended in the City of Hamilton Stormwater Master Plan;
- Offer financial incentives to replace driveways and decks with permeable pavement, interlocking brick, etc;
- Promote the City of Hamilton and Green Venture Programs for water conservation and green building;
- Retrofit dry ponds to wet ponds;
- Promote the use of constructed wetland technology and Low Impact Development (LID) in the design of stormwater management facilities. In that regard, the Action Plan calls for water quantity and quality benefits;

Impervious Surface Management

- Create demonstration sites to show BMPs and LID measures;
- Incorporate a proportionally impervious surfacing fee for large commercial/industrial areas;

- Enhance groundwater recharge to enhance water balance;

Stormwater Runoff Water Quality

- Undertake studies to determine best snow management practices
- Liase with city in regard to road salt management
- Investigate the use of the Region of Waterloo salt management guidelines (i.e. Smart About Salt Program)

Sediment Loading

- Maintain a Total Suspended Sediment Solid target (PWQO) and turbidity recommendations between 5 and 50 NTU);
- Work to mitigate non-point sediment sources identified in the Watershed Planning Network Priority Remediation Report;
- Ensure phasing of site clearing prior to development by contractors;
- Work with landowners to reduce sediment loading by implementing BMP projects including streambank stabilization structures, riparian buffers, and natural channel design

Stormsewer System and Outfalls

- Undertake water quality studies to evaluate water quality at outfalls;
- Work with City staff to retrofit outfalls;
- Work with landowners to disconnect downspouts and install rain barrels;
- Reduce stormwater load to meet the MOECC volumetric target of a 90% overflow capture rate for combined sewer systems

9.3.2 Middle-Spencer Creek Subwatershed Surface Water Plan

The Middle Spencer Creek Subwatershed: Stewardship Action Plan (Hamilton Conservation Authority, 2011) identified three main surface water stresses within the Middle Spencer Creek subwatershed:

- Surface water takings for agriculture;
- Storm sewer outfalls;
- Septic systems
- Erosion and sediment loading; and,
- Stream degradation (on-line pond, agricultural encroachment, perched culverts, insufficient riparian buffers, debris jams and channelization).

Water takings:

There are forty-four active permits to take water (PTTW) in the Middle Spencer Creek subwatershed.

The Hamilton Conservation Authority (HCA recommended that efforts to coordinate and reduce these water takings, especially surface water takings, should be taken during low water conditions. The HCA staff should continue to review permit applications, both new and renewal, focusing on assessing the cumulative impacts of multiple takings on one system. HCA staff should also recommend to the Ministry of the Environment and Climate Change (MOECC) that ecological impacts of water takings should also be considered by the MOECC when reviewing permit to take water applications.

Mitigation steps recommended by the HCA include:

- Encourage landowners with surface water takings to install groundwater systems;
- Encourage landowners with water taking needs to establish an Irrigation Advisory Committee to schedule takings alternately.
- Host open houses when experiencing Level 1 low water conditions to address landowner concerns and promote recommended reductions in rates and volumes of takings.
- Utilize workshops, information sessions, literature, websites, public service announcements, interpretive signage & direct landowner contact to promote BMP's relating to water conservation technology;
- Develop monitoring program to assess impacts of surface water takings on creek systems and aquatic wildlife during periods of low water, include recommendations for reducing impacts.

Lead agencies: Hamilton-Halton Watershed Stewardship Program HHWASP) and the HCA.

Partner agencies: the Ministry of Natural Resources, Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA).

Reference: OMAFRA Best Management Practices Series – Irrigation Management

Stormwater and Storm outfalls

Anecdotal reports and ecological monitoring have identified sediment loading and subsequent nutrient loading as a concern in the Middle Spencer Creek Subwatershed.

The Hamilton Harbour Remedial Action Plan 2009 draft document on Non Point Sediment Sources, identifies two sites for priority remediation; one site of active erosion behind the properties along Newton Avenue and the release of sediment following the removal of Crooks Hollow dam.

The following recommendations were proposed:

- An assessment of stormwater impacts on this site and a remediation plan should be developed by the Spencer Creek Stewardship Action Plans Implementation Team. The potential for sedimentation associated with the removal of the Crooks Hollow dam has been addressed through the Crooks Hollow Site Remediation Project (**Appendix L**);
- Utilize workshops, information sessions, literature, websites, public service announcements, interpretive signage & direct landowner contact to promote stormwater management BMP's including: disconnected downspouts, roof gardens, rain barrels, biofilters, permeable pavement, rain gardens, etc.
- Promote the City of Hamilton Public Works Stormwater Pollution Solutions for Urban and Rural Residents Outreach Program
- Development code: Host annual training sessions for City staff & developers to create awareness regarding the incorporation of development related BMPs into planning applications (i.e. pervious pavement, low maintenance lawns, green rooftops, storm water management, road-salt alternatives, snow-piling, erosion & sediment control measures, compliance & enforcement, etc.)

Reference documents: Credit Valley Conservation and Toronto and Region Conservation Authority Low Impact Development Stormwater Management Manual; HCA Planning and Regulation Policies and Guidelines; City of Hamilton Stormwater Master Plan Class Environmental Assessment Report

Lead Agencies: Hamilton Conservation Authority and the City of Hamilton

Partner Agencies: Hamilton-Halton Watershed Stewardship Program (HHWMS)

Faulty Septic Systems

Aging, poorly maintained system with plugged distribution lines and infrequently pumped tanks lead to untreated sewage contaminating our ground and surface water. The Stewardship Action Plan recommended the following:

- Create demonstration sites on public lands that highlight properly functioning septic systems;
- Utilize workshops, information sessions, literature, websites, public service announcements, interpretive signage & direct landowner contact to promote the proper maintenance of existing septic systems
- Develop a tax reduction incentive or grant program for upgrading faulty septic systems
- Analyze existing water quality data for high levels of bacteria, chlorides, phosphorous, nitrates and TKN and cross reference the results against land use data to prioritize areas for education outreach and restoration.

Reference documents: City of Hamilton Guidelines for Hydrogeologic Studies and Technical Standards for Private Services, Rural Hamilton Official Plan, Hamilton-Halton Watershed Stewardship Program – Septic Awareness in Rural Hamilton

Information sources include:

Ontario New Home Warranty Program – A New Homeowner's Guide to Septic Systems
http://www.ovhi.ca/library/Septic_HomeOwnersGuideTo.pdf

CMHC Evaluating the Performance of On-Site Sewage Disposal Systems:
http://www.cmhc-schl.gc.ca/odpub/pdf/62689.pdf?lang=en

CMHC – Buying a House with a Well and Septic System
http://www.oowa.org/resources/PDF/CMHC_well_septic.pdf

CMHC – Your Septic System
http://www.oowa.org/resources/PDF/CMHCHomeOwnerSeptic.pdf

CMHC - Innovative On-site Wastewater Treatment
http://www.cmhc-schl.gc.ca/odpub/pdf/62739.pdf

City of Hamilton – Residential Pollution Prevention
http://www2.hamilton.ca/NR/rdonlyres/E24A4294-D402-42AA-9904-C71CD4B39A6B/0/P2ResidentialPollutionPreventionSepticSystems.pdf

Ontario Rural Wastewater Centre and MOE – Your Septic System: Protecting your Investment and the Environment
http://www.uoguelph.ca/orwc/Resources/documents/SepticBrochure-NewFormat_V7-ONLINE.pdf

Ontario Rural Wastewater Centre – At Home Solutions for your Onsite System
http://www2.hamilton.ca/NR/rdonlyres/4A689EA6-8E94-4F9A-9B6E-8AD5F0BDDF01/37776/SepticSystem.pdf

Hamilton-Halton Watershed Stewardship Program – Is Your Septic System Functioning Properly?
www.conservationhamilton.ca/images/PDFs/Planning/Stewardship%20Resources/Septic_System_Factsheet.pdf

Lead Agency:	The Hamilton-Halton Watershed Stewardship Program
Partner Agencies:	The City if Hamilton, Hamilton Conservation Authority

Conduct an inventory to determine how many households in the Spencer Creek watershed are serviced by on-site treatment systems.

9.3.3 Subwatershed Groundwater Plan

The Middle Spencer Creek Subwatershed Stewardship Action Plan (Hamilton Conservation Authority (2011) reveals that water quality problems recognized in the Greensville RSA are found across the entire Middle Spencer Creek Subwatershed. For example:

- The HCA identified at least 28 abandoned groundwater wells in the subwatershed , representing direct conduits to groundwater aquifers.
- The 2012 test results compiled by the City of Hamilton (Hamilton Rural Well Water Quality Report) show that 24% of water samples taken from private residential wells and cisterns with the City have unsafe levels of bacteria.

The stewardship plan provided several recommendations to address groundwater in the Middle Spencer Creek Subwatershed:

- Utilize workshops, information sessions, literature, websites, public service announcements, interpretive signage & direct landowner contact promote the importance of decommissioning abandoned groundwater wells to protect drinking water and prevent human and wildlife injury;
- Conduct a direct mailing to all property owners identified in the HCA and Groundwater Study database as having abandoned groundwater wells onsite;
- Promote legislation related to decommissioning and/or upgrading groundwater wells and the City of Hamilton Well Decommissioning Program. The Hamilton-Halton Watershed Stewardship Program states that funds are available through the City of Hamilton to assist landowners with the cost of decommissioning their abandoned water wells. Residents may be eligible to receive 100% financial assistance to decommission a well up to a maximum of $1,000 per well, with a limit of two wells per property. Information is available through the Hamilton Conservation Authority.

Lead Agency: Hamilton-Halton Watershed Stewardship Program.

Partner Agencies: City of Hamilton and Hamilton Conservation Authority,

Information sources include:

City of Hamilton – Private Well Water Supplies

http://www.hamilton.ca/HealthandSocialServices/PublicHealth/SafeWater/WellWater.htm

City of Hamilton – Questions Related to Water Well Results

http://www.hamilton.ca/HealthandSocialServices/PublicHealth/SafeWater/PrivateInterpretationResults.htm

OMAFRA Best Management Practices Series – Water Wells BMP12 (Revised 2003)

Ontario Ground Water Association, Ontario Federation of Agriculture – Well Aware. A Guide to Caring for your well and protecting your family's health.

http://www.protectingwater.ca/protectingWater/uploads/WellAware.pdf

WellAware.ca, available on the internet:

http://www.wellaware.ca/downloads/WA_Booklet_2011_FINAL%20July%202011.pdf

Septic systems

In 2004 Septic Awareness Survey was conducted for the City of Hamilton with questionnaires sent to over 4,000 address in the rural communities of Carlisle, Freelton, Greensville, and Lynden as well as to households within a 1-kilometre radius of the community boundaries. A total of 992 responses were received, representing 24% of mailings.

Of interest was that 34% of respondents stated that their septic systems were between 25 and 50 years old. Given that a properly designed, operated and maintained septic system can last for 25 years or more, this statistic has worrisome implications.

The HCA recommended conducting demonstration projects, workshops, information sessions, literature, websites, public service announcements, interpretive signage & direct landowner contact to promote septic awareness and the proper maintenance of existing septic systems.

Information sources include:

Ontario New Home Warranty Program – A New Homeowner's Guide to Septic Systems

http://www.ovhi.ca/library/Septic_HomeOwnersGuideTo.pdf

CMHC Evaluating the Performance of On-Site Sewage Disposal Systems:

http://www.cmhc-schl.gc.ca/odpub/pdf/62689.pdf?lang=en

CMHC – Buying a House with a Well and Septic System

http://www.oowa.org/resources/PDF/CMHC_well_septic.pdf

CMHC – Your Septic System

http://www.oowa.org/resources/PDF/CMHCHomeOwnerSeptic.pdf

Lead Agency: The Hamilton-Halton Watershed Stewardship Program

Partner Agencies: The City if Hamilton, Hamilton Conservation Authority

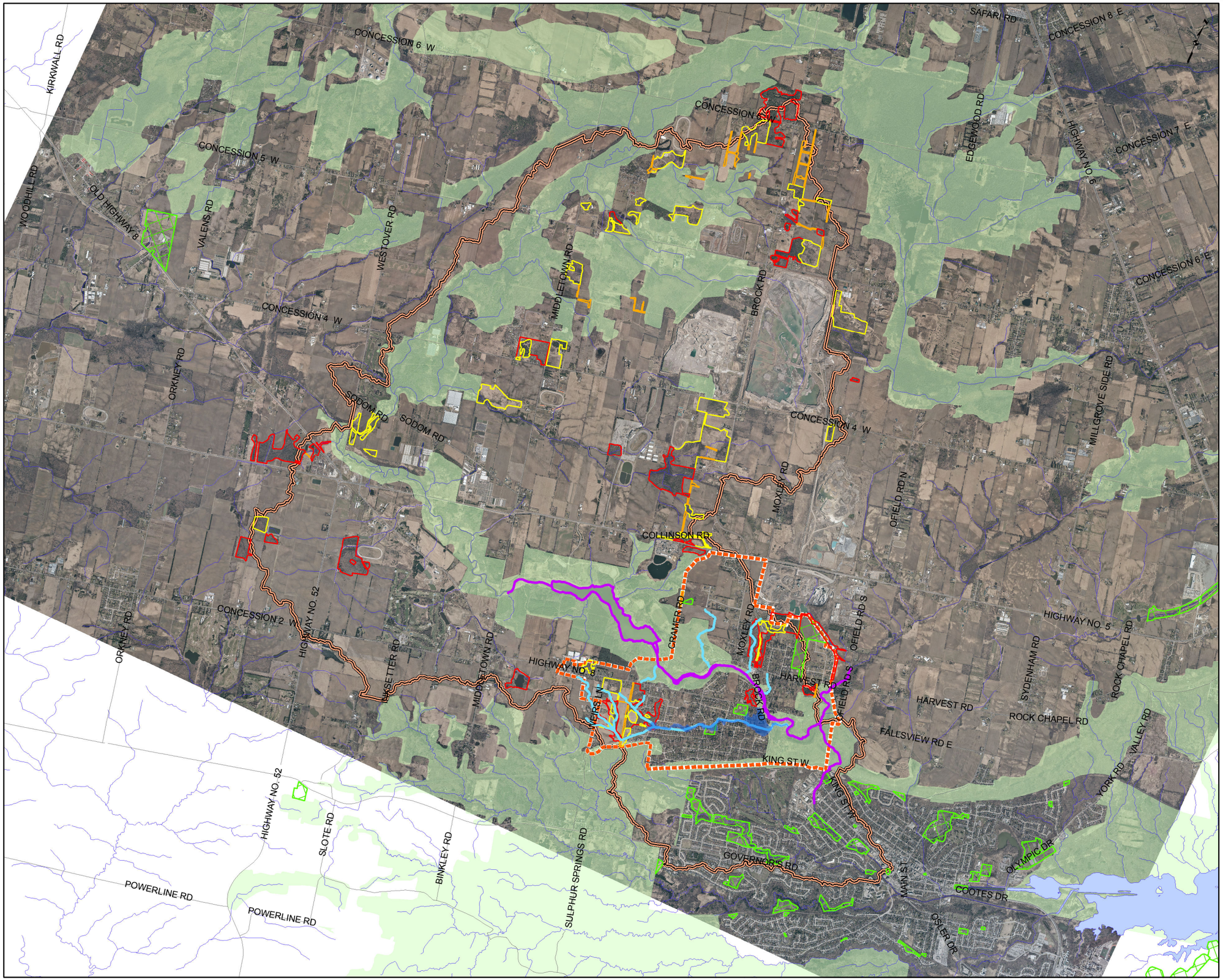
9.3.4 Subwatershed Natural Heritage Plan

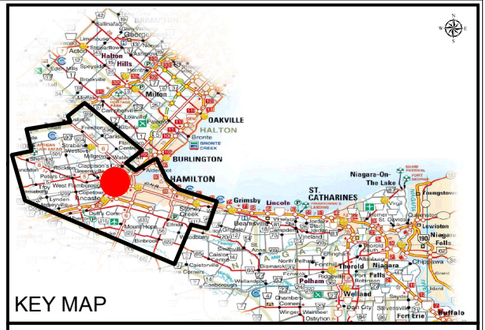
The Revised Natural Heritage System is comprised of Core Natural Heritage Features and Linkages, as described above in **Section 4.7** and summarized in **Section 9.2.3**. Individual elements of the Revised NHS are detailed and illustrated in **Section 4.7.4**. Natural heritage features outside of the preliminary NHS were identified using a combination of air photo interpretation, reconnaissance and roadside site visits, and select detailed vegetation community studies. As lands outside of the RSA were not slated for development, detailed assessments of natural heritage features and their candidacy as Key Natural Heritage Features and/or Key Hydrologic Features was not analysed. Vegetation community information was used at a high-level to ascertain the applicability of Core Natural Heritage Feature and Linkage status of each vegetation community identified outside of the Preliminary NHS.

A summary of the Core Natural Heritage Features and Linkages within the the Mid-Spencer/Greensville Subwatershed outside of the preliminary NHS and the RSA is provided below:

- A total of thirty (30) vegetation communities qualify as Core Natural Heritage Features (17 in Zone A, 11 in Zone B, and 2 in Zone C). Of these, 6 are wetland communities, 2 are alvars, 14 are upland wooded communities (e.g. forest, woodland, plantation), and 8 are thicket or meadow communities.
- A number of watercoursess are present throughout the greater subwatershed study area. The majority of stream length is contained within the preliminary NHS, though some headwater areas are located outside of the preliminary NHS.
- Outside of the preliminary NHS, the following Core Natural Heritage Features were not identified:
    - ANSIs;
    - Significant valleylands;
    - Lakes;
    - Seepage areas and springs; and
    - Sand barrens, savannahs, tallgrass prairies.
- Aside from watercourses, a total of seventy two (72) vegetation communities qualify as Linkages (45 in Zone A, 25 in Zone B, and 2 in Zone C).

A map of the Revised Natural Heritage System for the Mid-Spencer/Greensville Subwatershed is provided below in **Figure 9.3.1**.





LEGEND:

- Rural Settlement Area
- Mid-Spencer Creek Subwatershed Boundary
- Watercourse
- Parks

Resvised Natural Heritage System

- Core Areas
- Linkages
- Hedgerow
- Preliminary Natural Heritage System
- Floodplain

FishHabitat

- Direct Fish Habitat
- Indirect (Contributing) Fish Habitat

NOTES:
All watercourses are considered Core Areas

0 0.5 1 2 3
Kilometers

Aquafor Beech Limited

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Hamilton ON
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Fax: (905) 546-4435

GREENSVILLE SUBWATERSHED STUDY

Revised Natural Heritage System:
Entire Subwatershed Area

FIGURE: 9.3.1

DATE: February 2016

The Greensville Natural Heritage System Plan, includes areas within and outside of the Revised NHS recommended for rehabilitation and enhancement (**Section 9.3.5**, below), and aims to maintain and in some cases enhance the ecological function of the existing natural heritage features on the landscape. The following subsection details rehabilitation and enhancement opportunities within the Mid-Spencer Creek/Greensville Subwatershed study area. Per the request of the City of Hamilton, the decription of each enhancement area is illustrated on an accompanying map. These maps are located in **Appendix K**.

