TECHNICAL APPENDIX:
FUNCTIONAL STORMWATER
AND ENVIRONMENTAL MANAGEMENT STRATEGY

BOYNE SURVEY SECONDARY PLAN AREA
FINAL REPORT

TOWN OF MILTON

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TABLE OF CONTENTS

Section **Page No.**

APPENDICES

LIST OF FIGURES

LIST OF DRAWINGS

LIST OF TABLES

1. INTRODUCTION

This Technical Appendix to the Subwatershed Update Study for the Sixteen Mile Creek Areas 2 & 7 provides technical support to the Secondary Land Use planning process for the Town of Milton, Boyne Survey Area (ref. Drawing 1) related to aquatic and terrestrial resources, surface water and groundwater resources, and outlines where the various features and functions prove to be constraints and/or opportunities to specific land uses. This Technical Appendix specifically also outlines the preferred stormwater and environmental management strategy for the recommended Boyne Survey Secondary Plan land use.

The Functional Stormwater and Environmental Management Strategy (FSEMS) builds upon direction from the Sixteen Mile Creek Watershed Plan 1996, Sixteen Mile Creek Subwatershed Planning Study - Areas 2 & 7, January 2000, Indian Creek/Sixteen Mile Creek Sherwood Survey Subwatershed Management Study, December 2004, and the Sixteen Mile Creek Subwatershed Update Study – Areas 2 & 7, November 2015 (SUS). The Subwatershed Update Study (SUS) environmental goals and objectives have been integrated into the proposed land use plan.

2. BACKGROUND INFORMATION REVIEW

The Boyne Survey Secondary Plan encompasses an area of approximately 956 ha located south of Louis St. Laurent Avenue in the southern part of the Town of Milton (ref. Drawing 1). The current land use is predominantly agricultural with the Sixteen Mile Creek Main Branch running through the approximate middle of the area (ref. Drawing 2). As part of the Secondary Plan process for this area, a preferred land use concept for the study area has been prepared (ref. Drawing 3).

A number of previous stormwater servicing and environmental studies have been completed for various development areas within the study area including:

i) Environmental Audit of channel works, Bristol Survey, Milton, Aquafor Beech Ltd in association with C. Portt & Associates, November, 2005.

ii) Indian Creek /Sixteen Mile Creek Sherwood Survey Subwatershed Management Study, Town of Milton, Philips Engineering Ltd., 2004.

iii) Sixteen Mile Creek Areas 2 & 7 Subwatershed Update Study, AMEC Environment & Infrastructure, November 2015 (parent document to this Technical Appendix).

iv) Functional Stormwater and Environmental Management Strategy Highway 401 Industrial/Business Park Secondary Plan Area, Philips Engineering Ltd., July 2000.

v) Sixteen Mile Creek Subwatershed Planning Study Areas 2 & 7, Philips Planning and Engineering Limited, January 2000.

vi) Bronte Creek Watershed Study (Planning and Engineering Initiatives Ltd., Schroeter and Associates, October 2002.

More specific/relevant detail related to some of the foregoing is offered in the following sections:

2.1 Watershed and Subwatershed Studies

These legacy documents contain data and analysis which form a major component of the background data and natural heritage approaches that were in effect at the time they were completed.

The Sixteen Mile Creek Watershed Plan (Ecoplans Ltd., 1996) documented woodlots located below the Niagara Escarpment using a woodlot polygon classification system developed by Geomatics International (1993) for the Oak Ridges Moraine within the boundaries of the Greater Toronto Area. Woodlot documentation was principally reliant on background data sources; limited field study of woodlots was conducted. Information for 171 discrete woodlots was summarized; this included 21 woodlots in Subwatershed 2, and 18 woodlots in Subwatershed 7.

The Bronte Creek Watershed Study (Planning and Engineering Initiatives Ltd., Schroeter and Associates, October 2002) included hydrologic analyses and geomorphological characterizations within the context of the Bronte Creek Watershed. Preliminary guidance

regarding stormwater management requirements were also provided for the various subwatersheds, based upon the high-level analyses completed for that study. More refined analyses within the Indian Creek Subwatershed were completed as part of the Sherwood Survey Subwatershed Management Study (Philips Engineering Ltd., December 2004), principally related to the Sherwood Survey Secondary Planning Area and select components of the receiving natural systems.

The Sixteen Mile Creek Subwatershed Planning Study, Areas 2 & 7 (Philips Planning and Engineering Ltd., January 2000) provided preliminary constraint guidance for the stormwater and environmental management system within the Boyne Survey area in order to satisfy watershed-based targets. In 2007, the Town of Milton initiated a study to update that original Subwatershed Study. The Subwatershed Update Study (AMEC Environment & Infrastructure, November 2015) provides a detailed evaluation of the environmental features and constraints within the Boyne Survey Secondary Planning area, as well as an overview of various management alternatives, including the conceptual framework for the Natural Heritage System through the study area; while intended to provide an update to the constraints and environmental management systems specifically related to the Sixteen Mile Creek Subwatersheds, the work plan for this study also included a scoped assessment and constraints ranking for the Boyne Survey Area within the Indian Creek Subwatershed of the Bronte Creek Watershed. The detailed management strategy provided within this document has built upon the constraints and opportunities identified within the SUS.

2.2 Region of Halton "Sustainable Halton Growth Management Plan"

The Sustainable Halton Plan is a growth management planning project initiated in May 2006, intended to promote the concept of sustainable development. It includes a Natural Heritage System which identifies the Region's conceptual approach defined as considering the importance of maintaining and protecting ecological features in the environment (woodlands, wetlands, and watercourses, etc.), ecological functions of the environment (water storage and water quality enhancement by wetlands, winter deer yards provided by dense cedar woodlands, amphibian breeding habitat in ephemeral forest ponds, etc.) and ecological interactions that occur over varying scales of time and space (animal predation and herbivory, the daily, seasonal and long term movement patterns of plants and animals), and the role of ecological disturbance mechanisms (fire, wind, water, and disease, etc.). Further details regarding the information and direction provided by Sustainable Halton is provided in the Sixteen Mile Creek Subwatershed Update Study (November 2015).

3. STUDY AREA INVENTORY AND CONSTRAINT IDENTIFICATION

The study area resources have been examined as part of the watershed and subwatershed studies (*ref*. *Philips Planning and Engineering Ltd., 2000, Philips Engineering Ltd., 2004, and AMEC Environment & Infrastructure, 2015*). As part of this functional strategy, these resources have been examined in greater detail in order to facilitate the land use and infrastructure planning process. Specific discipline areas considered in the assessment have included hydrogeology, hydrology, hydraulics, water quality, fisheries, streams and terrestrial systems. Full details regarding the methodology and findings applied for the baseline constraint assessment are provided within the Subwatershed Update Study and the Indian Creek Subwatershed Management Study; this section summarizes the key findings related to each study discipline for the purpose of developing the stormwater and environmental management strategy for the Boyne Survey area. Unless sufficient justification is provided to indicate otherwise, field data greater than 5 years old cannot be used in a Subwatershed Impact Study (SIS), and must be redone, or at a minimum, validated. Additional details regarding the local monitoring program requirements to support the SISs are provided in the SIS Terms of Reference (ref. Appendix 'M').

3.1 Hydrogeology

The following summarizes the key findings presented in Subwatershed Update Study specifically related to the Boyne Survey study area.

Physiography and Geology

- The study area consists of the physiographic regions identified as the Peel Plain and the South Slope.

- The shape of the bedrock surface as well as the occurrence of the overburden units which make up the above regions is a result of the repeated glacial advances and retreats which have occurred in Southern Ontario.

- The surficial overburden of the South Slope physiographic unit in the study area is comprised of the silty to clayey Halton Till. The surficial material in the Peel Plain, which covers the majority of the study area, consists of glaciolacustrine silts and clays.

- The topography within this area has a gentle, somewhat undulating form sloping southwest.

- The bedrock underlying the glacial deposits consists of the Queenston shale. The upper 5 m of the shale can be weathered and fractured.

- The overburden thickness in the Boyne Survey study area varies from 3-20 m. It is less than 5 m within Area B on Map 1 (Appendix 'B' and Drawing 2) and increases in thickness to the south and east (based on overburden thickness map OGS Map 2179 in Appendix 'B').

Conceptual Groundwater Flow System Characterization

- Within the Boyne Survey study area, much of the surficial overburden consists of clay material which typically is of a low permeability, that is, it does not transmit water readily. Relative to the thick clay till there are areas with other hydrostratigraphic characteristics which may provide an increased potential for groundwater recharge. Within the Boyne Survey area this would include Area B, a localized area of thin, fractured till overburden less than 5 m thick.

- The underlying bedrock is a low permeability shale which will not provide a significant underdrain and as such will likely not lead to extensive fracturing in the overlying clay tills. Areas where the overburden is thinner may allow for a higher level of infiltration compared to the thicker silt/clay deposits.

- The general direction of horizontal groundwater flow within the shallow overburden/shale system will be northwest to southeast, reflecting the general bedrock and overburden topography. The horizontal component of groundwater flow, particularly within the overburden, will be weak due to low permeability of the silt/clay sediments.

- Discharge may occur where the watercourses cut into the upper fractured shale or sand and gravel lenses but this has not been observed within the Boyne Survey area.

- Groundwater recharge is expected to be relatively low and may be directed to the surface watercourses but the existing hydrostratigraphy indicates that this groundwater movement would be minor.

- The low permeability of the Halton Till provides a significant level of protection to groundwater quality within the underlying shale and sand/gravel units. The protection is lessened where the till is thinner (i.e. less than 5 m).

- The installation of monitoring wells was not within the scope of the Boyne Survey FSEMS and water level trends were based on data reviewed for the Subwatershed Update Study. The groundwater level trends for the Halton Region wells tend to show consistent water levels or a slight increase. The groundwater level trend in the PGMN well shows a minor downward trend from 2001 through 2007 along with seasonal variations of approximately 2.5 m. Data for 2008 shows a general increase of approximately 0.5 m. The wells for the environmental monitoring program were monitored July-November 2006 and showed seasonal trends as well but were more subdued, on the order of 1 metre. This was likely due to missing the spring recharge event or buffering of the water table as the wells are located near surface water sources. Groundwater level hydrographs can be found in Appendix ‘B’.

- The shallow groundwater mapping (Appendix ‘B’) indicates some minor groundwater divides which to a degree follow the surface water divides. Shallow flow appears to be directed more to the south in the eastern portion of the Boyne Survey area and to the southeast in the western portion. The deeper groundwater flow tends to follow the general pattern of the shallow groundwater flow to the east/south-east (Appendix ‘B’).

Groundwater Function and Availability

- Private domestic wells are generally drilled into the Queenston shale (10-15 m into the shale), localized discontinuous sand lenses within the silt clay overburden or discontinuous sand and gravel lenses at the overburden/bedrock contact. The quality of water within the Queenston shale is generally poor due to naturally elevated levels of iron, manganese and chloride.

- Within or immediately adjacent to the Boyne Survey area there are approximately 14 overburden wells and 21 bedrock wells. The majority of the wells have capacities less than 1.4 l/min. One of the overburden wells and 2 of the bedrock wells have specific capacities of 1.4-5.8 l/min. This information was obtained from the Tier 1 Water Budget Halton Region Source Protection Area (Draft Report, 2008).

- For the Subwatershed Update Study spot baseflows were measured in the field at selected sites (Map 1 Appendix 'B'). Within the Boyne Survey study are these included sites IC21, IC20 and sites 53, 54, 55, 58, 59 and 60. These sites were visited 3 times in 2007, twice in 2008 for the Subwatershed Update Study and 3 times in 2010 for the Boyne Survey study for indications of baseflow. At no time was baseflow observed in these reaches within the Boyne Survey area.

Hydrogeology Related to the Halton Till

The following discussion provides additional technical insight into the groundwater flow system within the Halton Till based on a literature review and detailed field work and modelling carried out in a similar hydrogeologic setting in Northwest Brampton, within the Huttonville Creek and Fletcher's Creek Subwatersheds of the Credit River Watershed (study period 2006 to 2011).

The horizontal component of groundwater flow, particularly within the overburden, will be weak due to the low permeability of the silt/clay sediments. The upper fractured till is expected to transmit more significant quantities of water but on a more local scale. A significant amount of research has focused on the hydrogeology of fractured glacial tills. The following are some of the hydrogeologic factors that relate to the till in the study area:

- Frequency and depth of fractures can depend on the clay/silt/sand content, average precipitation and temperature
- Fractures can occur up to 6 m but they are likely more prevalent with the upper 2-3 m of fractured till
- The lateral connection within the upper fractured till can be relatively significant locally.
- Horizontal flow patterns in the upper fractured till will be controlled by local depressional topography and restricted by underlying more massive and less permeable till
- Vertical groundwater flow below the upper fractured till is generally low unless more permeable, interconnected lenses exist
- Evapotranspiration will significantly reduce water levels in the upper fractured till
- Lateral flow in the upper fractured till reduces more quickly as the water levels drop due to less fracture with depth
- Gradients can be reversed within the underlying massive till (downward to upward) as water levels in the upper fractured till lower thereby reducing recharge to depth

Where the underlying till is massive both vertical and horizontal groundwater flow is restricted. The vertical hydraulic gradients are generally higher than the horizontal gradients. Some level of fracturing may occur in the more massive till as well as interconnected more permeable layers which may transmit more groundwater to depth. In areas where the overburden thickness is on the order of 6 m, it is expected there is an increased potential for groundwater flux to the bedrock but where the overburden thickness is on the order of 2-3 m, it is expected there is a much more direct connection from ground surface to the upper bedrock.

The potential for draining of the water table due to the presence of certain infrastructure (i.e. storm drains) has been presented. Conceptually the backfill within certain underground infrastructure can be more permeable than the native overburden and therefore acts as a more preferential groundwater pathway. The literature review for Northwest Brampton, previously noted, has presented analytical approaches for the assessment of trench dewatering for geotechnical purposes. The assessment within the Halton Till in Northwest Brampton which is similar to the overburden in Milton, indicates that drainage to an open trench would not affect the water table beyond 30 m (+/-). This is a conservative estimate and would be expected to be less in a trench that is actually backfilled.

Key Findings

i) The low permeability of the Halton Till tends to restrict infiltration/recharge and the movement of groundwater with minimizes the potential for groundwater discharge.
ii) The shallow fractured till provides for an increased potential for local groundwater movement.
iii) Discharge may occur where the watercourses cut into the upper fractured shale or sand and gravel lenses but this has not been observed within the Boyne Survey area.
iv) The low permeability of the Halton Till provides a significant level of protection to groundwater quality within the underlying shale and sand/gravel units. The protection is lessened where the till is thinner (i.e. less than 5 m).