9.3.5 Rehabilitation and Enhancement Opportunities: Overview

The Revised NHS was reviewed to identify opportunities to enhance the attributes of constituent Core Areas and Linkages, including watercourses, by rehabilitating/creating natural cover (e.g. tree planting). Further reccommendedations related to drainage and infrastructure improvements are outlined in **Section** Drainage and Infrastructure Improvement Works**10.4.2**.

Attributes of Core Areas considered for enhancement include size, completeness, shape and potential for connectivity. Attributes of Linkages considered for enhancement include ecological function, scale, and crossing opportunities. A full list of the attributes of Core Areas and Linkages considered for enhancement is provided by **Table 4.7.8** and **Table 4.7.9** of the *Natural Heritage Reference Manual* (NHRM), respectively (MNR 2010).

Environment Canada has published a framework for guiding habitat rehabilitation (*How Much Habitat Is Enough?* 2004). The framework contains scientifically-based recommendations for minimum targets for forest, wetland, and riparian cover to sustain minimum viable wildlife populations and maintain selected ecosystem functions and attributes. **Table 9.3.1** below, provides a comparison between the guidelines in *How Much Habitat is Enough?* and the available natural land cover statistics of the Greensville Subwatershed Study Area from the *Middle Spencer Creek Stewardship Action Plan* (HCA 2011). Aquafor Beech Limited staff considered existing natural land cover deficiencies, as illustrated in **Table 9.3.1** below, when identifying areas for, and types of, rehabilitation and enhancements. Accordingly, the main foci of the Rehabilitation and Enhancement recommendations below are enhancing riparian buffer coverage and increasing forest cover, though other habitat types and rehabilitation measures are briefly mentioned. These opportunities are outlined below in **Sections 9.3.5.1** to **9.3.5.7**. For ease of mapping and interpretation, Rehabilitation and Enhancement Opportunities are organized by Area (e.g. Areas A – G), and are shown in **Appendix K (**See **Appendix K**, **Figure 1** for the location of each Area within the Subwatershed). As per the direction of the City of Hamilton, rehabilitation opportunities included in this document are not a comprehensive list of all candidate sites. Rather, candidate sites represent areas where the most ecological benefit will be

gained from rehabilitation and enhancement activities. Further information regarding site-specific rehabilitation opportunities are found in the aforementioned *Middle Spencer Creek Stewardship Action Plan* (HCA 2011).

Table 9.3.1: Summary of Natural Land Cover Types in the Greensville Subwatershed.

Natural Land Cover Type	Percentage of Natural Land Cover Type		Difference	Action
	How Much Habitat is Enough? Guideline	Middle Spencer Creek Subwatershed *		
Forest (overall)	30.0%	12.6%	-17.4%	More forest cover needed
Interior Habitat (as measured 100m from the forest edge)	10.0%	14.0%	4.0%	Interior habitat 100m from forest edge exceeds guideline
Interior Habitat (as measured 200m from the forest edge)	5.0%	1.8%	-3.2%	More interior habitat 200 m from forest edge needed
Wetlands	6.0%	6.4%	0.4%	Wetland cover exceeds guideline
Riparian Cover (30m buffer on either side)	75.0%	38.8% (Identified as the primary stressor in the subwatershed)	-36.2%	More natural riparian cover needed

*Land cover data taken from the Middle Spencer Creek Stewardship Action Plan (HCA 2011).

All of the rehabilitation and enhancement plantings recommended below (**Sections 9.3.5.1** to **9.3.5.7**) are best planted in the spring or fall months and should consist of native, preferably indigenous, stock. In addition, further studies assessing the feasibility of creating habitat for specific target species are encouraged where applicable.

Targets

The primary targets of the enhancement recommendations below are to:

- Naturalize hazard lands (e.g. floodplains) to benefit wildlife and improve adjacent natural heritage features
- Diversify habitat types within the Greensville Subwatershed
- Decrease the edge-interior ratio of natural areas and especially of forest blocks, with an emphasis on enhancing interior forest habitat

- Protect existing Natural Heritage Features
- Increase stream health, with 95% of streams buffered by natural vegetation and 75% of stream buffers forested
- Facilitate and enhance wildlife movement
- Reduce invasion opportunities for invasive species

9.3.5.1 Rehabilitation and Enhancement Opportunities in Area A

Area A contains a number of habitat types including meadow, deciduous woodland, plantation, thicket, and wetland. The variety of habitat types present increases Area A's significance to wildlife; the NHRM (MNR 2000) and the Significant Wildlife Habitat Technical Guide (MNR 2000) both note that areas containing a diversity of habitats and/or having a diversity of habitat types in close proximity are more valuable than those that are uniform or removed from dissimilar habitats. Accordingly, Area A is the focus of several proposed enhancements.

Rehabilitation and enhancement opportunities identified in the west portion of Area A will enhance both Core Natural Heritage Features and Linkages. The goal of the recommendations is to enhance wildlife habitat and increase the area and quality of a potential wildlife corridor. Rehabilitation and enhancement opportunities identified in the east portion of Area A are intended to increase both wildlife movement opportunities and interior forest habitat.

Area A West

Natural heritage features in Area A West consist of a watercourse, wetlands, ponds, thickets, and woodlands. Much of this Area is designated as the Hayesland Alvar ESA. The Hayesland Swamp ESA sweeps across Area A West in a northeast to southwest direction. Dwyer et al., recognise the need to link natural areas in the Hayesland Alvar ESA with other natural areas (2003). Wildlife movement from the Hayesland Alvar to the Hayesland Swamp ESA is limited to natural and semi-natural areas northeast of 5th Concession Road W and Middletown Road. Accordingly, it is recommended that locations outlined in **Appendix** , **Figure 2** be planted with woody vegetation, as connected habitat patches are more valuable than disjunct habitat patches (MNR 2010). Plantings in Area A West will increase woody cover for wildlife, thus increasing the area's use as a wildlife movement corridor between the two aforementioned ESAs.

It is recommended that woody plantings consist of nucleation pods planted in a gradient of concentration from the edge of existing Core Natural Heritage Features and Linkages (higher concentration) outwards to the limits of the floodplain (lower concentration). Such a planting density gradient would mimic patterns of natural succession, providing habitat diversity within the ecotone and enhancing its potential use by wildlife (MNR 2000). Recommended riparian plantings would have the added benefit of improving water quality and enhancing aquatic habitat.

Area A East

The forest edge-to-interior ratio in the east of Area A is relatively high. In order to a) minimize edge effects; b) increase the area's value as wildlife habitat; and c) increase the amount of forest cover in the Subwatershed, Aquafor Beech Limited recommends that the forest gaps and edges identified in **Appendix K**, **Figure 2** be planted with woody vegetation (e.g. trees and shrubs).

9.3.5.2 Rehabilitation and Enhancement Opportunities in Area B

Area B is located within the Hayesland Alvar ESA. As mentioned in **Section** 0, forest cover is lacking in the Greensville Subwatershed. Rehabilitation and enhancement opportunities identified by Aquafor Beech Limited focus on habitat gaps and establishing linkages between natural areas (see **Appendix K**, **Figure 3**).

Firstly, it is recommended that the clearly visible barren area with a clearly defined path to the south (Area B west, **Appendix K**, **Figure 3**) be rehabilitated through active restoration efforts. The aforementioned barren gap was not field truthed as part of this study. Should the area contain intact alvar habitat (i.e. supporting native alvar flora), rehabilitation and enhancement efforts may be scaled or, in some cases, may not be appropriate. Should the barren gap contain vegetation communities dominated by exotic flora, rehabilitation efforts as described below would likely be appropriate. Decommissioning trails and planting site-appropriate vegetation in the barren gap will aid in habitat creation and decrease opportunities for invasive species to proliferate. At present, exact site conditions are unknown. However, Dwyer et al. (2003) cited that in some areas soils are thin (as is to be expected in an alvar). Accordingly, rehabilitation efforts should take into consideration the unique and challenging character of the site. Depending on site conditions, it may be advisable to focus on actively rehabilitating the barren gap to a more easily established community dominated by herbaceous plants with occasional woody plants (younger, small planting stock is advisable).

Secondly, opportunity exists to connect core areas within the Hayesland Alvar ESA. Currently, a vegetated wildlife corridor between the eastern and western woodlands in Area B is lacking. Re-establishing connections between these two woodlands will facilitate wildlife movement within the Hayesland Alvar ESA. Two locations for wildlife corridor rehabilitation have been identified by Aquafor Beech Limited (Area B east, **Appendix K**, **Figure 3**); built-in redundancy provides wildlife with options for movement pathways (MNR 2000). Ideally, these corridors should be reforested using species that mirror those of the surrounding woodlands.

Opportunity for rubbish removal (e.g. abandoned vehicles) within Area B should also be explored. As a compromise between landowners and rehabilitation of the forest, Aquafor Beech Limited suggests creating an evergreen screen outside of the ESA that would allow for the out-of-sight storage of scrap metal and vehicles while keeping rubbish out of natural areas (see **Figure 9.3.2**). Fencing could also be integrated into the rehabilitation design. Rehabilitation of

the disturbed woodland can be either passive or active, depending on availability of stewardship resources. A closely planted evergreen privacy screen has the added benefit of providing winter cover for avian wildlife.

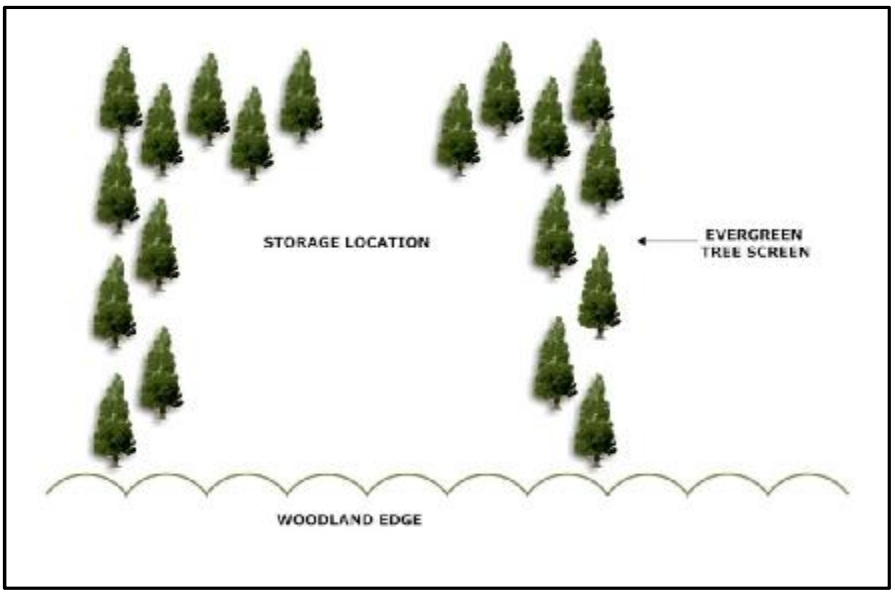


Figure 9.3.2: Schematic Diagram of Evergreen Privacy Screen

9.3.5.3 Rehabilitation and Enhancement Opportunities in Area C

Area C consists of riparian meadow and wetland habitats bisected by Middletown Road and surrounded by agricultural land use (**Appendix K**, **Figure 4**). Based on summer air photos, it appears that portions of the agricultural lands surrounding the riparian area of the creek west of Middletown Road are, at a minimum, seasonally saturated. Accordingly, in collaboration with the landowner it may be possible to extend riparian buffer widths into these saturated areas and provide more tree cover throughout the greater riparian zone. Additionally, a substantial area of open meadow on the east side of Middletown Road contains an anthropogenically influenced pond/water feature. Enhancing existing riparian plantings, enhancing wetland habitat, and planting a wooded area on the north and south sides of the creek in this area will:

- Aid in achieving the minimum natural land cover targets listed above (**Section 9.3.5**);
- Enhance habitat for amphibians (e.g. American Toad and Spring Peeper) known to inhabit the area (Ecoplans 2006); and
- Enhance a Core Natural Heritage Feature of the NHS.

9.3.5.4 Rehabilitation and Enhancement Opportunities in Area D

Located upstream of Area C, Area D consists of two isolated woodlands and two branches of a tributary of Spencer Creek surrounded by agricultural land (**Appendix K, Figure 5**). Natural riparian vegetation in this area is lacking, and opportunity exists to connect the woodlands via planted riparian buffer strips. As previously mentioned, lack of riparian buffer coverage was cited as the main stressor to the Greensville Subwatershed (HRCA 2011). Aquafor Beech Limited recommends including fast-growing species such as native Poplar species (*Populus* spp.), Silver Maple (*Acer saccharinum*), and Freeman's Maple (*A.* x *freemanii*) as well as evergreen species such as Eastern White Cedar (*Thuja occidentalis*) in the planting list so that tree cover can be established quickly and so that shading will occur throughout the seasons. In addition, the inclusion of berry-bearing shrubs will help to attract avian fauna to the buffers, which in turn will likely aid in the colonization of the riparian buffers by other species spread through bird droppings.

Additional enhancements to Area D include taking an existing online pond offline and planting trees from the southern edge of the woodland in the east of Area D to connect said woodland (a Linkage) with the nearby watercourse (a Core Natural Heritage Feature). It is recommended that woodland enhancement plantings consist of species that mirror those extant in the woodland.

9.3.5.5 Rehabilitation and Enhancement Opportunities in Area E

Rehabilitation and enhancement opportunities identified in Area E **(Appendix K**, **Figure 6**) consist of tree planting along watercourse (Spencer Creek) edges and within the floodplain. The upper reach of Area E is considered a Linkage, and connects the Donald Farm Complex ESA (Core Natural Heritage Feature) with the Christie Stream Valley ESA to the south (Core Natural Heritage Feature).

Currently, overhanging tree cover in the area is disjunct and insufficient. Riparian vegetation consists mostly of grasses (**Figure 9.3.3**). Aquafor Beech Limited also recommends that the lands within the floodplain adjacent to Spencer Creek be subject to restoration consisting of nucleation pods planted in a gradient of concentration from the edge of Spencer Creek (higher planting concentration) outwards to the limits of the floodplain (lower planting concentration). Such a planting density gradient would mimic patterns of natural succession, providing habitat diversity within the ecotone and enhancing its potential use by wildlife (MNR 2000). Recommended riparian plantings would have the added benefit of improving water quality and enhancing aquatic habitat.

Figure 9.3.3: Riparian vegetation typical of Mid-Spencer Creek along areas identified in Restoration and Enhancement Area E.

9.3.5.6 Rehabilitation and Enhancement Opportunities in Area F

Area F is a prime illustration of the lack of riparian cover in the Greensville Subwatershed. It is recommended that watercourses illustrated in **Appendix K**, **Figure 7** be the subject of a comprehensive riparian buffer planting and watercourse enhancement initiative that connects natural heritage features (e.g. woodlands and meadows) and fills in woodland gaps. Currently, lands surrounding the subject watercourses are used for agricultural and commercial purposes. Tree cover is very limited and it is evident from air photos that the watercourses have been straightened.

It is recommended that opportunities to work with landowners to establish adequate wooded riparian buffers along watercourses are explored. It may also be possible to restore straightened channels by employing natural channel design techniques. If possible, opportunities to take online ponds, of which there are several, offline should also be explored. Aquafor Beech Limited recommends including fast-growing species such as native Poplar species (*Populus* spp., also good for roadside plantings where salt is an issue), Silver Maple (*Acer saccharinum*), and Freeman's Maple (*A.* x *freemanii*) as well as evergreen species such as Eastern White Cedar (*Thuja occidentalis*) in the planting list so that tree cover can be established quickly and so that shading will occur throughout the seasons. In addition, the inclusion of native berry-bearing shrubs will help to attract avian fauna to the buffers, which in turn will likely aid in the colonization of the buffers by other species spread through bird droppings.

9.3.5.7 Rehabilitation and Enhancement Opportunities in Area G

Area G consists of a riparian wetland within an agricultural landscape and several forest canopy gaps occupied by cultural meadow (**Appendix K**, **Figure 8**). Based on air photo interpretation and field studies, lands adjacent to the wetland have been ploughed up to the limits of the wetland and adjacent significant woodland. Aquafor Beech Limited recommends including the minimum 30 m buffer areas for the wetland-woodland habitat matrix as part of the rehabilitation and enhancement recommendations outlined below.

Based on Ecological Land Classification work, it is known that Reed Canary Grass (*Phalaris arundinacea*) is the dominant species type in the wetland. It is recommended that rehabilitation opportunities within the wetland in Area G focus on long term invasive species management. Suggested management options could include species removal and replacement. Additional plantings (e.g. trees and shrubs) within the wetland would contribute to the habitat structure of the wetland.

Additional lands in the south of Area G currently in cultivation have been identified as a Rehabilitation and Enhancement opportunity based on the land's location between two Core Natural Heritage Features: the aforementioned wetland and the Dundas Valley ESA to the south. The MNR (2000) recognises the value enhancing and protecting core natural heritage features in close proximity to large core areas (e.g. the Dundas Valley). It is recommended that enhancement plantings link the two aforementioned Core areas and be of sufficient width to function as a wildlife movement corridor.

Lastly, it is recommended that forest gaps be subject to tree plantings as a means of filling in the gaps and decreasing the edge to interior ratio of the woodlands. Three such gaps have been identified in Area G. It is further recommended that planted species mirror the species composition of the adjacent woodland, provided that the woodland is a naturally occurring community type. Planted species should be native and should not mirror extant exotic and/or invasive species present in the woodland.

10 IMPLEMENTATION

10.1 General

The City of Hamilton initiated the study for the Greenville Rural Settlement Area (RSA) and surrounding Mid-Spencer Creek Subwatershed in support of future development within the Greensville Rural Settlement Area (RSA), with an overarching objective to "provide guidelines to determine the extent and density of residential development that can be sustained without degradation of the quality or quantity of ground or surface waters within and outside the Secondary Plan Boundary".