3.2 Hydrology

Existing Land Use Surface Water Assessment

The HSP-F hydrologic models developed for the *Sixteen Mile Creek Subwatershed Update Study – Areas 2 & 7, (AMEC, 2015)* and the *Indian Creek/Sixteen Mile Creek Sherwood Survey Subwatershed Management Study (Philips Engineering Ltd., 2004)* have been used as part of this study to establish pre-development surface water flow rates at each of the primary outlet locations from the Boyne Survey Area within the Sixteen Mile Creek Watershed and the Indian Creek Watershed, respectively. The subcatchment boundary plan for existing land use conditions is presented in Drawing 4. The flow rates have been developed using the HSP-F continuous simulation technique and frequency analysis of annual peak flows. Table 3.2.1 provides a summary of the frequency flows and peak flows for the Regional Storm event at key locations throughout the study area (ref. Drawing 4).

Table 3.2.1: Pre-Development Land Use Frequency Flows (m^3/s)									
Node	**Location/Description**	**Frequency (years)**							
		1.25	**2**	**5**	**10**	**20**	**50**	**100**	**Regional**
8.530	West Indian Creek Outlet	0.64	1.03	1.63	2.07	2.51	3.13	3.62	10.70
9.120	East Indian Creek Outlet	0.59	0.94	1.50	1.90	2.30	2.86	3.29	10.00
2.402		0.10	0.16	0.26	0.34	0.44	0.60	0.75	1.87
2.509	West 16MC Outlet	0.56	0.86	1.38	1.81	2.29	3.03	3.67	9.72
2.514	West Central 16MC Outlet	0.87	1.32	2.10	2.73	3.44	4.52	5.47	16.00
2.100	Britannia Road - Main	18.40	27.30	41.00	50.90	61.10	75.10	86.30	381.00
2.802	East Central 16MC Outlet	0.67	1.05	1.76	2.37	3.09	4.22	5.26	11.70
2.009		0.23	0.36	0.61	0.82	1.07	1.47	1.84	4.03
7.303		0.07	0.10	0.15	0.18	0.22	0.27	0.32	0.97
7.302	Omagh Tributary Outlet	1.19	1.73	2.685	3.39	4.20	5.42	6.48	20.50
7.111		0.88	1.52	2.68	3.63	4.68	6.26	7.60	31.90

3.3 Hydraulics

Culvert Crossings

As part of the SUS, field reconnaissance and survey has been completed in order to develop an inventory of the culvert crossings within the Study Area. The various crossings form the primary hydraulic constraints within the study area (ref. Drawing 6).

The existing hydraulic structures spanning the regulated watercourses within the Boyne Survey Area are all less than 6 m span and are primarily located along rural arterial roads. As such, these structures are required to provide 1.0 m freeboard during the 25 year storm event, in accordance with current standards as provided in the Ministry of Transportation Drainage Design Manual (ref. MTO, October 1997). An HEC-RAS hydraulic model has been developed for the reaches through the Boyne Survey Area, as part of the Sixteen Mile Creek Subwatershed Update Study. That model has been used in order to determine whether or not the existing hydraulic structures within the Boyne Survey Area satisfy the current criteria for freeboard. The results of this assessment are summarized in Table 3.3.1.

Table 3.3.1: Freeboard Assessment Summary for Existing Hydraulic Structures within Boyne Survey					
ID	**Location**	**Minimum Top of Road Elevation**	**Freeboard Elevation**	**Freeboard Event**	**Overtopping Event**
1	Britannia Rd, 325 m west of Bronte Rd	185	184	<2 year	10 year
3	Britannia Rd, 700 m east of Bronte Rd	184.5	183.5	5 year	Regional
4	Britannia Rd, 90 m west of Regional Rd	183.5	182.5	<2 year	5 year
5	Britannia Rd, 650 m east of Regional Rd	175	174	100 year	Regional
7	Britannia Rd, 80 m east of Bronte Rd	189	188	<2 year	Regional
8	Thompson Rd, 415 m north of Britannia Rd	190.25	189.25	10 year	Regional
9	Fourth Line, 975 m north of Britannia Rd	192.75	191.75	<2 year	Regional
10	Britannia Rd, west of Fourth Line	191.25	190.25	2 year	Regional
11	Britannia Rd, 450 m east of Tremaine Rd	183.75	182.75	<2 year	Regional
12	James Snow PKWY, 1050 m north of Britannia Rd	191.5	190.5	100 year	N/A
15	4th Line north of Britannia Rd	191.452	190.452	< 2 year	Regional

The results in Table 3.3.1 indicate that the major crossing of Britannia Road at the Sixteen Mile Creek Main Branch and the James Snow Parkway crossing at the Centre Tributary (ref. Crossings 5 and 12) are in conformance with current hydraulic standards. The results also indicate that the balance of the minor structures generally do not conform to current hydraulic standards for freeboard; this condition is considered common for hydraulic structures along rural roads in areas with limited topographic relief.

Any assessment completed as part of future works must consider the change in road classification (i.e. change from “rural” to “urban”) as part of the determination of the design event for the freeboard assessment. All future crossings must be designed in accordance with current hydraulic criteria for freeboard, as well as providing for aquatic and terrestrial wildlife passage and addressing any fluvial geomorphologic design criteria. In addition, the design of future crossings must address depth of overtopping and vehicular and pedestrian passage, particularly for any roads designated as emergency routes.

Flood Plain Mapping/Delineation

Floodline mapping through the Boyne Survey Area has been completed as part of the Sixteen Mile Creek Subwatershed Update Study, November 2015, and previously as part of the Indian Creek/Sixteen Mile Creek Subwatershed Management Study, 2004 for the portion of the study area which lies within the Sixteen Mile Creek Watershed and Indian Creek respectively, in order to establish the Regulatory Floodplain through the study area. The floodlines have been developed based upon the HEC-RAS hydraulic models. As per the current practice required by Conservation Halton, the floodplain has been developed for those reaches with upstream

drainage areas in excess of 50 ha, and has applied the greater of the 100 year and Regional (Hurricane Hazel) Storm events. The floodline mapping is depicted on Drawing 7.

With respect to the floodline mapping along the Centre Tributary, analyses completed and approved by Conservation Halton in 2006 documented the changes in floodlines resulting from the construction of the James Snow Parkway bridge and roadway. The road construction increased flood elevations in upstream areas. During subsequent discussions with the affected landowners, it was agreed that the post road construction floodline represented an interim condition which would not result in a loss of developable land, excluding any additional land requirements that would normally be necessary as part of the land use planning approval process. This was confirmed through correspondence dated October 23, 2008 between the Milton Land Syndicate III owners and Conservation Halton (ref. Appendix 'A'). These commitments should be reflected in floodline delineation and creek design in subsequent SIS analyses.

3.4 Water Quality

The existing water chemistry within the Boyne Survey Area has been characterized as part of the Subwatershed Update Study. The field monitoring conducted for that study has demonstrated that the surface water chemistry within the Boyne Survey Area is generally consistent with the surface water chemistry for agricultural land areas in other areas and as documented in literature.

The potential impact of urban development within the Boyne Survey Area on pollutant loading has been previously documented in the Sixteen Mile Creek Subwatershed Update Study. The increase in impervious surfaces along with vehicular traffic, and other human uses increases the loading and wash off of pollutants potentially impairing instream water quality. These potential impacts include the following:

- Increase in annual pollutant loading from developing areas resulting in degraded in-stream water quality
- Increases in pollutant concentrations during storm event impacting aquatic resources
- Thermal inputs due to runoff from paved surfaces and from stormwater management facilities may increase water temperature.

Other potential impacts would include the potential for contamination of groundwater resources (through unmanaged infiltration) due to urban pollutants and spills.

These potential impacts would need to be addressed through the recommended stormwater management strategy. Typically, stormwater management would include provision of stormwater quality treatment facilities (wet ponds, wetlands, hybrids) prior to discharge to receiving watercourses, spill containment measures, thermal mitigation and measures such as maximizing infiltration to reduce wash off and transport of pollutants (where appropriate given the groundwater resources in the area and type of urban discharge). Infiltration of cleaner roof top drainage would be generally preferred to infiltration of road and parking area discharge.

3.5 Fisheries

Background Review

Fisheries resources within the study area have been previously identified as part of the Sixteen Mile Creek Watershed Plan, with an emphasis on the main branches. That report summarized existing information and confirmed that the West Branch of Sixteen Mile Creek is coldwater habitat upstream of urban Milton. While the fish community within and downstream of urban Milton in the Main Branch is generally composed of coolwater and warmwater species, this portion of Sixteen Mile Creek is an important migratory route for Rainbow Trout, Brown Trout, and Chinook Salmon, which mainly spawn from the vicinity of Regional Road 25 upstream to the Kelso Dam. However, some spawning by these species has been observed at specific locations within the study area downstream of Regional Road 25 (Andrea Dunn, Conservation Halton. Personal communication).

All watercourses within the Boyne Secondary Plan Area were examined as part of the Subwatersheds 2 & 7 study (Philips Planning and Engineering Limited, 2000), with some of the western watercourses re-examined during the Indian Creek/Sixteen Mile Creek Sherwood Survey Subwatershed Management Study (Philips Engineering Limited, 2004), and the Centre Tributary from the Middle Branch of Sixteen Mile Creek re-examined during an audit of the interim conditions within the Phase 1 lands (Aquafor Beech Ltd. and C. Portt and Associates, 2005). These studies noted that permanent flow within the Boyne Survey Secondary Plan Area was only found in the Main Branch of Sixteen Mile Creek at the centre of the Boyne area, and in the Centre Tributary from the Middle Branch of Sixteen Mile Creek at the east end of the Boyne area. Flow conditions had been intermittent in the Centre Tributary at the time of the Subwatersheds 2 & 7 study (Philips Planning and Engineering Limited, 2000). All other tributaries that drained the Boyne Survey area were intermittent at the time of study, and dried to widely spaced standing pools, primarily at online ponds and culverts. While a diverse fish community occurs in the Main Branch, and a less but still relatively diverse fish community occurs in the Centre Tributary, only a few fishes tolerant of conditions in muddy, isolated pools occurred in the remaining watercourses within the Boyne area. The intermittent tributaries generally had fine-grained substrate, though some coarser substrates occurred locally where gravel or sand had been washed into the watercourses from roads. The channel form of the smaller tributaries was usually poorly defined swales through agricultural fields, except where they had been ditched or channelized.

Inventory

As part of the Subwatershed Update Study for Areas 2 & 7 (AMEC, 2015), field investigations were primarily undertaken during 2007 and 2008 to update the information gathered during the 1998/1999 field investigations, however, some focussed investigations were undertaken in 2009 and 2010. The methods and results of this inventory related to the Secondary Plan study area are outlined as follows.

Methods

All tributaries within the Secondary Plan Study area were re-evaluated initially by examining detailed aerial photography (Google Earth, 2007) combined with strategically located field examinations on September 5 – 7, 2007. Follow-up examinations by C. Portt & Associates staff (C. Portt, G. Coker) of most intermittent tributaries occurred over April 14 to 16, 2008, accompanied by representatives of DFO, Conservation Halton, and Parish Geomorphic. Fish collections and additional habitat investigations were undertaken on April 18, July 4 and October 22, 2008. On April 15, 2010, all watercourses within the study area that cross Sixth Line, and Derry Road between Fifth and Sixth Lines, were examined, and on May 7, 2010, the Boyne area tributaries of Indian Creek were examined, accompanied by representatives of DFO, Conservation Halton, and Parish Geomorphic.

LGL Limited provided data from fish sampling that was conducted in the Phase 3 study area by their staff in 2007 and 2008 (Ken Glasbergen, Pers. Comm., October 2008) and additional data were available from sampling conducted by C. Portt and Associates in 2005. All historic fish sampling data on file with Conservation Halton were also examined.

Fish habitat evaluation was guided initially in 2008 using the Credit Valley Conservation and Toronto and Region Conservation document "Evaluation, Classification and Management of Headwater Drainage Features: Interim Guidelines (2007), and then the updated Interim Guidelines in 2009, rather than the system used in the 1998/1999 field investigations. While the terminology and some of the class boundaries differed somewhat between the two systems, the resulting classification and attendant habitat values and recommended protection strategies, indicate that the change in classification system did not result in major differences between the outcomes of the 1998/1999 and the 2007/2008 assessments. The 2009 guidelines are provided below.

1. *Permanent* - Provides direct habitat onsite (e.g. feeding, breeding, and/or migration) as a result of year round groundwater discharge and/or permanent standing surface water within a storage feature (i.e. ponds, wetlands, refuge pools, etc.). Habitat may be either existing or potential (i.e. isolated by a barrier). Permanent habitat also may include critical fish habitat (i.e. habitat that is limited in supply, essential to the fish life cycle, and generally habitat that is not easily duplicated or created). Hydrogeological studies and/or water balance calculations may be required to confirm groundwater contributions, as appropriate, with regard to the scale of the development application(s). The sub-class *Permanent with rehabilitation potential* was not part of the 2009 guidelines, but has been added to allow Reach BP-4-C of the Centre Tributary to be rehabilitated to improve fish habitat. Reach BP-4-C is a straightened section of watercourse that would have formerly been classed as *Seasonal*, except that it now receives flow from infrastructure and SWM facilities recently constructed in the Phase 1 lands.

2. *Seasonal* - Provides limited direct habitat onsite (e.g. feeding, breeding, migration and/or refuge habitat), as a result of seasonally high groundwater discharge or seasonally extended contributions from wetlands or other surface storage areas that support intermittent flow conditions, or rarely ephemeral flow conditions. Occasionally, limited permanent refuge habitat may be identified within seasonal habitat reaches.

3. *Contributing* - Provides indirect (contributing) habitat to downstream reaches – functions generally increase with flow and/or as flows move downstream with increasing length of channel or channel density (e.g. extent of contributing area). There are two types of contributing habitat:

   i) Complex contributing habitat – generally as a result of intermittent (or less commonly ephemeral) surface flows, can have marginal sorting of substrates – generally well vegetated features that influence flow conveyance, attenuation, storage, infiltration, water quality, sediment, food (invertebrates) and organic matter/nutrients (i.e. there are two types of nutrients, e.g. dissolved nutrients, and course/fine matter). Generally, two structural types: a) defined features with natural bank vegetation consisting of forest, scrubland/thicket or meadow (as defined in OSAP or ELC); or b) poorly defined features (swales) typically distinguished by hydrophilic vegetation.
   ii) Simple contributing habitat – generally as a result of ephemeral (or less commonly intermittent) surface flows – generally not well-vegetated features that influence flow conveyance, attenuation, storage, infiltration, water quality and sediment transport. Generally two types: a) defined features characterized by crop cultivation, mowing or no vegetation; or b) poorly defined features (swales) may contain terrestrial vegetation.

4. *Not Fish Habitat* - The pre-screened drainage feature has been field verified to confirm that no features and/or functions associated with headwater drainage features is present – generally characterized by no definition or flow, no groundwater seepage or wetland functions, and evidence of cultivation, furrowing, presence of a seasonal crop, lack of natural vegetation, and fine textured soils (i.e. clay and/or silt).