The Subwatershed Study was undertaken in support of the Secondary Plan and is being completed in three stages:

Stage 1: Investigate and define existing environmental conditions, including environmental constraints and opportunities for development (**Chapter 4**);

Stage 2: Evaluate future land use impacts and develop a Subwatershed Strategy, comprised of recommended works and measures to address stormwater management and the maintenance, protection and enhancement of the study area's significant natural heritage features and ecological functions (**Chapters** 6**,** 7 **and** 9); and

Stage 3: which is the premise of this Chapter, and its purpose is to develop an implementation plan to guide future work by the City of Hamilton and development proponents, which is the purpose of this Section of the study.

The **Stage 1** and **Stage 2** components of this study characterized existing environmental conditions and identified opportunities and constraints to development based on background review, field investigations, and modelling. The **Stage 1** and **Stage 2** components also assessed potential land use impacts on the natural resources of the study areas and reviewed alternative management measures to mitigate these impacts. Both stages concluded with a recommended Subwatershed and RSA Plan that consists of a series of management controls and management measures to maintain, protect and enhance the study area's significant natural heritage features and ecological functions, including the identification of a recommended Natural Heritage System (NHS).

In the following sections, objectives and targets related to the Subwatershed Strategy are re-visited and final recommendations related to the implementability of the Strategy are presented including:

- Future studies;
- Phasing considerations;
- Approvals; and
- Design guidance and policy considerations

10.2 Study Area

The study area is comprised of two areas:

1. Mid-Spencer Creek Subwatershed, and
2. Greensville Rural Settlement Area (RSA)

Implementation considerations for both areas are addressed in the following sections, with special focus on the Greensville Rural Settlement Area (RSA).

10.3 Objectives

The purpose of the Implementation section of this study is to guide the future work required to implement successfully the components of the recommended solutions and strategies developed earlier (**Chapters** 7 **and** 9). Key objectives include:

- Review of the key Subwatershed Strategy components;
- Identify responsibilities and roles for each of the Subwatershed Strategy components;
- Provide direction as to the types of future studies required for the successful implementation of the Subwatersheds Strategy;
- Provide recommendations with respect to the phasing of proposed works;
- Provide additional design guidance and policy considerations for key Subwatershed Strategy components
- Review of approvals considerations

10.4 Rural Settlement Area Implementation

10.4.1 Stormwater Management for New Development

As illustrated in **Figure 6.1.1**, there are nine (9) new development areas to be constructed within the Rural Settlement Area. This section presents targets that could restore water quality and quantity from post to pre-development conditions for these new areas.

In general, the City of Hamilton is not responsible for the planning and design of the stormwater management ponds, and LID controls recommended under the Subwatershed Strategy. These works are related to future urban development and therefore are the responsibility of development proponents. However, it should be noted that the City of Hamilton ought to play a role in ensuring co-ordination of future studies between development lands so that the number of stormwater ponds is minimized. The City should also provide policy guidance through its role as the primary review and approval agency for these works.

This section describes the implementation of the Subwatershed Strategy stormwater management measures for which development proponents are responsible, i.e. those that are either directly

related to future urban development or are expected to provide a direct benefit to the developing lands.

a) End-of-Pipe Stormwater Management Ponds

End-of-pipe wet pond facilities are recommended for water quality, erosion and flood control for future development lands.

Water Quality Control Targets

In terms of water quality control, Level 1, or "Enhanced" water quality control is required. The MOE Stormwater Management Planning Manual was used to define the following targets for water quality control:

- 138 m^3/ha of permanent pool storage, and 40 m^3/ha of active storage for ponds servicing residential land uses (50% impervious); and
- 202 m^3/ha of permanent pool storage, and 40 m^3/ha of active storage for ponds servicing industrial land uses (80% impervious).

Table 10.4.1 shows water quality control targets for the Rural Settlement Area. **Table 9.2.1** and **Table 9.2.2** illustrate in detail, storage volumes and targets needed for water quality control for each subcatchment within the Rural Settlement Area.

Erosion and Flood Control Targets

The surface runoff estimates presented in **Chapters** 4 and 6 were used to estimate a preliminary target for the erosion and quantity control storage requirements within stormwater management facilities on the future development lands (**Table 9.2.1** and **Table 9.2.2**). The modelling results indicate that, for those areas requiring erosion and quantity control, on average, approximately 392 m^3/ha of storage is necessary to control post-development runoff rates to pre-development rates.

The conceptual stormwater pond locations throughout the proposed development lands are presented in **Figure 9.2.1**, yet the exact number of ponds, their locations and sizes are unknown at this point in time. These factors will ultimately depend on the location and depth of suitable pond outlets, fragmentation of land ownership, and ability to co-ordinate the timing of various development sites through functional servicing studies (see below).

Table 10.4.1 includes average storage volume targets (m^3/ha)which can be applied within the study area. **Table 9.2.1** presents details for storage requirements on a catchment-by-catchment basis. For areas with limited space, traditional on-site controls are recommended to provide the water quality and quantity controls. The storage requirements summarized in **Table 10.4.1** can be applied to define the targets for these small sites.

Table 10.4.1: Summary of Stormwater Management Strategy Components for New Development Areas

Components:	**Groundwater Resources**	**Water Quality**	**Erosion/Flood Control**	**Aquatic/Terrestrial Resources**
Low Impact Development (LID) Source Controls:				
Targets:	In order to overcome the anticipated recharge deficit resulting from residential development within areas underlain by silt loam and sand loam soils, future infiltration measures would be required to capture and infiltrate a volume of 127 m^3 of groundwater recharge per year on a typically 1 acre residential lot.			
Benefits:	- maintain groundwater recharge rates;	- improved water quality through removal of suspended contaminants	- moderate reductions in stormwater runoff	- protect stream baseflows and improved water quality
Wet Ponds (catchment area > 5ha) and Traditional Source Controls (catchment area <5ha)				
Targets:		- Level 1 (normal) water quality control - residential landuses (50%impervious): 138 m^3/ha permanent pool, 40 m^3/ha active storage - industrial landuses (80%impervious): 202 m^3/ha permanent pool, 40 m^3/ha active storage	- overcontrol of events up to 2-year storm for erosion control: ranging from 111 to 214 m^3/ha (average = 128 m^3/ha) active storage (**Table 9.2.1**); - post-to-pre runoff control for flooding: ranging between 333 nd 588 m3/ha (average = 392 m3/ha) active storage (**Table 9.2.1**)	
Benefits:		- improved water quality through settling and capture of suspended contaminants	- prevent increases in runoff rates which could otherwise worsen existing downstream erosion and flooding	- improved water quality

Future Studies

It is anticipated that two progressively more detailed levels of study will be required as development and stormwater management planning and design progresses. The two detailed levels are:

1. Functional Design Stage; and
2. Detailed Design Stage

1. Functional Design Stage

This stage of planning should include efforts to refine the conceptual pond locations identified in the Subwatershed Strategy. As noted earlier, location planning and design of future stormwater management ponds should take into account adjacent developments within a catchment, rather than on a site-by-site basis, in order to identify opportunities to minimize the overall number of facilities by providing larger, more efficient centralized ponds which are shared by more than one development site. The centralized ponds would provide benefits to both the development proponent and the City through savings in land and lower future maintenance requirements.

The preliminary planning and design of the overall drainage and stormwater pond networks should be completed as part of a Functional Servicing Study (FSR). The FSR would include:

- hydrologic modelling to confirm/refine storage requirements based on updated drainage areas and development densities;
- preliminary design of SWM Ponds, including preliminary grading, inlet/outlet locations and elevations, and stage-storage-discharge rating curves; and
- geotechnical investigations to confirm soils and groundwater conditions at proposed pond locations.
- erosion hazard and mander belt assessments to define hazard limites.

In addition to the above, the Functional Design stage for stormwater ponds draining to several specific receiving streams will need to account for proposed downstream capacity constraints and/or stream works. The proposed stream works, which should also be commenced at the Functional Design stage, are discussed in **Section 10.4.2.**

2. Detailed Design Stage

The detailed design stage of planning builds upon the preliminary work at the functional design level in order to finalize the drainage and stormwater designs. The following studies and analyses will be required:

- Preparation of Detailed Stormwater Management Reports for individual subdivisions or sites to demonstrate how the proposed systems conform to the targets identified in the overall Subwatershed Strategy and/or FSR findings. This includes:
    - Site grading;
    - Calculations and/or modelling for sizing and detailed design of the major/minor drainage systems;

  - Detailed design for end-of-pipe stormwater ponds, including grades, operating levels, inlet/outlet designs, forebay, maintenance access, emergency overflow, etc.
- An Operations and Maintenance Manual for stormwater facilities;
- Landscaping plans for stormwater ponds;
- An Erosion and Sediment Control Plan;

Detailed listings and general checklists of the components expected in SWM Reports and Operation and Maintenance Manual submissions is provided in the City of Hamilton's 2007 *Criteria and Guidelines for Stormwater Infrastructure Design* document.

Design Guidance and Policy Considerations

Design of future stormwater management ponds should be guided by the criteria and recommendations in the MOE 2003 Stormwater Management Planning and Design Manual and the City of Hamilton's 2007 *Criteria and Guidelines for Stormwater Infrastructure Design* document.

Approvals

The City of Hamilton and Hamilton Conservation Authority are primarily responsible for the review and approval of the proposed stormwater management ponds. Stormwater management systems are considered 'utilities' under the Niagara Escarpment Plan; SWM ponds proposed within the Greensville Minor Urban Centre will also be subject to review and approval by the Niagara Escarpment Comission (NEC).

b) Traditional Source Controls

Targets/Objectives

For sites which are too small to be serviced by a stormwater pond (i.e. less than 5 ha), the Subwatershed Strategy recommends that traditional lot-level source controls be used to provide the necessary water quality, erosion and flood control.

Where traditional source controls are to be used instead of an end-of-pipe wet pond facility, the same storage and release targets identified in **Table 10.4.1** for SWM ponds within the same watercourse/catchment should be applied.

Future Studies

The following studies and analyses will be required at the Detailed Design stage for sites using Traditional Source Controls:

- Preparation of Detailed Stormwater Management Reports for individual sites to demonstrate how the proposed systems conform to the targets identified in the overall Subwatershed Strategy. This includes:
  - Site grading;

  - Calculations and/or modelling for sizing and detailed design of the major/minor drainage systems;
  - Detailed sizing and design of stormwater devices and storage areas, including grades, operating levels, inlet/outlet designs, pre-treatment areas, maintenance access, emergency overflow, etc.
- An Operations and Maintenance Manual, where appropriate;
- Landscaping plans for naturalized stormwater treatment areas;
- An Erosion and Sediment Control Plan;

Detailed listings and general checklists of the components expected in SWM Reports and Operation and Maintenance Manual submissions is provided in the City of Hamilton's 2007 *Criteria and Guidelines for Stormwater Infrastructure Design* document.

Design Guidance and Policy Considerations

The City of Hamilton's 2007 *Criteria and Guidelines for Stormwater Infrastructure Design* document notes that the City generally discourages the use of the following source control methods:

- Reduced lot grading;
- Rear yard ponding; and
- Rooftop storage (considered on site-by-site basis).

The document notes that the City of Hamilton may allow the use of:

- Soakaway pits; and
- Parking lot storage.

In the case on Oil-Grit separators, their use requires pre-treatment. Therefore, where they are proposed for use in the RSA study area, it is recommended that they be located down-gradient from the other recommended LID techniques which could perform a dual function of pre-treatment for the oil-grit devices as well as groundwater recharge to meet the Subwatershed Study infiltration targets.

In terms of water quality control, the City of Hamilton may also consider a cash-in-lieu arrangement whereby equivalent funds for small infill sites are applied to other larger water quality initiatives within the watershed.

Approvals

The City of Hamilton is the primary approval agency for traditional stormwater source controls with additional review and approval provided by the Hamilton Conservation Authority. Approvals from the NEC will also be required.

c) <u>Low Impact Development (LID) Controls</u>

Targets/Objectives

Low Impact Development (LID) techniques are recommended to maintain the groundwater recharge rates within the study area. Water balance estimates for the study area indicate that in order to overcome the anticipated recharge deficit resulting from residential development within areas underlain by silt loam and sand loam soils, future infiltration measures would be required to capture and infiltrate 31.5mm (**Section 9.2.1.1**), which corresponds to a volume of 127 m^3 of groundwater recharge per year on a typically 1 acre residential lot.

It is important to note that, in addition to providing groundwater recharge benefits, many LID measures may also provide other water balance, water quality, and erosion control benefits.

Future Studies

Most LID controls will be implemented at the individual site or subdivision level and the majority of their design will take place at the Detailed Design level. The following studies and analyses will be required at the Detailed Design stage for the use of LID controls within proposed development sites/subdivisions:

- In-situ Guelph Permeameter tests or equivalent as detailed in **Appendix C** of the Low Impact Development Planning and Design Guide Version 1.0 (TRCA/CVC 2010) to define the infiltration rates to be used in the design of the LID measures.
- Preparation of Detailed Stormwater Management Reports for individual sites to demonstrate how the proposed LID controls conform to the groundwater recharge targets identified in the overall Subwatershed Strategy. This includes:
    - Site grading;
    - Calculations and/or modelling for sizing and detailed design of the drainage systems;
    - Detailed sizing, location and design of LID controls, including grades, operating levels, inlet/outlet designs, pre-treatment areas, underdrains, maintenance access, emergency overflow, etc.
- An Operations and Maintenance Manual, where appropriate;
- Landscaping plans for naturalized LID stormwater treatment areas;
- An Erosion and Sediment Control Plan;

Design Guidance and Policy Considerations

In most cases, the placement of LID stormwater source controls or other traditional source controls on individually or communally-owned private lands will be constructed, operated and maintained by the landowner. Consideration should be given to the following:

- Adoption of standardized LID facility design and construction standards/manual and references i.e. LID SWM Planning and Design Guide (TRCA/CVC, 2010).
- Testing to confirm as-built performance (monitoring programs).
- Adoption of standardized annual monitoring/inspection reports.

- The definition (or redefinition) of 'standing water' in the City's Criteria and Guidelines for Stormwater Infrastructure Design to allow for up to 48 hrs of ponded water within LIS source controls.
- Performance bonds for approved on-site source controls to ensure proper installation in the field.

Municipalities need to have some assurances and long standing arrangements whereby they can ensure that these facilities continue to perform as designed into the future. Examples include:

- Agreements which make the removals of on-site source controls unlawful.
- Placement on title of on-site LID source control.
- Maintenance agreements that assign long-term maintenance responsibility.
- On-site source controls are placed/sited within easements and have adequate access for inspection and maintenance. Consideration should be given to easement requirements which permit the City to gain access to the private property to lawfully inspect, enforce maintenance requirements and undertake such maintenance or repair works should conditions of the maintenance agreement be violated (i.e. existing non-compliance regulations and/or variants of property standard by-laws).
- The management of multi-unit and single lot freehold developments utilizing source controls on communally owned private lands through the Condominium Act 1998 (Westminster Woods - Guelph, ON ; Dixon et al., 2005). These common stormwater management elements are governed and maintained by a member elected Board of Governors, and requires all owners of parcels of tied lands to automatically become members, provides for mandatory mediation and arbitration and is enforced by the Condominium Boards (then the Ontario Superior Court of Justice).
- Covenants placed on title of individually owned lots requires owners, individually and collectively, to maintain repair and replace infrastructure (Dixon et al., 2005) and enforced through Municipal Property Standards By-laws or other such strategies would allow the municipality to lawfully enter private property, inspect and maintain on-site SWM controls.

10.4.2 Drainage and Infrastructure Improvement Works

As explained in the characterization component of this study (**Section 4.5**), the Greensville Tributary is considered to be the most sensitive to watershed land use change among other surface water features (Middle Spencer and Logies Creeks) within the Rural Settlement Area (RSA). Within the Greensville RSA, the completed geomorphic assessments have identified a number of opportunities to mitigate historic impacts and/or restore stream forms and functions from both geomorphological and ecological perspectives (**Figure 4.5.2**). Accordingly, there are two categories of restoration opportunities related to infrastructure improvement:

High Priority Restoration Options

- Greensville Tributary – Replacement of culvert at Brock Road;
- Middle Spencer Creek – Stabilize bank upstream of Brock Road

Moderate Priority Restoration Options

- Logies Creek – Replacement of culvert at Harvester Road;
- Logies Creek – Consider restoration options for naturalization of Reach LG-4b
- Middle Spencer Creek – Removal dam structures, Reach MS-5a

10.4.3 Stormwater Retrofit Measures

Retrofit opportunities related to source control measures were recommended in **Section** 7 of this study. The successful implementation of these measures requires a number of steps prior to implementing them within existing urban areas. These steps are meant to examine the feasibility of implementing source control measures, and they include:

1. Social marketing research to understand public support/barriers to different stormwater measures;
2. Field work to understand the physical conditions with respect to landscape and existing drainage infrastructure in representative areas within the city; and
3. Meetings and discussion with municipal staff from various departments to determine municipal support barriers to different stormwater measures.
4. Training requirements: City review staff responsible for approvals and inspections should be given specific LID SWM training which should include the basics of LID principles and techniques i.e. LID goals and objectives, function and performance, design basics, approval requirements and operation and maintenance considerations. This can be accomplished through tailored LID seminars or workshops or through existing second party programs such as the Canadian Standards Association (CSA) Sustainable Stormwater Practices training modules.

Figure 10.4.1 shows SWM retrofit opportunities for a typical residential area within the Rural Settlement Area. As illustrated, retrofit opportunities for water quality and quantity management purposes could be provided using a suite of LID measures. The presented schematic shows seven (7) measures draining the whole lot area through complementation among all measures. The residential area eventually drains to a pocket wetland (LID measure 7) for further stormwater treatment.