5. *Recharge Zone* - Coarse-textured soils described as sand and/or gravel have been confirmed through field verification; majority of potential flow will be infiltrated. These features may have ill-defined channels as a relic of past flows; however the key function is groundwater recharge and maintenance of downstream aquatic functions via groundwater connections to streams. No direct fish habitat or indirect contributions through surface flow conveyance, allochthonous or sediment transport provided.

The upstream limit of permanent fish habitat was determined by direct sampling, or by examining the habitat at the farthest upstream location where fish were collected, and then extending upstream to where that type of habitat changed to something less likely to support fish on a permanent basis. Similarly, the upstream limit of seasonal fish habitat was determined by examining the habitat at the farthest upstream location where fish were seasonally present, and then extending upstream to where that type of habitat changed to something less likely to support fish for a biologically significant length of time at any time of year.

Results

Overall, little difference in habitat conditions were found between those observed in 1998/1999, and those observed in 2007/2008. Watercourses for which the surrounding conditions and land use had not significantly changed in the intervening 9 years, were not obviously different from a

habitat or fish community perspective. However, for the Centre Tributary which originates upstream of the Boyne Secondary Plan Area in the Phase 1 development where the surrounding land use has changed from agriculture to urban residential, the flow regime has changed from ephemeral or intermittent, to permanent, which has had a profound effect upon aquatic habitat and fish community composition. Another notable change to the fish community has been the apparently widespread appearance of Silver Shiner (*Notropis photogenis*) in collections conducted during 2013 in the main Sixteen Mile Creek channel, downstream of Derry Road. However, rather than becoming more widespread, it is thought that due to improved education on the identification of this species and the transfer of knowledge regarding optimal sampling approaches, its presence in the Sixteen Mile Creek Watershed has instead become more widely known. It may be possible that Silver Shiner had previously been misidentified as species that look similar, such as the Rosyface Shiner or the Emerald Shiner. Silver Shiner are listed as "Special Concern" in Schedule 3 of the Species At Risk Act (SARA) (http://www.sararegistry.gc.ca, May 12, 2015), and as "Threatened" under the Ontario Endangered Species Act (http://www.ontario.ca/environment-and-energy/species-risk-ontario-list, May 12, 2015). The habitat classifications are provided in Drawing 9. The results of fish collections, as well as the scientific names of fishes found within the Boyne Secondary Plan Area, are provided in Tables 1, 2 and 3 of Appendix 'D'. Watercourse number references have been based on the numbering system developed for *the Sixteen Mile Creek Subwatershed Areas 2 & 7 Update Study* (AMEC, 2015), and are provided in Drawing 9. Each reach is discussed in further detail in Section 3.5.3 of the SUS.

Broad-Level Constraints

The following general constraint rankings for each class of watercourse aquatic habitat are presented in the *Evaluation, Classification and Management of Headwater Drainage Features: Interim Guidelines* (ref. CVC and TRCA, March 2009). Broad-level constraints (High, Medium, Low) have been assigned to each sub-class of management recommendations to feed into the Integrated Constraint Rating for each watercourse section.

1. Protection – Permanent Fish Habitat, Critical Habitat and Species at Risk (SAR).

Protection 1 ***(High Constraint)*** – permanent, critical fish habitat or habitat associated with species at risk. Generally associated with permanent groundwater discharge or wetland storage – either habitat and/or flow source characteristics may be difficult to replicate or maintain.

Protection 2 ***(High Constraint with rehabilitation potential)*** – permanent fish habitat generally with permanent standing surface water associated with a wetland and/or pond flows.

2. Conservation – Seasonal Fish Habitat.

Conservation 1 ***(Medium Constraint)*** – seasonal fish habitat associated with seasonally high groundwater discharge or seasonally extended contributions from wetlands potential permanent refuge habitat may be provided by a storage feature.

Conservation 2 ***(Medium Constraint)*** – seasonal fish habitat associated with intermittent surface flows.

3. Mitigation – Contributing Fish Habitat

Mitigation 1 ***(Medium Constraint)*** – Complex contributing fish habitat: flows conveyed through natural vegetation communities that support complex, contributing fish habitat i.e. influences water quality, sediment, organic matter, food and nutrients to the downstream habitat.

Mitigation 2 ***(Medium Constraint or Low Constraint)*** – Simple contributing fish habitat: flows that support simple contributing fish habitat, i.e. influences flow conveyance, attenuation and storage to downstream reaches.

4. No Management Recommendation Required *(Low Constraint)* – Not Fish Habitat.

5. Recharge Protection – Recharge Zone - No direct habitat or indirect habitat providing surface flow, sediment transport, or allochthonous contribution to downstream fish habitat.

The fisheries constraint level associated with each watercourse is provided in Table 3.8.1, and shown in Figure 3 of Appendix 'D'.

Key Findings

(i) The Centre Tributary previously went dry during the summer months prior to the development of Phase 1, but are now flowing permanently due to discharge from the stormwater management system of the Phase 1 lands. Though this has greatly increased the productivity and diversity of the fisheries resources in these watercourses, portions of these watercourses (Reach BP-4-C within the Boyne area) would benefit from rehabilitation.
(ii) All watercourses within the Boyne Secondary Plan Area, except for the Main Branch of Sixteen Mile Creek, and the Centre Tributary (Reach BP-4-C), go completely dry during most summers, except for on-line dug ponds or within some road or railway culverts.
(iii) As a consequence of the annual drying of watercourses, fish communities within the Boyne Secondary Plan Area are severely limited outside of the Main Branch of Sixteen Mile Creek and the Centre Tributary.

3.6 Stream Morphology

Background Review

As part of the *Sixteen Mile Creek Areas 2 & 7 Subwatershed Update Study (November 2015)* existing information was reviewed, including the preceding *Sixteen Mile Creek Subwatershed Planning Study - Areas 2 & 7 (January, 2000).* The original Subwatershed Planning Study described the state of watercourses within the Boyne Survey lands at the time. However, this description is largely focussed on the Main Branch of Sixteen Mile Creek (Reach 2-II). Additional geomorphic assessment was therefore undertaken in order to satisfy relevant policy requirements and provide appropriate geomorphological baseline information for all streams,

upon which the Boyne Survey Secondary Plan and subsequent post-development targets / monitoring can be based.

Inventory

As part of the additional assessment undertaken to update the Subwatershed Planning Study, geomorphological reaches were defined throughout the Boyne Survey (Phase 3) lands. These reaches were subject to rapid assessment using Rapid Geomorphological Assessment (RGA) and Rapid Stream Assessment Technique (RSAT) protocols. The RGA documents indicators of channel instability (MOE, 1999), while the RSAT provides a broader indication of the ecological function of the stream (Galli, 1996).

The results of the rapid assessments indicate that the drainage characteristics of the Boyne Survey (Phase 3) lands are typical of headwater systems within Southern Ontario, with the majority of drainage features characterized as swales (i.e., features lacking a defined bed and banks). These swale features represent the headwaters of Sixteen Mile Creek and Indian Creek and are considerably impacted by agricultural practices. Key exceptions are the portions of Sixteen Mile Creek Main Branch (Reach 2-II) and the Centre Tributary (Reach BP-4-C) which flow through the Boyne Survey lands.

- **Reach 2-II** displays well-defined riffle-pool morphology and channel widening was the prevailing geomorphic process at the time of survey as indicated by fallen/leaning trees, extensive basal scour and exposed bridge footings. Degradation and planform adjustment were also observed, as indicated by exposed underlying clay till and the formation of chutes and islands respectively. This reach was classified as being “In Adjustment” according to the RGA results and of “Moderate” stream health according to the RSAT results.

- **Reach BP-4-C** displayed defined riffle-pool sequences at the time of survey and was classified as being “Transitional” according to the RGA results and of “Moderate” stream health according to the RSAT results. This reach is immediately downstream of the Bristol Survey (Phase 1) lands. The dominant processes at the time of survey were aggradation, as indicated by lateral bars, siltation in pools and soft, unconsolidated bed conditions. This reflects the fact that, at the time of survey, in-channel works were ongoing along the Centre Tributary within Bristol Survey lands and upstream portions of this reach as part of the Phase 1 development.

The remaining defined drainage features took the form of selected higher order streams accumulating flows from the upstream swale features. In general, these lower order streams were found to be stable or ‘in regime’.

Geomorphological Constraint Rankings

Based on the characteristics of the reaches identified within the Boyne Survey (Phase 3) lands, each reach was assigned a geomorphological constraint ranking. The constraint system identifies three categories: high, medium and low constraint (ref. Table 3.6.1).

Table 3.6.1: Definition of Geomorphological Constraints	
Ranking	**Definition**
High	Reaches that comprise a defined channel with well-developed channel morphology (i.e., riffle-pool) and/or a well-defined valley. These reaches possess both geomorphological form and function and are high-quality systems that could not be re-located and replicated in a post-development scenario.
Medium	Reaches that may or may not have a well-defined morphology (form) but do maintain geomorphic function and have potential for rehabilitation. In many cases, these reaches may exhibit evidence of geomorphic instability or environmental degradation due to historic modifications and land use practices.
Low	Ephemeral headwater systems that lack defined bed and banks (form) but do perform a geomorphic function through the conveyance of flow and sediment.

In geomorphological terms, all of the reaches were assigned a “low constraint” with the exception of Reach 2-II, which was classified as of “High constraint” and Reaches BP-4-C, SWS-2-A and 7-IX (downstream of the study area) which were classified as “Medium constraint”. The geomorphological constraint rankings have been taken into account in net constraint rankings of reaches (ref: Section 3.8).

Meander Belt Width

Meander belt widths have been delineated for all high and medium constraint reaches within the Boyne lands (i.e. those reaches with a defined channel), according to standard protocols for subwatershed level planning studies (Parish Geomorphic, 2004). A meander belt width defines the area that a watercourse currently occupies or can be expected to occupy in the future. For unconfined channels, limits of the meander belt are defined by parallel lines drawn tangential to the outside bends of the laterally extreme meanders of the planform for each reach. For confined channels, the meander belt width is generally defined by parallel lines drawn parallel to the central valley trend of the reach. The meander belt width does not refer to the bottom of valley width. Because the belt width has distinct, linear boundaries, instances can occur where the belt width captures the majority of the river valley but may extend into the valley in isolated areas, as the valley undulates back and forth while maintaining a consistent center line trend. In the majority of cases, the meander belt width for a channel is smaller than the flood plain for unconfined systems. When alterations to the flood plain occur (e.g. filling), the flood plain becomes smaller and the meander belt width can become the constraining parameter for watercourse extent.

Table 3.6.2 indicates the meander belt width for each reach within the study area, as well as an additional erosion setback component. Due to the higher-level nature of this Functional Stormwater and Environmental Management Strategy, in lieu of calculating the 100 year migration rate for each reach, a factor of safety was calculated as 20% of the meander belt width (i.e. 10% on either side of the meander belt width).

In the immediate vicinity of Boyne Survey, the valley of the Main Branch of Sixteen Mile Creek meets criteria for Significant Valleylands as defined under the Provincial Policy Statement (2005); The Sixteen Mile Creek south of Britannia Road is within the Greenbelt which has Significant Valleylands policies. Applicable criteria include surface water functions, landform

prominence, community and species diversity, and linkage functions, The affected areas are shown on Figure T5.

Table 3.6.2: Meander Belt Widths on a Reach Basis for Streams in the Study Area			
Reach	**Belt Width (m)**	**10% Factor of Safety Either Side of Channel**	**Final Belt Width (m)**
2-II	100.0	10.0	120.0
SWS-2-A	25.0	2.5	30.0
BP-4-C	28.0	2.8	33.6
7-IX	42.0	4.2	50.4

Key findings

- Many of the reaches within the Boyne Survey (Phase 3) lands have been extensively modified by agricultural practices. These reaches could potentially be enhanced, including through the reduction of agricultural impacts.
- The majority of the reaches within the study area are of low geomorphological constraint, with the key exceptions of Reaches 2-II (Main Branch of Sixteen Mile Creek) and BP-4-C (Centre Tributary). SWS-2-A was also classified as of Medium geomorphological constraint.
- Reach 2-II is in a state of active adjustment and experiencing some natural bank erosion, therefore, peak flows should not increase and flow volumes should not decrease within this reach.
- Sediment being transported downstream within the Boyne Survey lands consists of a substantial portion of fine materials conveyed in suspension; thus on-line ponds should be avoided.

3.7 Terrestrial Resources

Terrestrial Resources

Section 3.6 of the Subwatershed Update Study (SUS) presents a detailed summary of the known terrestrial resources within the Subwatershed Update Study areas, including the Boyne Survey Secondary Plan Area, based on background data and field studies conducted in 2007-2008, plus supplementary investigations in 2009. Literature and background data pertaining to terrestrial resources in the study areas (including Boyne Survey) was obtained from the Region of Halton, Conservation Halton, Ministry of Natural Resources, and the Natural Heritage Information Centre (Peterborough). Additional background information was assembled including earlier subwatershed studies, published documents, data from other consultant studies, and other literature relevant to resources in the study area.

A more detailed summary characterization of the terrestrial resources in Boyne Survey is presented in the following.

Vegetation Resources

Vegetation communities in the Boyne Survey study area were originally mapped as part of the Sixteen Mile Creek Subwatershed Planning Study for Areas 2 & 7 (2000), and the Indian Creek/Sixteen Mile Creek Sherwood Survey Subwatershed Management Study (2004). All natural and semi-natural vegetation communities within the Boyne Survey study area were re-visited during the 2007 and 2008 field seasons, with supplementary site visits to some wetlands in 2009. Vegetation communities were mapped as polygons onto orthogonally rectified digital base provided by the Town of Milton. Portions of the Boyne Survey lands were initially mapped onto 2005 photography, and subsequently (in part) on 2007 orthophotos which became available from the Town in the fall of 2008.

Vegetation and disturbance data were collected from natural and cultural communities; detailed data on community structure, composition and soils was collected from natural communities. This information was used to classify natural vegetation communities to the Vegetation Type level according to the ELC (Ecological Land Classification) methodology for Southern Ontario (Lee *et al*., 1998). Figure T2 in Appendix 'F' summarizes ELC Communities identified in the Boyne study area. Selected species of difficult taxonomic genera were collected for further laboratory examination. Species status was confirmed in accordance with available documents including Varga *et. al*. (2005 draft), and Crins et al. (2006).

Wildlife Resources

Wildlife surveys were initiated and completed in 2008 to document breeding birds, calling amphibians, snakes and odonates (damselflies and dragonflies). Nocturnal amphibian call surveys were conducted in the vicinity of all wetland and aquatic features during the spring and summer of 2008. Calling levels were documented according to the Marsh Monitoring Program protocol (BSC, 2003). Breeding birds were documented from natural and semi-natural communities during the late spring and summer of 2008 according to the Ontario Breeding Bird Atlas protocols (OBBA, 2001). The timing (June through early July) corresponded with the peak singing for most songbirds. Earlier visits in the spring also yielded additional breeding bird observations. All of the existing woodlots were surveyed, as were smaller successional areas. Given the predominance of agricultural lands within the survey area, careful attention was also paid to documenting open country species, a bird category showing significant declines across North America.