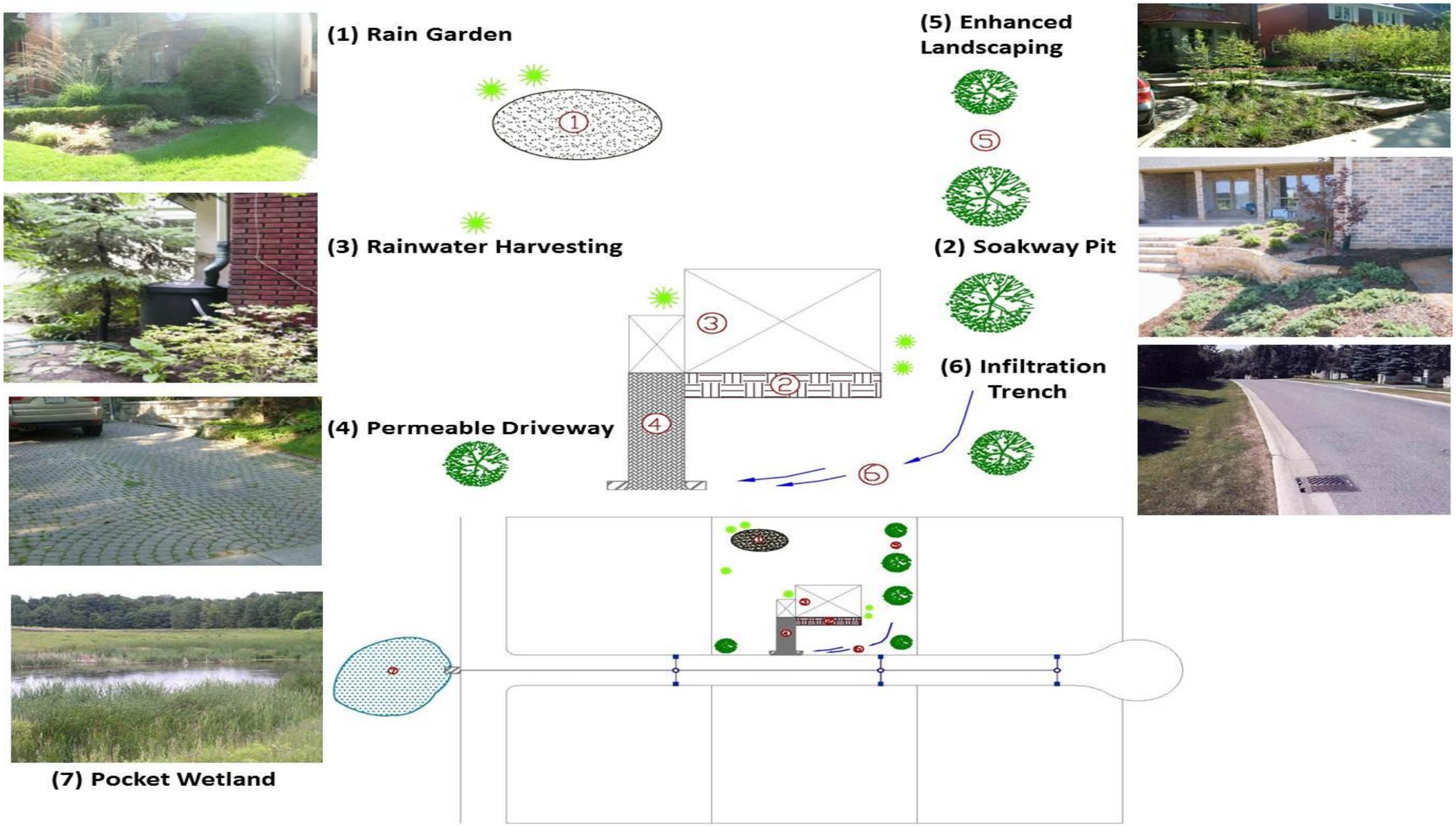


Figure 10.4.1: Low Impact Development Measures Covering a Typical Residential Area within the Rural Settlement Area

10.4.4 The Recommended Natural Heritage System within the Rural Settlement Area

The Greensville Subwatershed Study identifies a recommended NHS intended to maintain, protect and enhance the study area's significant natural heritage features and ecological functions. The recommended NHS consists of the following:

- Core Areas as defined by the City of Hamilton (2012) including Key Natural Heritage Features, Key Hydrologic Features and Local Natural Areas;
- Linkages as defined by the City of Hamilton (2012); and
- Hazardous Lands as defined by the Hamilton Conservation Authority (2009).

The Revised Natural Heritage System as shown in this report illustrates the preliminary (i.e. conceptual) boundaries of the recommended NHS. The final boundaries of the recommended NHS are to be determined at a subsequent planning stage (Draft Plan of Subdivision or Site Plan) through the completion of additional studies. Site-appropriate management options and vegetation protection zones (VPZs) will be determined as part of these additional studies.

10.4.4.1 Natural Heritage Policy and Approvals

The Greensville RSA is within the City of Hamilton's rural boundary and is subject to the provisions of the City's Rural Official Plan (2012). The City of Hamilton's Rural Official Plan presents overarching policy goals and provides direction for new development and site alteration on lands within and/or adjacent to natural heritage features. Additionally, the RSA is subject to the policies of the Greenbelt Plan (2005). All of the Greensville RSA is considered Protected Countryside under the Greenbelt Plan. In addition, the majority of the Greensville RSA is subject to the provisions of the Niagara Escarpment Plan (NEP), and as such approvals from the NEC may be required. Hazard lands, including wetlands, floodplains, watercourses, erosion hazards, valley/slopes, etc. and lands adjacent to them are regulated by the Hamilton Conservation Authority.

"Any *development* within the Niagara Escarpment Plan area, as shown on Schedule A – Provincial Plans, shall meet the requirements of this Plan and the Niagara Escarpment Plan and Section 3.3 of the Greenbelt Plan. Where there is discrepancy between this Plan and the Niagara Escarpment Plan, the most restrictive policies will prevail." (City of Hamilton UOP policy 1.1.1)

Accordingly, approvals from the City of Hamilton and possibly the Niagara Escarpment Commission and/or Hamilton Conservation Authority will be required for proposed development and site alteration. Should proposed site development and alteration potentially impact Endangered or Threatened species and/or their habitats, consultation with the MNRF is required. Further details with regards to regulatory approvals is contained below in **Table 10.4.2**.

A general overview of the requirements of the Rural Official Plan for both Core Natural Heritage Features and Linkages within the Greensville RSA are presented below.

Core Natural Heritage Features

Within the Greenbelt Natural Heritage System of the Protected Countryside:

"***New development*** or ***site alteration*** shall not be permitted within a ***key natural heritage feature*** within the Greenbelt Natural Heritage System or a ***key hydrologic feature*** anywhere in the Protected Countryside**,** including any associated ***vegetation protection zone***. However, new ***development*** or ***site alteration*** proposed adjacent to (within 120 metres of) a ***key natural heritage feature*** within the Greenbelt Natural Heritage System or a ***key hydrologic feature*** anywhere in the Protected Countryside requires an Environmental Impact Statement which identifies a ***vegetation protection zone***, according to the requirements in Sections C.2.4.10, C.2.4.11, C.2.4.12, C.2.4.13, and C.2.4.14." (ROP Section 2.4.2)

Within the Protected Countryside outside of the Greenbelt Natural Heritage System:

"Beyond the Greenbelt Natural Heritage System within the Protected Countryside new ***development*** and site alteration shall not be permitted within or adjacent to ***key natural heritage features*** in the Greenbelt Protected Countryside unless it has been evaluated through an Environmental Impact Statement and has been demonstrated that there shall be no ***negative impacts*** on the natural features or their ***ecological functions***." (ROP Section 2.4.8)

Also,

"New ***development*** and ***site alteration*** within the Protected Countryside of the Greenbelt Plan Area that is proposed to take place within or adjacent to any other ***Core Area*** identified on Schedule B - Natural Heritage System, through a consent, Plan of Subdivision, Zoning By-law, Site Plan approval, Official Plan amendment or ***Site Alteration*** By-law permit shall require an Environmental Impact Statement in accordance with Sections C.2.4.6 of this Plan." (ROP Section 2.4.9)

Furthermore,

"An Environmental Impact Statement shall also propose a ***vegetation protection zone*** which:

a) Has sufficient width to protect the ***Core Area*** and its ***ecological functions*** from impacts of the proposed land use or ***site alteration*** occurring during and after construction, and where possible, restores or enhances the ***Core Area*** and/or its ***ecological functions***; and
b) Is established to achieve, and be maintained as ***natural self-sustaining vegetation***." (ROP Section 2.4.10)

Linkages

The City of Hamilton defines linkages as: "Connections between natural areas provide opportunities for plant and animal movement, hydrological and nutrient cycling, and maintain ecological health and integrity of the overall Natural Heritage System."

The City's Rural Official Plan (ROP) policy further states:

"The City recognizes the importance of sustaining ***linkages*** between *Core Areas* shown on Schedule B - Natural Heritage System. It is the intent of this policy that ***linkages*** be protected and enhanced to sustain the Natural Heritage System wherever possible." (ROP Section 2.7.1)

The Revised Natural Heritage System as shown in this report illustrates the preliminary boundaries of the recommended NHS. NHS boundary refinements can be determined at a subsequent planning stage (Draft Plan of Subdivision or Site Plan) through the completion of additional studies such as an Environmental Impact Study. Note that the limits/boundaries of NHS features, including and not limited to wetlands, are subject to staking in consultation with the City of Hamilton and the Hamilton Cconservaiton Authority at the detailed design phase. Site-appropriate management options and/or refinements to the minimum vegetation protection zones (VPZs) outlined in this study will be also determined as part of these additional studies in accordance with the provisions of City of Hamilton's Official Plan (i.e. ROP Sections 2.4.10, 2.4.11, 2.4.12, 2.4.13 and 2.4.14).

Approvals

As mentioned above, proposed development and site alteration within and adjacent to the NHS, where permitted, requires approvals by regulatory agencies. The following table (**Table 10.4.2**) provides a summary of the elements of the revised NHS for the Greensville RSA and the corresponding relevant approval agencies.

Table 10.4.2: Summary of Approvals for Site Development and Alteration Proposed Within or Adjacent to the NHS in the Greensville RSA

Natural Heritage Feature Potentially Affected by Proposed Site Development and Alteration	Approval Agencies
Core Natural Heritage Features and Adjacent Lands	
Significant Habitat of Endangered, Threatened, and Special Concern Species (Provincial)	• City of Hamilton • MNRF • NEC • DFO
Fish Habitat	• City of Hamilton • MOECC • Hamilton Conservation Authority • MNRF • NEC • DFO
Wetlands	• City of Hamilton • Hamilton Conservation Authority • NEC
ANSIs (Life and Earth Science)	• City of Hamilton • MNRF • NEC
Significant Valleylands	• City of Hamilton • Hamilton Conservation Authority • NEC
Significant Woodlands	• City of Hamilton • NEC
Significant Wildlife Habitat	• City of Hamilton • MNRF • NEC • DFO
Sand Barrens, Savannahs, & Tallgrass Prairies	• City of Hamilton
Alvars	• City of Hamilton
Permanent and Intermittent streams	• City of Hamilton • Hamilton Conservation Authority
Lakes	• City of Hamilton • Hamilton Conservation Authority
Seepage Areas and Springs	• City of Hamilton • Hamilton Conservation Authority
Environmentally Significant Areas (ESAs)	• City of Hamilton • Hamilton Conservation Authority
Linkages	
Woodland Linkages	• City of Hamilton

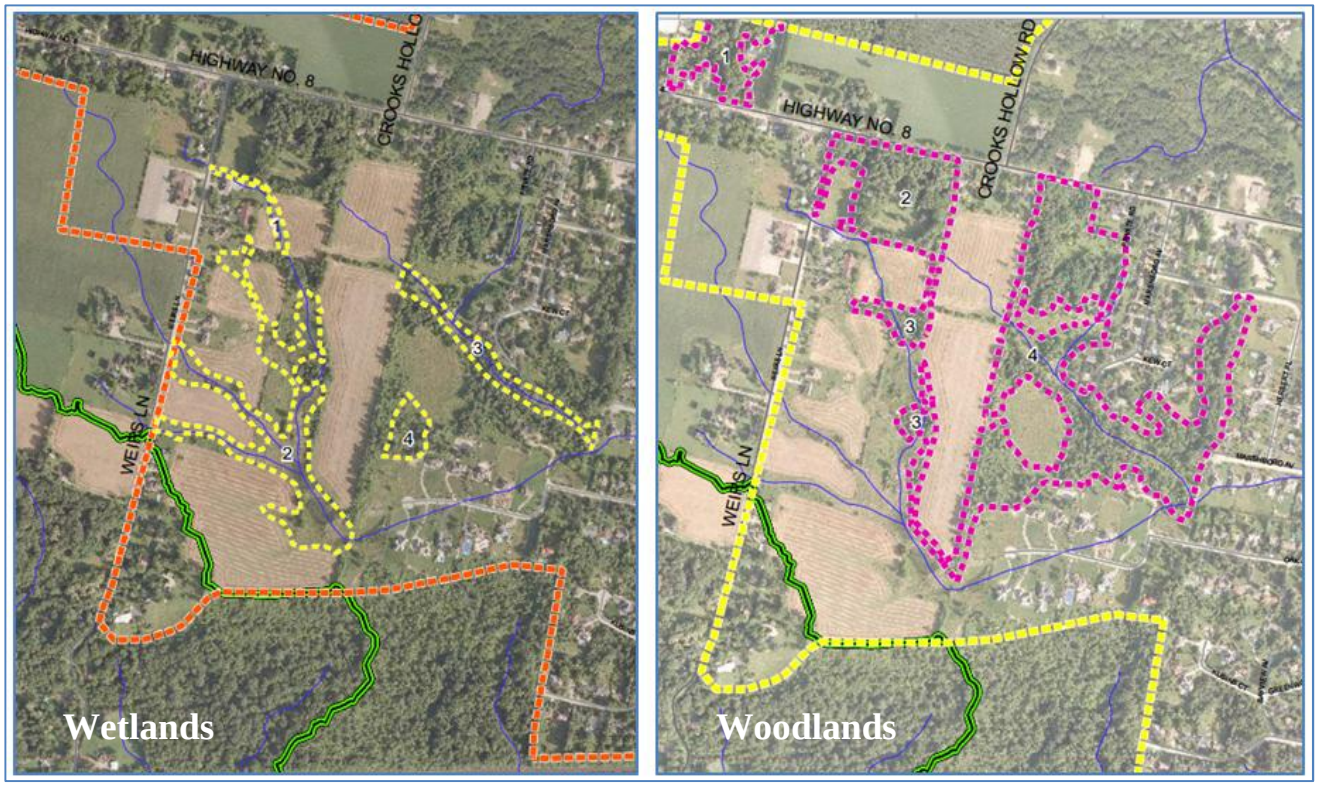
Natural Heritage Feature Potentially Affected by Proposed Site Development and Alteration	Approval Agencies
	• NEC
Other Natural Vegetation Types	• City of Hamilton
Streams and Watercourses	• City of Hamilton • Hamilton Conservation Authority • DFO
Hazards and Adjacent Lands	
Floodplain	• City of Hamilton • Hamilton Conservation Authority
Meanderbelt	• City of Hamilton • Hamilton Conservation Authority
Valleylands, incl. lands within the Dundas Valley	• City of Hamilton • Hamilton Conservation Authority
Wetlands	• City of Hamilton • Hamilton Conservation Authority • NEC
Ravine or Steep Slopes, incl. the Niagara Escarpment	• City of Hamilton • Hamilton Conservation Authority • NEC
Watercourses	• City of Hamilton • Hamilton Conservation Authority

10.4.4.2 Environmental Rehabilitation and Enhancement

The Subwatershed Strategy includes a number of recommendations to address existing environmental issues or to protect/enhance the Core Areas and Linkages of the recommended NHS. Recommended rehabilitation and enhancement measures are not required, but rather are encouraged. Rehabilitation and enhancement measures can be undertaken by stewardship groups (including the Hamilton Conservation Authority) as well as landowners.

Within the RSA, the recommended measures generally refer to the southwest portion of the RSA and include the following:

- Enhancement of wildlife corridors via plantings connecting Wetland 2 (below, left) with the Dundas Valley ESA to the south;
- Plantings in and adjacent to Wetland 2 (inset figure below, left) to improve habitat structure, increase the diversity of adjacent habitats, and create a buffer to future land uses;
- Plantings in and around Woodland 4 (inset figure below, right) and the Dundas Valley ESA to the south to reduce the woodlands' edge-interior ratios and improve opportunities for north-south wildlife movement, and;
- Invasive species management/removal throughout the RSA as necessary.



Detailed descriptions of rehabilitation and enhancement measures for lands *outside* of the Greensville RSA are found in **Section 9.3.5** of this report.

10.4.4.3 NHS Management

To ensure its long-term protection, a variety of management measures should be employed to mitigate the potential impacts of future land uses on the recommended NHS. These measures, to be implemented at the development application stage, include the following:

- the development of an Edge Management Plan;
- the use of fencing to prevent encroachment within the NHS;
- consideration of the location and design of road crossings of the NHS;
- the use of public trails to control access to sensitive vegetation communities within the NHS;
- NHS monitoring prior to, during, and after development and site alteration; and
- public education through signage and/or other material (e.g. homeowner's brochures) to highlight natural heritage features and encourage stewardship.

The 1992 Greensville Secondary Plan dictates the locations and amount of residential and commercial development that can take place within the RSA. As stated in the Secondary Plan, Section B.11.1.2.5, new residential development shall be integrated with parks and open space. As such, consideration should be given to identifying suitable locations for trails adjacent to non-sensitive elements of the NHS such as meadows. It is further recommended that trails be located outside of vegetation protection zones (VPZs). The location of trails should be determined through a context-appropriate study, such as an Environemntal Impact Study, which shall assess the sensitivity of natural heritage features adjacent to where a trail is proposed, and demonstrate that there will be no negative impacts to the ecological form and function of the natural heritage features within the NHS.

10.4.4.3.1 Stewardship

Aquafor Beech Limited recommends that the City of Hamilton develop educational materials (e.g. brochures) to encourage local stewardship of the Greensville NHS. Such brochures should:

- Emphasize the importance of conserving retained natural areas in urbanizing landscapes.
- Provide an overview of the significant natural heritage features and functions of the Greensville NHS.
- Provide specific recommendations to residents to promote environmental stewardship. Topics to be addressed could include (i) the proper means to dispose of organic and hazardous waste; (ii) recommended measures to avoid recreational impacts (e.g. stay on designated trails), (iii) examples of encroachment and their potential impact on retained natural areas, (iv) the importance of keeping cats indoors and dogs on a leash; (v) the use native species rather than invasive exotics in landscaping; and (vi) the proper use of pesticides.

- Outline the environmental responsibilities of the City of Hamilton, developers and local residents.
- Promote opportunities for resident participation in the management and restoration of retained natural areas.
- Provide contact information for sources of additional information and support for stewardship efforts, such as the Hamilton-Halton Watershed Stewardship Program and the Hamilton Landowner Stewardship Council. Such information is especially important for rural landowners.

Opportunities to restore and enhance natural areas exist throughout the Mid-Spencer Subwatershed. In the interest of long-term environmental recovery and sustainability, Aquafor Beech Limited encourages the City of Hamilton, Hamilton Conservation Authority and other relevant agencies to engage communities, organizations and other interest groups in support of stewardship projects throughout the Subwatershed. Opportunities to engage community partners such as the Hamilton-Wentworth Stewardship Council, ReLeaf Hamilton, the Hamilton Naturalists Club, and the Field and Stream Rescue Team should be investigated.

Aquafor Beech Limited has identified three stewardship initiatives that would be beneficial to the recovery, enhancement, and long-term sustainability of the Mid-Spencer Subwatershed:

1) Encourage landowners to avoid cutting grass/farming to the edge of watercourses and to help maintain naturally vegetated riparian areas. Landowners should be partnered with, and encouraged to plant native vegetation along riparian buffers. Healthy riparian areas will help maintain aquatic habitat health and water quality while providing habitat for terrestrial animals and birds. Lack of vegetation in riparian areas was identified as a significant environmental deficiency in the Mid Spencer Creek Stewardship Action Plan (HRCA, 2011).
2) Enhance aquatic, forest, and wetland habitat by eliminating anthropogenic debris (e.g. vehicles, garbage, etc.).
3) Encourage landowners to enhance and/or create naturally vegetated linkages between core areas of the Natural Heritage System.

10.4.4.4 Responsibility for Implementation

This report identifies who is responsible for the implementation of the various Subwatershed Strategy components. The recommended works and measures have been classified into two basic groups, according to who is responsible for implementation:

- City/Agency Responsibility – these works and measures are not directly related to future urban development. Rather, these works and measures are generally recommended to address existing issues or to protect/enhance existing aquatic and terrestrial resources; and,

- Development Proponents' Responsibility – these works and measures are either directly related to future urban development (e.g. stormwater management facilities) or are expected to provide a direct benefit to the developing lands.

Table 10.4.3 below outlines anticipated works for potential development properties within the greater Mid-Spencer/Greensville Subwatershed study area from a natural heritage perspective.

Table 10.4.3: Responsible Parties for Anticipated Works on Potential Development Properties

Task	Responsible Parties	
	City/ Agency	Development Proponent
Rehabilitation and Enhancement Measures	**ü**	**ü**
Buffer Plantings		**ü**
Monitoring Potential Development-Related Impacts		**ü**
Monitoring the Success of Rehabilitation and Enhancement Measures	**ü**	**ü**
Develop and Encourage Stewardship Measures	**ü**	**ü**

Section C2.2.8 of the City of Hamilton Urban Official Plan states that all natural features, required vegetation protection zones and enhancement or restoration areas on a property are to be placed under appropriate zoning in the zoning by-law and/or protected through a conservation easement to the satisfaction of the City of Hamilton or the Hamilton Conservation Authority, or deeded to a public authority. Acquisition by a public body may also be considered as an option for protecting natural features and functions. However, per Section C2.2.1 of the both the Urban and Rural Official Plans, the City of Hamilton is not obligated to purchase lands within the Natural Heritage System.

Per Section C2.12 of the Urban Official Plan and Section C2.11 of the Rural Official Plan, the City of Hamilton may also support the use of non-regulatory measures to establish the recommended NHS. Such measures could include conservation easements, land trusts, public land dedication or acquisition, property tax mechanisms, or similar tools.

10.4.4.5 Targets/Objectives

As stated in **Section 4.7** of this report, the purpose of developing a Natural Heritage System for the Greensville Subwatershed is to maintain, restore or, where possible, improve the diversity and connectivity of both the natural features in an area, and the long-term ecological function

and biodiversity of the natural heritage system. Accordingly, a key objective of the Greensville Subwatershed Study is to provide a framework to guide the development of the lands so that their ecological processes, functions and significant natural features are protected, maintained and enhanced (City of Hamilton, 2012).

The Middle Spencer Stewardship Action Plan (City of Hamilton, 2011) provides a comprehensive summary and analysis of environmental stressors in the Subwatershed, and identifies a number of natural heritage targets for the Subwatershed such as increased forest cover and increased stream buffering. The latter was identified as the primary concern in the Mid-Spencer Subwatershed. In keeping with major objectives of said plan, **Section 10.4.4.2** of this report details the targets and objectives of several rehabilitation and enhancements measures throughout Greensville Subwatershed, including those specific to areas within the Greensville RSA.

The primary targets of the enhancement recommendations within this plan are to:

- Naturalize hazard lands (e.g. floodplains) to benefit wildlife and improve adjacent natural heritage features;
- Diversify habitat types within the Greensville Subwatershed;
- Decrease the edge-interior ratio of natural areas and especially of forest blocks, with an emphasis on enhancing interior forest habitat;
- Protect existing Natural Heritage Features;
- Increase stream health, with 95% of streams buffered by natural vegetation and 75% of stream buffers forested;
- Facilitate and enhance wildlife movement; and
- Reduce invasion opportunities for invasive species.

Specific recommendations for rehabilitation and enhancement opportunities within the greater Mid-Spencer/Greensville Subwatershed study area are located above in **Section 9.3.5**.

10.4.4.6 Requirements for Future Studies

Minor refinements to the boundaries of Core Natural Heritage Features (e.g. wetlands, woodlands, etc) may occur through Environmental Impact Statements (EISs), watershed studies or other appropriate studies accepted by the City without an amendment to the Rural Official Plan. Major changes to boundaries, the removal or addition of Core Natural Heritage Features require an amendment to the Rural Official Plan. It is recommended that areas not extensively surveyed during this study be subject to comprehensive EISs at the direction of the City of Hamilton.

Furthermore, it is recommended that when development is proposed adjacent (i.e. within 120 m) to the Natural Heritage System, that an EIS be completed to identify and mitigate the potential impacts of the development on the natural features and functions of the NHS, to the satisfaction of the City of Hamilton, and other relevant agencies as listed in **Table 10.4.2** above. As mentioned above in **Section 10.4.4.1**, at the detailed design phase the limits/boundaries of natural heritage features are to be staked in consultation with the City of Hamilton and the Hamilton Conservation Authority.

10.4.4.7 Species at Risk and Other Species of Conservation Concern

As discussed in **Section 4.6.3** and **Section 4.7.2.1.1** (see **Table 4.6.23**), sixty four (64) Species at Risk and other Species of Conservation Concern are known or suspected to occur within the greater Mid-Spencer/Greensville Subwatershed study area, thus could also potentially occur within the RSA. Specific recommendations regarding the requirement for future surveys for select species is contained within the aforementioned Sections of this report. Generally, surveys for Species at Risk and species of conservation concern should be completed as part of planning applications.

Species in Ontario are continually being assessed by COSSARO. It is recommended that planners familiarize themselves with the latest iteration of the *Priority List of Candidate Species to be Assessed by COSSARO*, available online here: https://www.ontario.ca/environment-and-energy/help-protect-species-risk.

It is recommended that additional surveys will be completed in the future to confirm the distribution of newly-listed Species at Risk in and immediately adjacent to the study area of the Greensville Subwatershed Study and to guide the refinement of the recommended NHS to ensure that future development plans satisfy the habitat protection requirements of the Ontario Endangered Species Act (2007).

10.4.4.8 Phasing

The location(s) and design of future development within the Greensville RSA will be determined in part by the boundaries of the recommended NHS. Therefore Environmental Impact Studies to define the limits of NHS components, including Core Areas (e.g. the habitat of Species at Risk) should be completed before, or at least in conjunction with the site specific studies required at subsequent planning stages (i.e. Draft Plan of Subdivision or Site Plan) to define the final boundaries of the recommended NHS and the extent of the associated vegetation protection zone and other mitigative measures as appropriate.

The timing of the recommended restoration works and riparian plantings is not dependent on any other works or urban development. However, any required vegetation removals must adhere to

timing windows associated with the Migratory Birds Convention Act, administered by the Ministry of Environment and Climate Change (MOECC).

Ideally, restoration plantings plans would be implemented during the spring or autumn rather than during the hot, dry summer months. Monitoring of the survivorship of plantings should commence one year after planting has been completed and should continue for three to five years depending on site-specific conditions, the availability of funding, and the capacity of monitoring staff. Site-specific monitoring plans are to be developed as part of the overall restoration plan efforts.

10.4.4.9 Summary of Implementation Elements

The following table provides a summary of the implementation elements discussed above as they relate to specific development areas within the Greensville RSA. In the table, each development area is referred to by its catchment number, as illustrated in **Figure 9.2.1**, which has been reproduced below for ease of reference (**Figure 10.4.1**). Specific elements of the Revised NHS within the Greensville RSA (**Figure 10.4.2**), including known locations of Species at Risk and other species of conservation concern (**Figure 10.4.3**), are discussed in **Sections 4.6** and **4.7**. For ease of reference, relevant figures from those sections are reproduced below. It is advised that **Table 10.4.4** be read in concert with the aforementioned figures.

Table 10.4.4: Summary of NHS Implementation Elements Applicable to Each Development Areas within the Greensville Rural Settlement Area

Development Area (see Figure 6.1.2)	**NHS Element(s)**	**Future Natural Heritage Study Requirements***	**Objectives**	**Phasing Considerations**	**Natural Heritage Policy Considerations**	**Approvals**
New Development Area 1	Adjacent lands to the west contain the following NHS features: • Species at Risk • City of Hamilton's NHS • Greenbelt NHS	Environmental Impact Study to: • Confirm use of adjacent property by avian Species at Risk; • Define form and function of adjacent natural area; • Natural features staking; • Assess potential impacts to the NHS resulting from the proposed development; and • Provide VPZ recommendations.	Maintain and protect significant natural heritage features and the ecological functions of the lands within and adjacent to the Greensville RSA. Invasive species removal and/or management.	The location and design of future development within the Greensville RSA will be determined in part by the boundaries of the NHS. Therefore studies to define/refine the limits of NHS components should be completed before, or at least in conjunction with the site specific studies required at subsequent planning stages (i.e. Draft Plan of Subdivision or Site Plan) to define the final boundaries of the recommended NHS and the extent of their associated Vegetation Protection Zones (VPZs).	Eastern Wood-pewee (SC) habitat qualifies as Significant Wildlife Habitat. Significant Wildlife Habitat is considered a Core Natural Heritage Feature and is protected under the OP. Adjacent lands to the west contain Core Natural Heritage Features, including the Greenbelt NHS. Applicable sections of the City of Hamilton's Rural Official Plan (ROP) include: 2.4.2, 2.4.8, 2.4.9, 2.4.10, 2.4.11, 2.4.12, and 2.4.13.	• City of Hamilton • Hamilton Conservation Authority
New Development Area 2	A watercourse (fish habitat) bisects the property. Fish habitat is considered a Core natural Heritage Feature. Adjacent lands to the south and west are part of the City of Hamilton's NHS and are also considered to be an Escarpment Protection Area under the NEP. Natural heritage lands to the south may support amphibian breeding.	Environmental Impact Study to include: • Assessment of headwater drainage feature/contributing fish habitat; • Assessment of anuran and salamander breeding (e.g. HCA Pond and others as applicable), in consultation with the MNRF as applicable; • Assessment of form and function of adjacent Core natural area; • Natural features staking; • Assessment of potential impacts to the NHS resulting from the proposed development; and • VPZ recommendations.	Maintain and protect significant natural heritage features and the ecological functions of the lands within and adjacent to the Greensville RSA. Invasive species removal and/or management.		Core Natural Heritage Features are present within and adjacent to New Development Area 2. Applicable sections of the City of Hamilton's Rural Official Plan (ROP) include: 2.4.8, 2.4.9, 2.4.10, 2.4.11, 2.4.12, and 2.4.13. Stream works should conform to the policies of the Hamilton Conservation Authority's *Planning and Regulation Policies Guidelines* document.	• City of Hamilton • Hamilton Conservation Authority • MNRF • DFO • NEC
New Development Area 3	Species at Risk were identified on the property.	Environmental Impact Study to confirm use of property by avian Species at Risk. The MNRF may require that an Information Gathering Form form be completed; consultation with the MNRF is recommended.	Maintain and protect significant natural heritage features and the ecological functions of the lands within and adjacent to the Greensville RSA. Invasive species removal and/or management.	The location and design of future development within the Greensville RSA will be determined in part by the boundaries of the NHS. Therefore studies to define/refine the limits of NHS components should be completed before, or at least in conjunction with the site specific studies required at subsequent planning stages (i.e. Draft Plan of Subdivision or Site Plan) to define the final boundaries of the recommended NHS and the extent of their associated Vegetation Protection Zones (VPZs).	The habitat of Threatened and Endangered Species is considered a Core Natural Heritage Feature under the City of Hamilton's OP, and is thus protected under the OP. Applicable sections of the City of Hamilton's Rural Official Plan (ROP) include: 2.4.8, 2.4.9, 2.4.10, 2.4.11, 2.4.12, and 2.4.13. Furthermore, Eastern Meadowlark (THR) and its habitat are protected under the Ontario Endangered Species Act (ESA). Accordingly, an ESA permit from the MNRF may be	• City of Hamilton • MNRF

Development Area (see Figure 6.1.2)	**NHS Element(s)**	**Future Natural Heritage Study Requirements***	**Objectives**	**Phasing Considerations**	**Natural Heritage Policy Considerations**	**Approvals**
				It is further recommended that early consultation with the MNRF occur (i.e., prior to the commencement of the EIS). It is possible that site investiagtions completed as part of an EIS could be used to complete the IGF.	required.	
New Development Areas 4 and 5	The property contains or is adjacent to the following: • Species at Risk; • Species of conservation concern; • Core Areas: o Significant woodlands; o Wetlands; o Fish habitat. • Linkages The property is adjacent to the City of Hamilton's NHS and an Escarpment Natural Area, to the south.	Environmental Impact Study to include: • Assessment of Species at Risk and other species of conservation concern; • Assessment of headwater drainage features; • Assessment of fish habitat; • Assessment of form and function of adjacent Core natural area; • Natural features staking; • Assessment of potential impacts to the NHS resulting from the proposed development; • Linkages Assessment; and • VPZ recommendations. The MNRF may require that an Information Gathering Form form be completed in advance of a potential permitting process; consultation with the MNRF is recommended.	Maintain and protect significant natural heritage features and the ecological functions of the lands within and adjacent to the Greensville RSA. Invasive species removal and/or management.. Restoration opportunities have been identified on this property. See **Section 10.4.4.2** for further details.	The location and design of future development within the Greensville RSA will be determined in part by the boundaries of the NHS. Therefore studies to define/refine the limits of NHS components should be completed before, or at least in conjunction with the site specific studies required at subsequent planning stages (i.e. Draft Plan of Subdivision or Site Plan) to define the final boundaries of the recommended NHS and the extent of their associated Vegetation Protection Zones (VPZs). It is further recommended that early consultation with the MNRF occur (i.e., prior to the commencement of the EIS). It is possible that site investiagtions completed as part of an EIS could be used to complete the IGF.	Core Natural Heritage Features are present on adjacent lands and within New Development Areas 4 and 5. Linkages are also present within both New Development Areas. Applicable sections of the City of Hamilton's Rural Official Plan (ROP) include: 2.4.8, 2.4.9, 2.4.10, 2.4.11, 2.4.12, 2.4.13. and 2.7.1. Barn Swallow (THR) and its habitat are protected under the Ontario Endangered Species Act (ESA). Accordingly, an ESA permit from the MNRF may be required. Works proposed adjacent to wetlands and/or watercoureses should conform to the policies of the Hamilton Conservation Authority's *Planning and Regulation Policies Guidelines* document. A permit from the HCA may be required.	• City of Hamilton • Hamilton Conservation Authority • MNRF • DFO • MOECC • NEC
New Development Area 6	None identified on property. Adjacent to the City of Hamilton's NHS and an Escarpment Natural Area, to the north.	Environmental Impact Study to include: • Assessment of form and function of adjacent Core natural area; • Natural features staking; • Assessment of potential impacts to the NHS resulting from the proposed development; and VPZ recommendations.	Maintain and protect significant natural heritage features and the ecological functions of the lands within and adjacent to the Greensville RSA. Invasive species removal and/or management.	The location and design of future development within the Greensville RSA will be determined in part by the boundaries of the NHS. Therefore studies to define/refine the limits of NHS components should be completed before, or at least in conjunction with the site specific studies required at subsequent planning stages (i.e. Draft Plan of Subdivision or Site Plan) to define the final boundaries of the recommended NHS and the extent of their associated Vegetation Protection Zones (VPZs).	Core Natural Heritage Features are present on adjacent lands. Applicable sections of the City of Hamilton's Rural Official Plan (ROP) include: 2.4.8, 2.4.9, 2.4.10, 2.4.11, 2.4.12, and 2.4.13. The northern portion of this development area may be within an area regulated by the Hamilton Conservation Authority.	• City of Hamilton • Hamilton Conservation Authority • NEC
New Development Area 7	None identified on property. Adjacent to the City of Hamilton's NHS and an Escarpment Natural Area, to the	Environmental Impact Study to include: • Assessment of form and function of adjacent Core natural area; • Natural features staking;	Maintain and protect significant natural heritage features and the ecological functions of the lands within and adjacent to the		Core Natural Heritage Features are present on adjacent lands. Applicable sections of the City of Hamilton's Rural Official Plan (ROP) include: 2.4.8, 2.4.9, 2.4.10, 2.4.11, 2.4.12, and	• City of Hamilton • NEC

Development Area (see Figure 6.1.2)	**NHS Element(s)**	**Future Natural Heritage Study Requirements***	**Objectives**	**Phasing Considerations**	**Natural Heritage Policy Considerations**	**Approvals**
	east.	• assessment of potential impacts to the NHS resulting from the proposed development; and VPZ recommendations.	Greensville RSA. Invasive species removal and/or management.		2.4.13.	
New Development Area 8	None identified on property. Adjacent to the City of Hamilton's NHS and an Escarpment Protection Area, to the north, as well as woodland Linkages to the west and south.	Environmental Impact Study to include: • Assessment of form and function of adjacent Core natural area; • natural features staking; • Linkages assessment; • Assessment of potential impacts to the NHS resulting from the proposed development; and • VPZ recommendations.	Maintain and protect significant natural heritage features and the ecological functions of the lands within and adjacent to the Greensville RSA. Invasive species removal and/or management.		Core Natural Heritage Features are present on adjacent lands. Applicable sections of the City of Hamilton's Rural Official Plan (ROP) include: 2.4.8, 2.4.9, 2.4.10, 2.4.11, 2.4.12, 2.4.13. and 2.7.1.	• City of Hamilton • NEC
New Development Area 9	None identified on property.	N/A	N/A	N/A	N/A	• City of Hamilton • NEC

* Environmental Impact Studies must conform with the guidelines set out in the Ofifcial Plan, Section F.3.2.1. The list of Future Natural Heritage Study Requirements in this table are meant to inform future studies and do not represent a final or exhaustive list of study requirements. The Terms of Reference for future studies, including but not limited to Environmental Impact Studies, are to be determined in consultation with the relevant regulatory agencies.