Searches for snakes were conducted during the fall of 2008. Surveys for odonates were conducted during the summer and fall of 2008. Field guides prepared by Mead (2003), Nikula *et al.* (2003), Lam (2004), DuBois (2005) Jones *et al*. (2008) were used to assist with odonate identification when necessary. All other wildlife species observed during vegetation and wildlife surveys were recorded incidentally. No winter surveys were conducted. Details of the various wildlife survey visits are summarized in the Subwatershed Update Study. Figure T4 in Appendix 'F' summarizes wildlife data record locations within the Boyne study area.

Summary of Observations

Physical and Land Use Context

- The Study Area is flat to gentle in topography, containing gentle slopes except along the Main Branch of the Sixteen Mile Creek. Most of the study area is dominated by imperfectly drained, fine-textured soils.

- Intensive agriculture has eliminated most natural cover within the tablelands of the Study Area. The remaining habitats are undergoing continued fragmentation primarily for agriculture.

- Most remnant features have experienced various levels of repeated disturbance from human activities such as dumping, encroachment by agriculture, filling, firewood cutting and informal access.

Vegetation

- The Sixteen Mile Creek ESA (#16) extends into the detailed Subwatershed Update Study Area, located within the Boyne Survey lands. A portion of the Sixteen Mile Creek Valley ESA (#16) is also designated as a Regional and Candidate Provincial) Life Science Area of Natural and Scientific Interest (ANSI) (status reconfirmed with MNRF May 2015); OMNR (2006) mapping indicates that this designation does not extend north of Britannia Road. There is also an Earth Science ANSI located downstream of Britannia Road.

- A total of 63 ELC vegetation polygons were documented from the Boyne Survey study area (Figure T2 in Appendix 'F'). Eleven ELC community series were observed.

- A total of 19 vegetation polygons were identified as wetlands and 9 are forest communities. Natural forest and wetland comprise less than 5% of the total landscape within the Secondary Plan area.

- The most extensive natural communities are associated with the Main Branch of Sixteen Mile Creek, which are protected under Regional and Town policies. The Main Branch valley located south of Britannia Rd. is within the Greenbelt Plan.

- Natural communities outside the Sixteen Mile Creek valleylands occur as isolated pockets within the landscape. Tributaries generally lack well defined, continuous riparian cover.

- Forest species composition consists of deciduous cover (bur oak, shagbark hickory, sugar maple).

- Six features outside of the ESA meet the criteria for Significant Woodlands set out in the Halton Region Policies. Given the limited natural cover present, these features and

associated semi-natural communities represent key opportunities for woodland habitat within the future Natural Heritage System.

- Other woody vegetation cover consists of cultural woodland plantation, savannah and thicket as well as open-grown trees and hedgerows. Although they are often isolated in the landscape, these represent some local opportunities to consider for enhancement of linkages along stream corridors and between features.

- Wetland cover is limited within the Study Area although small wetland pockets can be found scattered throughout the landscape, usually associated with upland vegetation communities or watercourses. Wetlands in the landscape consist of deciduous swamp, meadow marsh and swamp thicket communities. The dominant swamp species are bur oak and swamp maple. The dominant meadow marsh species observed are cattail and reed canary grass.

- Small aquatic features (including remnant wetlands and excavated ponds) were identified as supporting amphibian activity. These contained fringes of typical wetland species such as cattails and bulrushes. Submerged and floating aquatic vegetation was observed in some ponds. These features are often isolated in the landscape, making it difficult to connect them to other natural heritage features.

- Riparian cover associated with smaller tributaries of the Sixteen Mile Creek is either very limited, or lacking due to agricultural encroachment. The enhancement of riparian cover along tributaries, which will be integrated into future development, represents a significant opportunity to create linkage corridors and achieve a ‘net gain’ of natural cover in the Study Area.

- The riparian corridor along the Main Branch of Sixteen Mile Creek represents the most significant opportunities for habitat enhancement, restoration and creation. The creation of a hierarchy of wetland habitats in stream corridors could provide a variety of ecosystem functions suitable to amphibian species and other biota.

Table 3.7.1: Boyne Survey - Summary of Polygons by Cover Type and Ecosite/Vegetation Type

BREAKDOWN OF POLYGONS BY GENERAL COVER TYPE

Cover Type	# of Polygons	Area (ha)	% Study Area
Agriculture	45	763.76	78.94
Anthropogenic	39	77.52	8.01
Forest	9	30.30	3.13
Cultural	34	52.48	5.42
Wetland (swamps, marshes)	19	11.73	1.21
Hedgerow	42	31.22	3.23
Thicket	1	0.58	0.06
TOTAL STUDY AREA	**189**	**967.59**	**100.00**

BREAKDOWN OF POLYGONS BY ELC ECOSITE/VEGETATION TYPES

ELC Community	ELC Code	ELC Ecosite/Vegetation Types	# of Polygons	Area (ha)	% Study Area
Cultural Meadow	CUM1	Mineral Cultural Meadow Ecosite	24	41.79	4.31
Cultural Plantation	CUP3	Coniferous Plantation Ecosite	2	1.25	0.13
Cultural Savannah	CUS1	Mineral Cultural Savannah Ecosite	1	1.93	0.20
Cultural Thicket	CUT1	Mineral Cultural Thicket Ecosite	1	1.39	0.14
Cultural Woodland	CUW1	Mineral Cultural Woodland Ecosite	6	6.13	0.63
		Total Cultural Communities	**34**	**52.48**	**5.42**
Deciduous Forest	FOD	n/a	3	21.19	2.19
Deciduous Forest	FOD4	Dry-Fresh Deciduous Forest Ecosite	2	3.37	0.35
Deciduous Forest	FOD7-3	Fresh-Moist Willow Lowland Deciduous Forest Type	1	0.45	0.05
Deciduous Forest	FOD9	Fresh-Moist Oak-Maple-Hickory Deciduous Forest Ecosite	1	1.43	0.15
Deciduous Forest	FOD9-3	Fresh-Moist Bur Oak Deciduous Forest Type	1	2.09	0.21
Deciduous Forest	FOD9-4	Fresh-Moist Shagbark Hickory Deciduous Forest Type	1	1.78	0.18
		Total Deciduous Forest Communities	**9**	**30.30**	**3.13**
Deciduous Swamp	SWD1-2	Bur Oak Mineral Deciduous Swamp Type	1	3.55	0.37
Deciduous Swamp	SWD3-3	Swamp Maple Mineral Deciduous Swamp Type	1	2.73	0.28
		Total Deciduous Swamp Communities	**2**	**6.28**	**0.65**
Meadow Marsh	MAM	n/a	6	1.32	0.14
Meadow Marsh	MAM2	Mineral Meadow Marsh Ecosite	1	0.62	0.06
Meadow Marsh	MAM2-2	Reed Canary Grass Mineral Meadow Marsh Type	3	1.89	0.19
Meadow Marsh	MAM2-10	Forb Mineral Meadow Marsh Type	1	0.15	0.02
Shallow Marsh	MAS2	Mineral Shallow Marsh Ecosite	1	0.27	0.03
Shallow Marsh	MAS2-1	Cattail Mineral Shallow Marsh Type	2	0.22	0.02
		Total Marsh Communities	**14**	**4.47**	**0.46**
Thicket Swamp	SWT	n/a	2	0.65	0.07
Thicket Swamp	SWT2-2	Willow Mineral Thicket Swamp Type	1	0.33	0.03
		Total Thicket Swamp Communities	**3**	**0.98**	**0.1**
Thicket	THDM2-4 (CUT1-4)	Gray Dogwood Deciduous Shrub Thicket Type (Gray Dogwood Cultural Thicket Type)	1	0.58	0.06
		Total Thicket Communities	**1**	**0.58**	**0.06**

Note: Areas noted in this table were calculated based on data collected between 2007 to 2009. Some changes have occurred since that time including new farming practices in some locations. Current areas will vary from those noted above based on farming practices and on further detailed site work to be completed at the SIS stage.