Mid-Spencer Creek / Greenville Rural Settlement Area Subwatershed Study

Legend

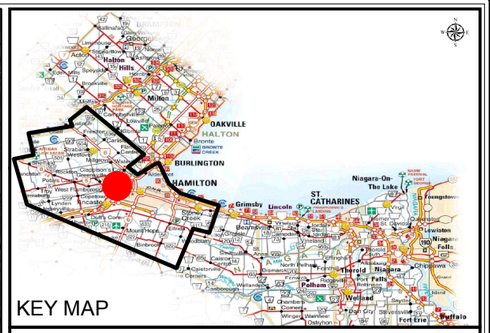
- Watercourses
- Floodline
- Catchment

Catchment Area for Development

- Catchment Area >5ha (Wet Pond)
- Catchment Area <5ha (Traditional Source Controls)
- 1-1 Stormwater management Pond (quality and quantity control)

FIGURE 10.4.2
Development Areas Within the Greensville Rural Settlement Area (includes subcatchments and SWM pond locations)

Aquafor Beech Limited



LEGEND:

- Rural Settlement Area
- Mid-Spencer Creek Subwatershed Boundary
- Parks
- Wetland
- Preliminary Natural Heritage System
- Significant Woodland
- Floodplain

Resvised Natural Heritage System

- Core Areas
- Linkages
- Hedgerow

FishHabitat

- Direct Fish Habitat
- Indirect (Contributing) Fish Habitat

NOTES:

0 125 250 500 750

Meters

Aquafor Beech Limited

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Fax: (905) 546-4435

GREENSVILLE SUBWATERSHED STUDY

Details of the Revised Natural Heritage System Within The Rural Settlement Area

FIGURE: 10-4-3

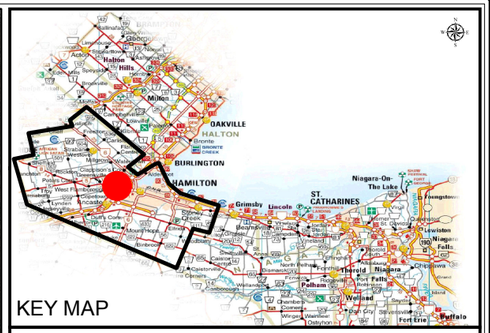
DATE: February 2016

Legend

- Mid-Spencer Creek Subwatershed Boundary
- Rural Settlement Area

Species At Risk

- Bank Swallow (2011)
- Barn Swallow (2011)
- Barn Swallow (2014)
- Black Bulrush (2007)
- Black Bulrush (2011)
- Blue Beech (2011)
- Bobolink (2011)
- Butternut (2007)
- Carolina Wren (2014)
- Chimney Swift (2011)
- Chorus Frog (2014)
- Downy Willow-herb (2011)
- Eastern Meadowlark (2011)
- Eastern Meadowlark (2014)
- Eastern Wood-pewee (2011)
- Tulip Tree (2011)
- Wood Thrush (2014)



KEY MAP

LEGEND:

NOTES:

To be read in conjunction with Natural Heritage maps and reports provided by Ecoplans (2006).

0 0.5 1 2

Kilometers

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Fax: (905) 546-4435

GREENSVILLE SUBWATERSHED STUDY

Species at Risk and Species of Conservation Concern Recorded by NRSI (2007 & 2011) and Aquafor Beech Limited (2014)

FIGURE: 10.4.4

DATE: April 2012

10.4.5 Groundwater Strategy

The City of Hamilton Rural Official Plan and the Greensville Rural Settlement Area Plan provide the planning framework for residential development under private services. The Guidelines for Hydrogeological Studies and Technical Standards for Private Services (City of Hamilton, 2013) provide guidance on how required studies are to be designed for approval by the City.

Section 4.4 described the groundwater system and water budget for the Greensville RSA and **Section 6.2** reviewed the impacts on groundwater quantity and quality under existing and future conditions.

10.4.5.1 Groundwater Targets (New Development)

The target for new development is to maintain or enhance pre-development groundwater recharge both on-site and off-site. It was demonstrated in **Section 9.2.1** that the anticipated recharge deficit from future residential development in the RSA is 127 m^3/ac/year, representing 32 mm precipitation that must be captured and infiltrated on an annual basis (**Table 10.4.1**). This figure represents a post-development impervious coverage of 15%. The application of LID measures are summarized in **Figure 10.4.1**.

The predicted post-development infiltration shortfall of 127 m^3/ac/year (or 32 mm precipitation) can be compensated by capturing and over-infiltrating precipitation, using LID methods reviewed in **Section 10.4.4** and **Figure 10.4.1**. Based on the precipitation distribution at the Hamilton Airport (average of 2010, 2011 and 2013), infiltration of an additional 1.0 mm for every precipitation event onto pervious areas will make up for the post-development shortfall.

The City of Hamilton Criteria and Guidelines for Stormwater Infrastructure Design can be used as a basis for modeling and selecting LID measures. Section 5.1 of this document discusses alternative modeling methods. For the purpose of approvals for new subdivisions continuous modeling (section 5.1.4) should be used. Assessments should be undertaken for existing and proposed conditions to ensure that the requirements as noted above are maintained. Section 2.2 of the Criteria document discussed the different types of measures that should be considered.

10.4.5.2 Design Guidance and Policy Considerations

The main design consideration for new development is lot sizing. Lot sizing are constrained by two policies and guidelines, namely:

- Minimum 1 acre (0.4 hectare) or larger *"as required by environmental and cumulative land use conditions for the discharge and dispersion of sewage system effluent"*(Rural Hamilton Official Plan, Vol. 1, Ch. C.5.1.3';
- "…severances for the purposes of single detached dwellings either as surplus farm dwellings or within rural settlement areas where all resulting lots for single detached dwellings are a minimum of one (1) hectare and a settlement capability study or other servicing study does not recommend larger lots for the subject lands. Note that residential severances under other conditions are not permitted under the Rural Hamilton Official Plan". (Guidelines for Hydrogeological Studies and Technical Standards for Private Development, City of Hamilton 2013, p.2).

Within the lot size range of 0.4 and 1 hectare (1 – 2.5 acres), lots sizes are determined by means of the on-site and off-site predictive assessment for nitrate impacts (City of Hamilton 2013, Appendix B), subject to the following constraints:

- Not exceeding an estimated concentration of 10.0 mg/l of nitrate in the receiving groundwater at the site boundary;
    - Only on-site precipitation will be accepted as a quantifiable dilution mechanism;
    - While in some cases the City will encourage the establishment of infiltration galleries or other LID measures, their real or perceived contribution to infiltration is not to be considered as a quantifiable dilution mechanism; and,
    - Mixing with (or dilution by) groundwater flowing through the site (i.e., underflow) will normally not be considered in the predictive assessment as it may not be possible to control present or future upgradient water uses.

Appendix B.1 of the City of Hamilton Guidelines for Hydrogeological Studies and technical Standards for Private Services provides an example for an On-Site Nitrate Impact Calculation for Privately-serviced Residential Subdivision.

As noted in the example the factors which impact the lot size are:

- Number of proposed lots
- Daily effluent flow
- Subdivision area
- Infiltration rate (which is soils dependent)
- Nitrate loading
- Impervious surface

The example, as shown, is based on a three bedroom house with a 10% impervious value for each of the 20 proposed lots.

Figure 10.4.5 defines the minimum lot size for each of the proposed development areas within the Greensville RSA. These lot sizes shall be used by the developer and should be increased subject to modifications for number of bedrooms and percent imperviousness according to the Hydrogeological Guidelines document. Should smaller lot sizes than those identified in Figure 10.4.5 be proposed, approval of applications under the *Planning Act* to permit the reduced lot sizes would be required.

Further, to implement the recommendations of the Subwatershed Study, amendments will be required to the Greensville Rural Settlement Area Plan Policies and Maps from Volume 2 of the ROP, including a requirement to remove the reference to phasing and the Major Development Areas.

10.4.5.3 Wellhead Protection Areas

The City of Hamilton (2013) hydrogeological guidelines outline the issues that must be addressed for new development, mainly relating to lots size and nitrate impacts. There are additional steps that go beyond the policies in the Rural Official Plan and Greensville RSA Plan.

The City reserves the right to request additional studies for any exempted conditions based on criteria that include, but are not limited to, the following:

- Areas of significant groundwater recharge
- Areas either in proximity to, or within, a wellhead protection area
- Areas deemed vulnerable with respect to groundwater, surface water, or the ecological community
- Areas with existing groundwater contamination issues
- Any other conditions deemed relevant by the City.

It is noted that previous modelling has identified the northern portion of the Greensville RSA (underlain by sand loam) as a Significant Groundwater Recharge Area (SGRA), with reference to Figure 6.7 of the Halton-Hamilton Source Water Committee Assessment Report (2012). Greensville also has a Well Head Protection Area (WHPA), defined by Earthfx (2010a, b).. Developments in these areas may be subject to additional studies for any otherwise exempted conditions based on these criteria.

Mid-Spencer Creek / Greenville Rural Settlement Area Subwatershed Study

Legend

Predominant Soil Texture [1]	Minimum Lot Size (ha)
Silty Sand	0.7
Sandy Silt	0.82

All lot sizes adjusted to 10% imperviousness (Hamilton Guidelines for Hydrogeological Studies and Technical Standards for Private Services, Appendix B and C1) and based on a three-bedroom home.

[1] Derived from Ontario Soil Survey Classifications catergorized into Predminant Soil Textures from Table C1 (Typical Groundwater Recharge Rates), Appendix C of the "Guidelines for Hydrogeological Studies and Technical Standards for Private Services'.

- Watercourses
- Streets

References:
Soils of Wentworth County, Report 32 of the Ontario Soil Survey (1965).
Mid Spencer Creek/Greensville Rural Settlement Area Subwatershed Study, Schlumberger (2007).
Hamilton Guidelines for Hydrogeological Studies and Technical Standards for Private Services.
Servicing Strategy Report-Brarcliffe Estates Subdivision Phase 2, MTE Consultants Inc. (2005)

FIGURE 10.4.5

Minimum Residential Lot Size by Predominant Soil Texture

Aquafor Beech Limited

10.4.6 Groundwater Retrofit Measures

The previous sections described the steps that need to be undertaken in order to ensure that groundwater and surface water conditions are maintained as new development proceeds. However, as discussed in **Chapters** 4 and 6, several issues relating to new and existing developments remain to be addressed at the implementation strategy:

1. Approximately 10% of the wells in Greensville (as of 2008) supply undrinkable water due to bacterial contamination, including the Briencrest communal well;
2. Nitrate levels in the Greensville Municipal Wells and in almost 40% of the private wells sampled in 2008 are presently stable at 60-70% of the Ontario Drinking Water Standard of 10 mg/L. These levels may increase by up to 2 mg/L under build-out conditions; and
3. Approximately 16% of the groundwater generated within the RSA originates from septic systems and many of these are old and not maintained.

There are a number of measures that homeowners could undertake on their properties that would increase the volume of water entering the groundwater systems as well as potentially improving existing water quality. Representative measures were discussed with the Community Advisory Group on two occasions and were also presented at the second Public Information Centre.

The primary retrofit opportunities relate to:

- Monitoring or replacement of septic systems
- Water conservation methods
- Replacement of private wells

Further details with respect to the types of measures that were presented together with the response from the CAG and the public is provided in **Appendix M**.

10.5 Subwatershed Plan Implementation

10.5.1 Surface/Groundwater Implementation Strategy

The Middle Spencer Creek Subwatershed Action Plan (HCA, 2011) identified thirty eight (38) stresses as negative impacts on environmental features and functions within the subwatershed. Out of these stressors, the Action Plan identified three (3) stresses related to surface water management, namely:

d) Water takings;
e) Stormsewer outfalls; and
f) On-line ponds

Implementation considerations related to the three (3) stresses are explained below.

Water Takings:

According to HCA (2011), there are forty four active permits to take water in the subwatershed. The reduction of water takings especially during low water conditions is necessary in order to maintain the ecological health and integrity of surface water features within the subwatershed. It is recommended that the Conservation Authority staff continue reviewing permit applications and assess ecological impacts accordingly.

Storm sewer Outfalls:

There are forty stormsewer outfalls in the subwatershed. Recommendations to address outfalls and stormwater runoff include:

- Undertake water quality studies to evaluate water quality at outfalls;
- Work with City staff to retrofit outfalls;
- Work with landowners to disconnect downspouts and install rain barrels;
- Reduce stormwater load to meet the MOE volumetric target of a 90% overflow capture rate for combined sewer systems

On-line Ponds

Numerous on-line ponds in the subwatershed represent physical and thermal barriers to fish migration and fragment the aquatic habitat landscape. Mitigation measures include:

- Aquatic habitat restoration is needed where on-line ponds act as barriers and fragment aquatic habitat;
- Habitat restoration may involve removing or retrofitting on-line ponds

10.5.2 Groundwater Implementation Strategy

The responsibility for implementing groundwater measures for new development and retrofit opportunities within both the Middle Spencer Creek Subwatershed and the Greensville Rural Settlement Area lies with the City of Hamilton and Hamilton Conservation Authority.

The enabling policy are the City of Hamilton Rural Official Plan and Greensville Rural Settlement Area Plan. The implementation guidelines and approval mechanisms are the City of Hamilton Guidelines for Hydrogeological Studies and Technical Standards for Private Services (2013).

Retrofit opportunities exist in the developed areas of both the Greensville RSA and the mid-Spencer Creek Subwatershed **(Table 10.5.1**) to address six outstanding issues related to water quantity and quality:

1. In the last dry year (2007), a number of wells ran dry;
2. In a 2008 survey, a number of residents stated that their wells were seasonally flooded;
3. There are at least 38 unused water wells in the Subwatershed and Greensville RSA that have not been properly abandoned (HCA, 2011);
4. 10% of the existing wells in Greensville (2008) supply undrinkable water due to bacterial contamination;
5. More than half the existing septic systems in the Greensville RSA are over 25 years old and many are over 50 years old and are beyond their expected lifespan; and,
6. Nitrate levels in the Greensville Municipal Well and in 40% of the private wells sampled in 2008 are presently stable at 60-70% of the Ontario Drinking Water Standard.

Provided below is a summary of existing rural development issues, recommended measures as well as source of information.

Table 10.5.1: Existing Rural Development - Retrofit Opportunities and Implementation

Issue	Recommended Measure	Source of Information
Wells running dry	Extend wells deeper	Section 4.4 (this document)
Unused and faulty wells	Decommission unused and faulty wells	O. Reg. 903, HCA (2011)
	Test well three time a year (free service by City of Hamilton)	City of Hamilton: Private Well Water Supplies - Safe Water
	Extend casing above ground and	O. Reg. 903

Bacteria in drinking water	modify surface drainage to prevent flooding in vicinity of wells	WellAware.ca
	Re-seal well annular space around well casing	O. Reg. 903
Elevated nitrate in water	Infill consents and severances Once the appropriate OBC amendments are approved, advanced treatment systems should be recommended for replacement of septic systems in High Vulnerability Areas.	City of Hamilton (2013) Hydrogeological Guidelines and Technical Standards Clean Water Act (2006) Ontario Drinking Water Stewardship Program (ODWSP) – program ended 2012. O. Reg. 287/07 Ontario Building Code, Division B, s.8.6.2 Ontario Building Code 2nd Consultation (may become mandatory with 2016 revisions to OBC)
Promote infiltration on pervious surfaces	Apply retrofit LID measures including: • Rainwater harvesting • Downspout discharging to pervious areas • bioretention areas	Sections 7.10 and 9.4.3

	• Grassed swales • Permeable pavement • Rain gardens • stormwater planters • Depression storage • Soakaway pits	Low Impact Development Stormwater Planning and Design Guide, V.1 (CVC and TRCA)
More than half of septic systems in Greensville are older than 25 years.	Promote inspection and replacement of faulty septic systems and proper maintenance.	Section 8.3.2 Ontario Building Code, Division C, 1.10.2 Clean Water Act, s. 1.1 and 1.2. Septic Smart – Advanced Treatment Systems, Booklet 2 (Rideau Valley Conservation Authority)
	Develop a tax reduction incentive or grant program for upgrading faulty septic systems	Section 8.3.2 Hamilton Conservation Authority Stewardship Action Plans

10.5.3 Natural Heritage Implementation Strategy, Greater Mid-Spencer/Greensville Subwatershed Study Area

Section 4.7 describes the elements which together comprise the Mid-Spencer Creek Subwatershed Natural Heritage System. The next step in the Subwatershed Study process is to develop a plan to guide future work so that the recommended NHS is successfully implemented.

Successful implementation of the NHS will require the combined efforts of the City of Hamilton, development proponents, local residents, the Hamilton Conservation Authority and other agencies (e.g. MNRF, LEAF). As such, this section outlines the following basic elements of a successful Natural Heritage implementation strategy for the greater Mid-Spencer/Greensville Subwatershed study area:

- Natural Heritage Policy and Approvals;
- Responsibility for Implementation;

- Targets/Objectives;
- Requirements for Future Studies; and
- Phasing.

A general overview of the above implementation elements is provided below.

10.5.3.1 Natural Heritage Policy and Approvals

The majority of the greater Mid-Spencer/Greensville Subwatershed study area is within the City of Hamilton's rural boundary and is subject to the provisions of the City's Rural Official Plan (2012). A portion of the study area is within the City of Hamilton's Urban boundary and is thus subject to the provisions of the Urban Official Plan (2013). The majority of the rural study area is considered Protected Countryside under the Greenbelt Plan. The Rural Official Plan presents overarching policy goals and provides direction for new development and site alteration on lands within and/or adjacent to natural heritage features. In addition, a portion of the study area, ***i.e. in the south***, is subject to the provisions of the Niagara Escarpment Plan (NEP). Hazard lands, including wetlands, floodplains, watercourses, erosion hazards, valley/slopes, etc. and lands adjacent to them are regulated by the Hamilton Conservation Authority. Accordingly, approvals from the City of Hamilton and possibly the Niagara Escarpment Commission and/or Hamilton Conservation Authority will be required for proposed development and site alteration. Further details with regards to regulatory approvals is contained below in **Table 10.5.2**.

A general overview of the requirements of the City of Hamilton's Urban and Rural Official Plans for both Core Natural Heritage Features and Linkages within the greater Mid-Spencer/Greensville Subwatershed study area are presented below.

Core Natural Heritage Features – Rural and Urban

Within the Greenbelt Natural Heritage System of the Protected Countryside:

"***New development*** or ***site alteration*** shall not be permitted within a ***key natural heritage feature*** within the Greenbelt Natural Heritage System or a ***key hydrologic feature*** anywhere in the Protected Countryside**,** including any associated ***vegetation protection zone***. However, new ***development*** or ***site alteration*** proposed adjacent to (within 120 metres of) a ***key natural heritage feature*** within the Greenbelt Natural Heritage System or a ***key hydrologic feature*** anywhere in the Protected Countryside requires an Environmental Impact Statement which identifies a ***vegetation protection zone***, according to the requirements in Sections C.2.4.10, C.2.4.11, C.2.4.12, C.2.4.13, and C.2.4.14." (ROP Section 2.4.2, UOP Section 2.4)

Within the Protected Countryside outside of the Greenbelt Natural Heritage System:

"Beyond the Greenbelt Natural Heritage System within the Protected Countryside new ***development*** and site alteration shall not be permitted within or adjacent to ***key natural heritage features*** in the Greenbelt Protected Countryside unless it has been evaluated through an Environmental Impact Statement and has been demonstrated that there shall be no ***negative impacts*** on the natural features or their ***ecological functions***." (ROP Section 2.4.8, UOP Section 2.4)

Also,

"New ***development*** and ***site alteration*** within the Protected Countryside of the Greenbelt Plan Area that is proposed to take place within or adjacent to any other ***Core Area*** identified on Schedule B - Natural Heritage System, through a consent, Plan of Subdivision, Zoning By-law, Site Plan approval, Official Plan amendment or ***Site Alteration*** By-law permit shall require an Environmental Impact Statement in accordance with Sections C.2.4.6 of this Plan." (ROP Section 2.4.9, UOP Section 2.4)

Furthermore,

"An Environmental Impact Statement shall also propose a ***vegetation protection zone*** which:

a) Has sufficient width to protect the ***Core Area*** and its ***ecological functions*** from impacts of the proposed land use or ***site alteration*** occurring during and after construction, and where possible, restores or enhances the ***Core Area*** and/or its ***ecological functions***; and
b) Is established to achieve, and be maintained as ***natural self-sustaining vegetation***."

(ROP Section 2.4.10, UOP Section 2.4)

Linkages –Rural

The City of Hamilton defines linkages as: "Connections between natural areas provide opportunities for plant and animal movement, hydrological and nutrient cycling, and maintain ecological health and integrity of the overall Natural Heritage System."

The City's Official Plan further states:

"The City recognizes the importance of sustaining ***linkages*** between ***Core Areas*** shown on Schedule B - Natural Heritage System. It is the intent of this policy that ***linkages*** be protected and enhanced to sustain the Natural Heritage System wherever possible." (ROP Section 2.7.1)

In addition:

"Where new ***development*** or ***site alteration*** is proposed within a ***linkage*** in the Natural Heritage System as identified by an Environmental Impact Statement, the Environmental Impact Statement shall include a ***Linkage*** Assessment ***in*** accordance with Section F.3.2.2. (OPA(R)-5)". (ROP Section 2.7.5)

Linkages – Urban

The City of Hamilton defines linkages as: "…natural areas within the landscape that ecologically connect Core Areas. Connections between natural areas provide opportunities for plant and animal movement, hydrological and nutrient cycling, and maintain ecological health and integrity of the overall Natural Heritage System."

The City's Urban Official Plan further states:

"The City recognizes the importance of Linkages shown on Schedule B –Natural Heritage System in reducing the adverse impacts of habitat fragmentation on natural areas. Habitat fragmentation results in loss of species diversity and reduced ecosystem health and resilience. It is the intent of this policy that Linkages be protected**,** restored**,** and enhanced to sustain the Natural Heritage System wherever possible." (UOP Section 2.7)

In addition,

"Where new ***development*** or ***site alteration*** is proposed within a ***Linkage*** in the Natural Heritage System as identified in Schedule B – Natural Heritage System, the applicant shall prepare a Linkage Assessment. On sites where an Environmental Impact Statement (EIS) is being prepared, the Linkage Assessment can be included as part of the EIS report. Any required Linkage Assessment shall be completed in accordance with Policy F.3.2.1.11 - Linkage Assessments." (UOP Seciton 2.7.5)

The Revised Natural Heritage System as shown in this report illustrates the preliminary boundaries of the recommended NHS. NHS boundary refinements can be determined at a subsequent planning stage (Draft Plan of Subdivision or Site Plan) through the completion of additional studies such as an Environmental Impact Study. Site-appropriate management options and/or refinements to the minimum vegetation protection zones (VPZs) outlined in this study will be also determined as part of these additional studies.

Approvals

As mentioned above, proposed development and site alteration within and adjacent to the NHS, where permitted, requires approvals by regulatory agencies. The following table provides a summary of the elements of the revised NHS for the Greensville RSA and the corresponding relevant approval agencies.

Table 10.5.2: Summary of Approvals for Site Development and Alteration Proposed Within or Adjacent to the NHS in the Greater Mid-Spencer/Greensville Subwatershed Study Area

Natural Heritage Feature Potentially Affected by Proposed Site Development and Alteration	Approval Agencies
Core Natural Heritage Features and Adjacent Lands	
Significant Habitat of Endangered, Threatened, and Special Concern Species (Provincial)	• City of Hamilton • MNRF • NEC • DFO
Fish Habitat	• City of Hamilton • MOECC • Hamilton Conservation Authority • MNRF • NEC • DFO
Wetlands	• City of Hamilton • Hamilton Conservation Authority • NEC
ANSIs (Life and Earth Science)	• City of Hamilton • MNRF • NEC
Significant Valleylands	• City of Hamilton • Hamilton Conservation Authority • NEC
Significant Woodlands	• City of Hamilton • NEC
Significant Wildlife Habitat	• City of Hamilton • MNRF • NEC

Natural Heritage Feature Potentially Affected by Proposed Site Development and Alteration	Approval Agencies
	• DFO
Sand Barrens, Savannahs, & Tallgrass Prairies	• City of Hamilton
Alvars	• City of Hamilton
Permanent and Intermittent streams	• City of Hamilton • Hamilton Conservation Authority
Lakes	• City of Hamilton • Hamilton Conservation Authority
Seepage Areas and Springs	• City of Hamilton • Hamilton Conservation Authority
Environmentally Significant Areas (ESAs)	• City of Hamilton
Linkages	
Woodland Linkages	• City of Hamilton • NEC
Other Natural Vegetation Types	• City of Hamilton
Streams and Watercourses	• City of Hamilton • Hamilton Conservation Authority • DFO
Hazards and Adjacent Lands	
Floodplain	• City of Hamilton • Hamilton Conservation Authority
Meanderbelt	• City of Hamilton • Hamilton Conservation Authority
Valleylands, incl. lands within the Dundas Valley	• City of Hamilton • Hamilton Conservation Authority
Wetlands	• City of Hamilton • Hamilton Conservation Authority • NEC
Ravine or Steep Slopes, incl. the Niagara Escarpment	• City of Hamilton • Hamilton Conservation Authority • NEC
Watercourses	• City of Hamilton • Hamilton Conservation Authority

10.5.3.2 Responsibility for Implementation

This Report identifies who is responsible for the implementation of the various Subwatershed Strategy components. The recommended works and measures have been classified into two basic groups, according to who is responsible for implementation:

- City/Agency Responsibility – these works and measures are not directly related to future urban development. Rather, these works and measures are generally recommended to address existing issues or to protect/enhance existing aquatic and terrestrial resources; and,
- Development Proponents' Responsibility – these works and measures are either directly related to future urban development (e.g. stormwater management facilities) or are expected to provide a direct benefit to the developing lands.

Table 10.5.3 below outlines anticipated works for potential development properties within the greater Mid-Spencer/Greensville Subwatershed study area from a natural heritage perspective.

Table 10.5.3: Responsible Parties for Anticipated Works on Potential Development Properties

Task	Responsible Parties	
	City/ Agency	Development Proponent
Rehabilitation and Enhancement Measures	**ü**	**ü**
Buffer Plantings		**ü**
Monitoring Potential Development-Related Impacts		**ü**
Monitoring the Success of Rehabilitation and Enhancement Measures	**ü**	**ü**
Develop and Encourage Stewardship Measures	**ü**	**ü**

Section C2.2.8 of the City of Hamilton Urban Official Plan states that all natural features, required vegetation protection zones and enhancement or restoration areas on a property are to be placed under appropriate zoning in the zoning by-law and/or protected through a conservation easement to the satisfaction of the City of Hamilton or the Hamilton Conservation Authority, or deeded to a public authority. Acquisition by a public body may also be considered as an option for protecting natural features and functions. However, per Section C2.2.1 of the both the Urban and Rural Official Plans, the City of Hamilton is not obligated to purchase lands within the Natural Heritage System.

Per Section C2.12 of the Urban Official Plan and Section C2.11 of the Rural Official Plan, the City of Hamilton may also support the use of non-regulatory measures to establish the recommended NHS. Such measures could include conservation easements, land trusts, public land dedication or acquisition, property tax mechanisms, or similar tools.

10.5.3.3 Targets/Objectives

As stated in **Section 4.6.1** of this report, the purpose of developing a Natural Heritage System for the Greensville Subwatershed is to maintain, restore or, where possible, improve the diversity and connectivity of both the natural features in an area, and the long-term ecological function and biodiversity of the natural heritage system. Accordingly, a key objective of the Greensville Subwatershed Study is to provide a framework to guide the development of the lands so that their ecological processes, functions and significant natural features are protected, maintained and enhanced (City of Hamilton, 2012).

The Middle Spencer Stewardship Action Plan (City of Hamilton, 2011) provides a comprehensive summary and analysis of environmental stressors in the Subwatershed, and identifies a number of natural heritage targets for the Subwatershed such as increased forest cover and increased stream buffering. The latter was identified as the primary concern in the Mid-Spencer Subwatershed. In keeping with major objectives of said plan, Section 8.3.4 of this report details the targets and objectives of several rehabilitation and enhancements measures throughout Greensville Subwatershed, including those specific to areas within the Greensville RSA.

The primary targets of the enhancement recommendations within this plan are to:

- Naturalize hazard lands (e.g. floodplains) to benefit wildlife and improve adjacent natural heritage features;
- Diversify habitat types within the Greensville Subwatershed;
- Decrease the edge-interior ratio of natural areas and especially of forest blocks, with an emphasis on enhancing interior forest habitat;
- Protect existing Natural Heritage Features;
- Increase stream health, with 95% of streams buffered by natural vegetation and 75% of stream buffers forested;
- Facilitate and enhance wildlife movement; and
- Reduce invasion opportunities for invasive species.

10.5.3.4 Requirements for Future Studies

Minor refinements to the boundaries of Core Natural Heritage Features may occur through Environmental Impact Statements (EISs), watershed studies or other appropriate studies accepted by the City without an amendment to the Rural Official Plan. Major changes to boundaries, the

removal or addition of Core Natural Heritage Features require an amendment to the Rural Official Plan. It is recommended that areas not extensively surveyed during this study be subject to comprehensive EISs at the direction of the City of Hamilton.

Furthermore, it is recommended that when development is proposed adjacent to the Natural Heritage System, that an EIS be completed to identify and mitigate the potential impacts of the development on the natural features and functions of the NHS, to the satisfaction of the City of Hamilton.

10.5.3.5 Species at Risk and Other Species of Conservation Concern

As discussed in **Section 4.6.3** and **Section 4.7.2.1.1** (see **Table 4.6.23**), sixty four (64) Species at Risk and other Species of Conservation Concern are known or suspected to occur within the greater Mid-Spencer/Greensville Subwatershed study area. Specific recommendations regarding the requirement for future surveys for select species is contained within the aforementioned Sections of this report. Generally, surveys for Species at Risk and species of conservation concern should be completed as part of planning applications.

Species in Ontario are continually being assessed by COSSARO. It is recommended that planners familiarize themselves with the latest iteration of the *Priority List of Candidate Species to be Assessed by COSSARO*, available online here: https://www.ontario.ca/environment-and-energy/help-protect-species-risk.

It is recommended that additional surveys will be completed in the future to confirm the distribution of newly-listed Species at Risk in and immediately adjacent to the study area of the Greensville Subwatershed Study and to guide the refinement of the recommended NHS to ensure that future development plans satisfy the habitat protection requirements of the Ontario Endangered Species Act (2007).

10.5.3.6 Phasing

The location(s) and design of future development within the Mid-Spencer/Greensville Subwatershed study area will be determined in part by the boundaries of the recommended NHS. Therefore Environmental Impact Studies to define the limits of NHS components, including Core Areas (e.g. the habitat of Species at Risk) should be completed before, or at least in conjunction with the site specific studies required at subsequent planning stages (i.e. Draft Plan of Subdivision or Site Plan) to define the final boundaries of the recommended NHS and the extent of the associated vegetation protection zone and other mitigative measures as appropriate.

The timing of the recommended restoration works and riparian plantings is not dependent on any other works or urban development. However, any required vegetation removals must adhere to timing windows associated with the Migratory Birds Convention Act, administered by the MOECC.

Ideally, restoration plantings plans would be implemented during the spring or autumn rather than during the hot, dry summer months. Monitoring of the survivorship of plantings should commence one year after planting has been completed and should continue for three to five years depending on site-specific conditions, the availability of funding, and the capacity of monitoring staff.

10.6 The Class Environmental Assessment Process

Section 1.5 of this report describes the Municpal Class Environmental Assessment process. As noted in this section this study is being completed as a Master Plan project, following Approach 1.

Under Approach 1 of the Class EA process the Master Plan (this study) is used as a basis for future investigations of site specific Schedule 'B' and 'C' projects. Any Schedule 'B' and 'C' projects that need specific Phase 2 work and Phase 3 and 4 work, usually have the Phase 2, 3 and 4 works deferred until the actual project is implemented.

Section 7.4 and **0** of this report describe the long list of alternatives together with the evaluation and selection process for works that are eleigible under the Environmental Assessment process.

Two general types of works are eligible under the Environmental assessment process. These includes:

- Stormwater Management Measures for New Development, and
- Servicing Alternatives

For the stormwater works for the Rural Settlement Area the preferred alternative (#7) includes LID source control measures combined with Tradidional measures which included end-of-pipe wet ponds and oil grit separators. **Figure 10.4.2** illustrates the preliminary location for seven end-of-pipe facilities. These facilities fall under Schedule 'B' of the Class EA process.

A summary table showing the seven wet ponds together with the EA Schedule is provided below. Reference should be made to **Figure 10.4.2** for preliminary locations.

Table 10.6.1: Environmental Assessment – Stormwater Wet Ponds

STORMWATER POND NUMBERS	CLASS ENVIRONMENTAL SCHEDULE
1-1	B
1-2	B
2-2	B
2-3	B

2-4	B
6-1	B
7-1	B

Other elements of the preferred stormwater strategy fall under Schedule 'A' or 'A+' and thus no further work is required.

For the Servicing Works for the Rural Settlement Area the preferred alternative (#5) includes Maintain Staus Quo – Add in Back Up Well. The Back up Well would fall under Schedule 'C' of the Class Environmental assessment process. Therefore, completion of Phase 2 As well as undertaking of the Phase 3 works would be required.

11 CONCLUSIONS AND RECOMMENDATIONS

11.1 General

The City of Hamilton initiated this study for the Greenville Rural Settlement Area (RSA) and surrounding Mid-Spencer Creek Subwatershed.

The Greensville RSA and Mid-Spencer Subwatershed are located in the former Town of Flamborough and the City of Hamilton. Residents in the Greensville RSA and the subwatershed area are currently serviced by private septic systems and groundwater sourced municipal communal, private communal or individual wells.

A Secondary Plan was prepared for Greensville in 1992 and the land use policies and guidelines for development are outlined in Official Plan Amendment 13 (OPA 13) to the Official Plan for the Town of Flamborough. The Secondary Plan sets out requirements for stormwater drainage and hydrogeology studies to be completed prior to new development within the Greensville Settlement Area. **Figure 3.3.1** and **Figure 3.3.2** illustrate the areas designated for development and the land use designations for the RSA respectively.

The Secondary Plan outlines the requirement for a Comprehensive Servicing Study that is to be undertaken to "provide guidelines to determine the extent and density of residential development that can be sustained without degradation of the quality or quantity of ground or surface waters within and outside the Secondary Plan Boundary". One of the objectives of this study is to define existing environmental conditions and to determine the potential impact of proposed development within the Greensville RSA.

This study was completed as a Master Plan (Approach 1) under the Class Environmental process and will therefore address Phases 1 and 2 of the EA process for any Schedule 'B' projects that are identified and outline additional work that will be required to implement Schedule 'C' projects.

For this study there are two components which are to be addressed as part of the EA process. These include the Stormwater Management and Domestic Water Supply components.

11.2 Study Area

There are two distinct study areas for this project, the Greensville RSA and the Mid-Spencer Creek Subwatershed. Both are located within the Spencer Creek watershed, a majority of which is located within the western portion of the City of Hamilton (**Figure 1.2.1**).

The Mid-Spencer Creek is generally bounded by Governor's Road to the south, Westover Road to the west, Sixth Concession Road to the north and Brock Road to the east. The Mid-Spencer Creek drains an area of approximately 56.4km2. The dominant land use is rural, with the exception of the Greensville RSA and the former Town of Dundas which is located in the southern part of the Subwatershed.

The Greensville RSA is generally bounded by CN Railway to the south, Middletown Road to the west, Dundas Street East (Highway 5) to the north and Ofield Road South to the east. Presently, there are approximately 900 residences located within the RSA. The Greensville RSA covers an area of approximately 655 ha.

It should be noted that the level of effort, in order to respond to the Secondary Plan requirements was more considerable for the Rural Settlement Area. Work in this area included review of background information together with detailed field assessments to confirm the existing natural features. For the Subwatershed area the focus was to use existing information and augment the findings with a more limited degree of technical and field assessments.

11.3 Study Components – Rural Settlement Area (RSA)

The recommended works and measures which comprise the Subwatershed Strategy for the RSA can be classisifed into three general categories:

- Stormwater Management
- Groundwater
- Natural Heritage

Chapter 9 of this document describes the physical measures that comprise the Recommended Plan for the RSA while Chapter 10 defines that steps that are required to implement the Recommended Plan.

As noted above, the purpose of the Implementation Plan is to guide the future work required to implement successfully the components of the recommended solutions and strategies developed earlier (**Chapters** 7 **and** 9). Key objectives include:

- Review of the key Subwatershed Strategy components;
- Identify responsibilities and roles for each of the Subwatershed Strategy components;
- Provide direction as to the types of future studies required for the successful implementation of the Subwatersheds Strategy;
- Provide recommendations with respect to the phasing of proposed works;

- Provide additional design guidance and policy considerations for key Subwatershed Strategy components
- Review of approvals considerations

Details of the implementation may be found in Chapter 10. Provided below is a summary of the proposed measures.

Stormwater Management Strategy

There are nine new development areas to be constructed within the Rural Settlement Area. The preferred strategy involves a combination of Low Impact Development (LID) measures together with traditional stormwater measures (stormwater ponds) to address issues related to flooding, erosion and water balance. The LID measures will address potential groundwater deficits by promoting the infiltration of 127m3/ac/year on a residential lots while the stormwater ponds will maintain impacts associated with erosion an flooding for the 2-100 year storms. The general location of stormwater facilities is shown on **Figure 9.2.1.**

Findings from the impact assessment part of the study found that a variety of stewardship measures measures could be implemented within **existing properties** in order to improve groundwater quality or quantity. These measures which could include modifying the landscape to promote infiltration, installation of rain gardens or soakaway pits or redirection of downspouts were presented to the public for input. **Section 10.4.1** of the report provides further details.

Groundwater Strategy

For new development there are two primary considerations. The first item was addressed above and relates to the preservation of groundwater quantity as a result of proposed development (impermeable surfaces associated with proposed development will reduce the quantity of infiltration into the groundwater system).

The target for new development is to maintain or enhance pre-development groundwater recharge both on-site and off-site. As noted above, the anticipated recharge deficit from future residential development in the RSA is 127 m^3/ac/year, representing 32 mm precipitation that must be captured and infiltrated on an annual basis. This figure represents a post-development impervious coverage of 15%.

The predicted post-development infiltration shortfall of 127 m^3/ac/year (or 32 mm precipitation) can be compensated by capturing and over-infiltrating precipitation, using LID methods described in **Section 10.4.1.** Infiltration of an additional 1.0 mm for every precipitation event onto pervious areas will make up for the post-development shortfall.

The second item relates to lot sizes and the concerns with respect to nitrate loadings from new homes and businesses. The City of Hamilton Guidelines for Hydrogeological Studies and Technical Standards for Private Services provide detail for undertaking On-Site Nitrate Impact

Calculations. The objective is to ensure that the estimated concentration of 10.0 mg/l of nitrate in the receiving groundwater at the site boundary is not exceeded. This study (**Figure 10.4.5)** defines the minimum lot size for each of the nine proposed development areas within the Greensville RSA. These lot sizes shall be used by the developer and should be increased subject to modifications for number of bedrooms and percent imperviousness according to the Hydrogeological Guidelines document. Should smaller lot sizes than those identified in Figure 10.4.5 be proposed, approval of applications under the *Planning Act* to permit the reduced lot sizes would be required.

A series of measures to reduce the impacts associated with existing septic systems as well as measures to monitor or replace existing private wells were presented at the second Public Open House. Collectively these measures would improve the quality of the groundwater or protect/improve the reliability for existing wells. **Section 10.4.6** of the report provides further details.

Natural Heritage

The recommended Natural Heritage System strategy for the Greensville RSA presents recommendations for stewardship, monitoring, ecological rehabilitation and enhancement, as well as best management practices. The characterization of the Natural Heritage System and the related recommendations are presented as a means of maintaining or enhancing the Natural Heritage System. The NHS and natural hazards within the RSA are shown below in **Figure 9.2.3**. Per Section B.11.1.1.6 of the Greensville Secondary Plan and the provisions of the City of Hamilton's Rural Official Plan, the NHS for the Greensville RSA protects Key Natural Heritage Features, including Environmentally Significant Areas; identifies Linkages; and provides recommendations for minimum Vegetation Protection Zones (i.e. buffers) to Core Natural Heritage Features.

The Natural Heritage System Strategy presents an overview of the requirements of the City of Hamilton's Rural Official Plan. Requirements for future studies, including a list of applicable approval agencies, are also presented. Rehabilitation and enhancement recommendations follow the direction of the Mid-Spencer Creek Stewardship Action Plan.

11.4 Domestic Water Supply

The Greensville Rural Settlement Area area encompasses 655 hectares and a population of approximately 2,500 persons who rely on groundwater wells for drinking water. There is one City owned municipal well (supplying 36 homes) and the Briencrest well which supplies 26 homes.

A number of alternatives to provide domestic water to existing and future residents and businesses within the rural settlement area were considered. The alternatives which were considered include:

- Do Nothing
- Control/Limit development
- Bring up Municipal water
- Provide more Communal wells
- Maintain Status Quo and add a Backup City Well

Each of the alternatives were then evaluated against a series of criteria which are broadly categorized as:

- Physical and Natural Environment
- Social, Economic and Cultural Environment
- Technical Factors
- Financial Factors
- Legal and Jurisdictional Factors

The Preferred Domestic water supply Alternative is to maintain individual services (wells and septic systems) on future lots and to add a backup well to the existing city well.

This alternative was selected based on the impact to the environment, capacity of groundwater resources, consistency with existing policy and the objective to provide a better level of service to the homes currently serviced by the municipal well.

The location, sizing and preliminary design of the necessary infrastructure (treatment plant, storage tank) will be subject to further assessment to be undertaken under Schedule C of the Municipal Class Environmental Assessment.

12 REFERENCES

Aquafor Beech Ltd. 2008. Draft Report on Water Quality Survey of the Greensville Rural Settlement Area. Report prepared for the City of Hamilton Water and Wastewater Division, 13p.

Bickerton, H. and M. Thompson-Black. 2010. Recovery Strategy for the Eastern Flowering Dogwood (*Cornus florida*) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources, Peterborough, Ontario. vi + 21 pp.

Bolton, Ryan. "Western Chorus Frog (*Pseudacris Triseriata*)." *Reptiles and Amphibians of Ontario*. Ontario Nature, 2013. Web. 25 Feb. 2014.

Brunton, F.R. 2008. Preliminary Revisions to the Early Silurian Stratigraphy of Niagara Escarpment: Integration of Sequence Stratigraphy, Sedimentology and Hydrogeology to Delineate Hydrogeologic Unit, in Summary of Field Work and other Activities, Ontario Geological Survey Open File Report 6226, p. 31-1 to 31-18.

Cadman, M.D., D.A. Sutherland, G.G. Beck,D. Lepage, and A.R. Couturier (eds.). 2007. Atlas of the Breeding Birds of Ontario, 2001-2005. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources, and Ontario Nature, Toronto, xxii + 706 pp.

Canada Mortgage and Housing Corporation. 2001 (revised 2007). Innovative On-site Wastewater Treatment, Research Highlight, Technical Series 01-138.

Canada Mortgage and Housing Corporation. 2003 (revised 2005). About Your House – Buying a House with a Well and Septic System, CE 40.

Canada Mortgage and Housing Corporation. 2001 (revised 2005). About Your House – Your Septic System, CE34.

City of Hamilton. 2013. Guidelines for Hydrogeologic Studies and Technical Standards for Private Services.

City of Hamilton Health Department, Microsoft Access database. 2005.

City of Hamilton Public Health Services. 2012. Hamilton Rural Well Water Quality Report. 16p.

City of Hamilton. 2010. Residential Pollution Prevention - Septic Systems.

City of Hamilton Rural Official Plan, Chapters C – G, March 7, 2012

City of Hamilton Rural Official Plan, Volume 2, Chapter A – Secondary Plans and Rural Settlement Area Plans, June 28, 2011.

City of Hamilton. 2012. Rural Hamilton Official Plan. Volume 1: Policies.

City of Hamilton. 2014. Urban Hamilton Official Plan. Volume 1: Parent Plan.

City of Hamilton. 2008. Urban Natural Heritage System: Discussion Paper. 36 pp.

COSEWIC Species Database : Thrush, Wood." *COSEWIC Species Database : Thrush, Wood*. MNRF, n.d. Web. 24 Nov. 2014.

COSEWIC. 2013. COSEWIC assessment and status report on the Bank Swallow *Riparia riparia* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 48pp.

COSEWIC. 2011[1]. COSEWIC assessment and status report on the Barn Swallow *Hirundo rustica* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 37 pp.

COSEWIC. 2011[2]. COSEWIC assessment and status report on the Eastern Meadowlark *Sturnella magna* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 40 pp.

COSEWIC. 2010[1]. COSEWIC assessment and status report on the Cerulean Warbler *Dendroica cerulea* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 40 pp.

COSEWIC. 2010[2]. COSEWIC assessment and status report on the Monarch *Danaus plexippus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 42 pp.

COSEWIC. 2009. COSEWIC assessment and update status report on the Least Bittern *Ixobrychus exilis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 36 pp.

COSEWIC. 2008. COSEWIC assessment and status report on the Snapping Turtle *Chelydra serpentina* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 47 pp.

COSEWIC 2007. COSEWIC assessment and update status report on the Red-headed Woodpecker *Melanerpes erythrocephalus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 27 pp.

COSEWIC 2006. COSEWIC assessment and status report on the Golden-winged Warbler *Vermivora chrysoptera* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 30 pp.

Credit Valley Conservation and Toronto Region Conservation Authority 2010. Low Impact Development Stormwater Management Planning and Design Guide. Version 1.0, 2010, 300 p. + Appendices

Dwyer, J.K. (ed). 2003. Nature Counts Project: Hamilton Natural Areas Inventory. Hamilton Naturalists' Club.

Earthfx 2010a. Vulnerability Assessment and Scoring of Wellhead Protection Areas, City of Hamilton, Ontario. Prepared for the City of Hamilton Public Works Department, April 2010, 162 p.

Earthfx 2010b. Greensville Rural Settlement Area Groundwater Modeling Assessment, City of Hamilton. Prepared for the City of Hamilton Public Works Department, November 2010, 73 p.

EarthFX. 2015. Tier 3 Water Budget and Local Area Risk Assessment for the Greensville Groundwater Municipal System – Risk Assessment Report. Prepared for Conservation Halton, March 2015, 195p. + Appendices.

EarthFX. 2014. Tier 3 Water Budget and Local Area Risk Assessment for the Greensville Groundwater Municipal System – Phase I Model Development and Calibration Report. Prepared for Conservation Halton. May 2014, 263p.+ Appendices.

Environment Canada. 2014. Management Plan for the Monarch (*Danaus plexippus*) in Canada [Proposed]. Species at Risk Act Management Plan Series. Environment Canada, Ottawa. iv + 39 pp.

Environment Canada. 2011[1]. Management Plan for the Louisiana Waterthrush (*Seiurus motacilla*) in Canada [Proposed]. *Species at Risk Act* Management Plan Series. Environment Canada, Ottawa. iii + 18 pp.

Environment Canada. 2011[2]. Recovery Strategy for the Least Bittern (*Ixobrychus exilis*) in Canada [Proposed]. *Species at Risk Act* Recovery Strategy Series. Environment Canada. Ottawa. v + 34 pp.

Environment Canada. 2010. Recovery Strategy for the Butternut (*Juglans cinerea*) in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa vii + 24 pp

Environment Canada. 2007. Area Sensitive Forest Birds in Urban Areas. 64 p.

Environment Canada 2005. Residential Water Use Indicator, http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=7E808512-1

Environment Canada. 2004. How Much Habitat is Enough?: A Framework for Guiding Habitat Rehabilitation in Great Lakes Areas of Concern. Second Edition. Environment Canada, Ottawa, iv + 80 pp.

Farrar, John Laird. 1995. ***Trees in Canada***. Ottawa: Fitzhenry & Whiteside. Print.

Goodban, Anthony G. 2003. The Vascular Plants of Hamilton, Ontario.

Grant, G.E.; Schmidt, J.C.; and Lewis, S. L. 2003. A Geological Framework for Interpreting Downstream Effects of Dams on Rivers. Water Science and Application 7.

Griffiths, R.W. 1999. BioMAP: Bioassessment of Water Quality. Published by Niagara College, Niagara-on-the-Lake, ON.

Hamilton Naturalist Club. 2014. Checklist of the Birds of the Hamilton Area; http://hamiltonnature.org/birds/checklist

Halton-Hamilton Source Protection Staff. 2010. Assessment for Halton-Hamilton Source Protection Region and Report of Tier 2 Water Budget and Water Quantity Stress Assessments for the Upper West Branch of Sixteen Mile Creek and Middle Spencer Creek Subwatersheds. Version 4.3, August 27, 2010.

Hamilton-Halton Watershed Stewardship Program . 2004. Septic Awareness in Rural Hamilton – Final Project Report. Prepared for the City of Hamilton, November 2004.

Hamilton-Halton Source Protection Committee 2012. Approved Assessment Report. Hamilton Region Source Protection Area, January 2012, 337 p.

Hamilton Region Conservation Authority. 2011. Middle Spencer Creek Subwatershed Stewardship Action Plan.

Hamilton Conservation Authority. 2009. Logie's Creek Subwatershed Stewardship Action Plan.

Hamilton Region Conservation Authority. 1998. Spencer Creek Fisheries Assessment.

King, B.L. 1989. Seed germination ecology of Aureolaria virginica. *Castanea* 54.1: 19-28. Print.

Lamond, William G. 1994. The Reptiles and Amphibians of the Hamilton Area. A Historical Summary and Results of the Hamilton Herpetofaunal Atlas. Hamilton Naturalist Club.

Layberry, R.A., P.W. Hall, and J.D. Lafontaine. 1998. The Butterflies of Canada. University of Toronto Press, Toronto, Ontario. 280 pp.

Ministry of Municipal Affairs and Housing. 2014. Provincial Policy Statement.

Ministry of Municipal Affairs and Housing 2011a. Potential Changes for the Next Edition of the Building Code: Second Round of Consultation (February – April 2011), ISBN 978-1-4435-5537-1, 41 p.

Ministry of Municipal Affairs and Housing 2011b. On-Site Sewage System Maintenance Inspections, March 2011, 6 p.

Ministry of Municipal Affairs and Housing. 2005. Greenbelt Plan. 57 pp.

Ministry of Natural Resources and Forestry. 2014. https://www.ontario.ca/environment-and-energy/wood-thrush

Ministry of Natural Resources and Forestry. 2013[1]. *Executive Summary – Recovery Strategy for the Bobolink (Dolichonyx oryzivorus) and Eastern Meadowlark (Sturnella Magna) in Ontario*. Prepared by Jon McCracken, Ron Ried, Rosalind Renfrew, Barbara Frei, Jarmo Jalava, Amber Cowie and Andrew Couturier. May 31, 2013.

Ministry of Natural Resources and Forestry. 2013[2]. *General Habitat Description for the Bobolink (Dolyconyx oryzivorus).* July 2, 2013.

Ministry of Natural Resources and Forestry. 2013[3]. *General Habitat Description for the Eastern Meadowlark (Sturnella magna).* July 2, 2013.

Ministry of Natural Resources and Forestry. 2013[4]. *General Habitat Description for the Barn Swallow (Hirundo rustica).* July 2, 2013.

Ministry of Natural Resources and Forestry. 2013[5]. *General Habitat Description for the American Ginseng (Panax cinqufolius).* July 2, 2013.

Ministry of Natural Resources. 2014. Natural Heritage Assessment Guide. 109 p.

Ministry of Natural Resources. 2012. Draft Ecoregion Criteria Schedule for 7E.

Ministry of Natural Resources. 2011. Bobolink (*Dolichonyx oryzivorus*). Toronto: Queen's Printer for Ontario. 2 pp.

Morrison Beatty Ltd 1988. Preliminary Assessment Groundwater Availability and Soil Suitability: Proposed Residential Development, Part of Lot 7, Concession II. Report prepared for the Region of Hamilton-Wentworth, Report 635-88.

Natural Heritage Information Centre. Bird checklist Excel table spreadsheet. 2014. https://contrib.ontario.ca/environment-and-energy/get-natural-heritage-information

Niagara Escarpment Commission. 2005. The Niagara Escarpment Plan. Toronto: Queen's Printer for Ontario. 138 pp.

Ontario Building Code 2006, as amended to 2012.

Ontario Geological Survey 2011. Surficial Geology of Southern Ontario. Miscellaneous Release – Data.

Ontario Ministry of the Environment (MOE). 1999. Revised Stormwater Management Guidelines. Draft Report. Ontario Ministry of the Environment.

Ontario Ministry of Natural Resources. 1993. Ontario Wetland Evaluation System Southern Manual covering Hill's Site Regions 6 and 7. 3rd Edition. Revised 2002.

Ontario Rural Wastewater Centre. 2007. At Home Solutions for your Onsite System, Presentation for Greensville Source Water Protection Open House, November 21, 2007 presented by Katherine Rentsch, P. Eng.

Ontario Rural Wastewater Centre and Ontario Ministry of the Environment. 2014. Your Septic System: Protecting your Investment and the Environment.

Paulson, Dennis R. *Princeton Field Guides*: *Dragonflies and Damselfies of the East*. Princeton University Press. 2011. Print.

Peck, George K., and Ross D. James. *Breeding Birds of Ontario: Nidiology and Distribution*. Vol. 2. Toronto: ROM, 1983. Print.

"Red-headed Woodpecker." *Species Profile: Red-headed Woodpecker*. Government of Canada, 1 Nov. 2010. Web. 28 Mar. 2012. <http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=57>.

Redside Dace Recovery Team. 2010. Recovery Strategy for Redside Dace (*Clinostomus elongatus*) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources, Peterborough, Ontario. vi + 29 pp.

Rideau Valley Conservation Authority 2011. SepticSmart! Advanced Treatment Systems – Alternatives to Conventional Septic Systems, Booklet No. 2, http://www.rvca.ca/news/septic_smart_index.html

Seca. R. 1983. Sanitary Survey in the Rural Settlement of Greensville. Report prepared for the Regional Municipality of Hamilton-Wentworth, December 1983.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Bulletin. Fisheries Research Board of Canada. 184:1-966.

Sibley, David, Chris Elphick, and John B. Dunning. *The Sibley Guide to Bird Life & Behavior*. New York: Alfred A. Knopf, 2001. Print.

SNC Lavalin 2011. Greensville Well and Surface Water Sampling Program, Draft Report to City of Hamilton, March 2011.

Thornthwaite and Mather 1957. Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance. Drexel Institute of Technology, Laboratory of Climatology, Publications in Climatology 10(3), 311p.

Toronto and Region Conservation Authority (TRCA). 2009. Aquatic Habitat and Species Monitoring: A Discussion Paper in Support of the Development of a Regional Watershed Monitoring Network. http://www.trca.on.ca/dotAsset/114187.pdf. Accessed February 12, 2012.

Toronto and Region Conservation Authority. 2004. Forest Edge Management Plan Guidelines.

Waterloo Hydrogeologic Inc., now Schlumberger Water Services (2008): City of Hamilton Mid-Spencer Creek / Greensville RSA Stage 1 Report. Prepared for the City of Hamilton, February 2008.

Wetzel, R.G. 2001. Limnology. Lake and River Ecosystems. Third Ed. Academic Press, San Diego. xvi, 1006 pp. ISBN 0-12-744760-1

Wormington, A. and W. Lamond. 2003. The Butterflies of Hamilton, Ontario.