Wildlife

- A total of 400 site-specific wildlife observations were made within the Boyne Survey lands in 2008 by Dougan & Associates staff. This was based on numerous field visits made in spring, summer and autumn. It included 268 bird observations, 46 amphibian observations, four reptile observations, five mammal observations, 58 odonate (i.e. damselflies and dragonflies) observations, 18 butterfly observations, and one crayfish observation.

- Field surveys conducted in 2008 documented 93 species of wildlife from the Boyne Survey lands. Ninety species of wildlife were documented during their breeding seasons including 54 species of birds, 3 species of amphibians, 1 species of reptiles, 3 species of mammals, 16 species of odonates (i.e. damselflies and dragonflies), 12 species of butterflies, and one species of crayfish. Three additional bird species observed in September were migrants passing through on their way south.

- Bobolink, a provincially Threatened bird species, was recorded at 8 locations contained within 3 areas of concentration, within the Boyne Survey lands. Numbers at each location varied from a single individual to as many as 12. This area-sensitive open country species is reliant on agricultural fields; it is a ground-nesting species subject to disturbance from farming operations and from nest predation. Barn Swallow, and Eastern Meadowlark (provincially Threatened 'open country' birds) are also present in Boyne; all these species require consultation with OMNRF regarding strategies and potential permitting.

- A forest bird species of conservation concern (designated Special Concern in Ontario and Canada), Eastern Wood-Pewee (*Contopus virens*) was recorded in three woodlots.

- The majority of breeding bird species are associated with habitats other than woodlands or forests. This is not surprising given that the Boyne Survey lands are predominantly agricultural; open habitat species are most likely to be displaced by urban development.

- Amphibians were documented on 16 sampling events within the Boyne Survey lands in 2008 by Dougan & Associates staff. This total may include repeat observations of the same individual if the site was visited more than once. Three species were represented, including Spring Peeper (13 observations), Western Chorus Frog (2 observations) and Green Frog (1 observation). Western Chorus Frog is a species designated "Threatened" in Canada by COSEWIC and Not at Risk in Ontario (COSSARO).

- Two species of reptiles were documented from the Boyne Survey lands between 2008 and 2011 by Dougan & Associates staff. This included Snapping Turtle (one sighting) and Eastern Gartersnake (four sightings). Snapping Turtle is designated "Special Concern" in Ontario by OMNRF and in Canada by COSEWIC. A Snapping Turtle carcass was observed adjacent to the main branch valley of Sixteen Mile Creek just south of Louis St. Laurent Blvd. Specific turtle surveys were not undertaken; there is likely good habitat availability in the main branch. Site visits specifically to detect snakes

within the Boyne Survey study area were undertaken in the fall of 2008; no active hibernacula or species of concern were detected.

- Three (3) common mammal species were documented from the Boyne Survey lands in 2008 through incidental observations. It is likely that other urban tolerant species are present within the study area, however no specific mammal or deer surveys were undertaken or required under the Terms of Reference.

- Sixteen (16) species of odonates (i.e. damselflies and dragonflies) were documented from the Boyne Survey lands in 2008 by Dougan & Associates staff. Four (4) are listed as rare and 2 are listed as uncommon in Halton Region. The majority of the species were associated with Sixteen Mile Creek. A few others were associated with small wetlands and a woodlot.

- Twelve (12) species of butterflies were documented; one is considered locally uncommon in Halton Region (Compton Tortoiseshell), and one is locally rare (Giant Swallowtail – not resident). The Monarch is designated Special Concern in Ontario and Canada. The others observed are all considered common species.

In summary, the most significant wildlife habitat areas were the riparian corridors and scattered woodlots / successional habitat complexes. The corridor associated with the Main Branch of Sixteen Mile Creek exhibits the greatest diversity and greatest enhancement opportunities and serves as a wildlife movement corridor. Efforts to establish vegetated links along the smaller tributaries would be beneficial. Wildlife diversity could also be enhanced if the existing woodlots could be strategically enlarged and linked to expanded riparian cover systems.

Constraints

The current habitats and linkages in Boyne Survey are highly constrained by an intensive history of fragmentation under agricultural as well as anthropogenic uses (farmsteads, residential). While in general this has resulted in reduction of habitat for most native biota to critical levels, some biota which are somewhat adapted to agricultural land uses, such as open country birds, have benefited from the existing land uses.

Terrestrial constraints have been identified based on the identification and field verification of significant ecological features and functions; and the application of available screening criteria for federal, provincial and regional level legislative and policy designations, and other guidance under the mandate of Conservation Halton.

Resources that form the fundamental ‘significant’ features and attributes within the Boyne Survey study areas have been identified, including Significant Woodlands, wetlands, and sites known to support plant and wildlife species of concern. Wetland cover has been reviewed in accordance with criteria in the Ontario Wetland Evaluation System (OMNR 1993), and three (3) wetlands / complexes were evaluated and are recommended as locally significant (ref. Section 3.6.4 of the SUS for more details). Significant features and locations of significant species observed are summarized on Figure T5 in Appendix ‘F’. In addition, Significant Wildlife Habitats have been identified using the OMNR Significant Wildlife Habitat Technical Guide

(OMNR 2000) in conjunction with the expertise of Dougan & Associate's wildlife ecologists on the interpretation of these guidelines; these are summarized later in this section.

The Sixteen Mile Creek Subwatershed Update Study screened all features and records of significance for potential Significant Wildlife Habitat (SWH), and this information is summarized in Appendix 'H' of the SUS. Under the PPS (2005), the determination of Significant Wildlife Habitat is assigned to planning authorities, requiring the development of specific criteria applicable to that jurisdiction, and supported by specific field studies to corroborate evidence that criteria are met. The Town of Milton and Region of Halton have not undertaken such a study, and the SUS represents a snapshot of subwatershed conditions that may not detect complete evidence of SWH triggers. For the purposes of the SUS and FSEMS, potential Significant Wildlife Habitat was identified based on OMNR (2000) categories and criteria. More detailed site specific studies (such as the SIS) are intended to gather greater detail on the potential SWH. Figure T5 in Appendix 'F' identifies where observations were made of wildlife species with significance at the local, regional, provincial or federal level. The mere presence of a species does not automatically trigger Significant Wildlife Habitat; the identified species and/or habitats were reviewed to ascertain whether they justify SWH designation at the SUS level of study based on the habitat size, numbers of individuals, and sustainability in the existing and future landscape. Table_H4_in Appendix 'H' of the SUS summarizes all potential SWH categories, and assigns SWH where appropriate. On this basis several categories of SWH were assigned (see below). Other potential SWH triggers detected in the SUS (such as the Isolated Specialized Habitats), and in SIS studies, may result in further delineations of SWH.

As part of the multidisciplinary study team, the ecologists ranked all watercourses in the Boyne Survey study area according to their current functional roles in linking significant features both within and beyond the study area. Watercourses with high terrestrial constraints link core significant features within and beyond the study area. Medium terrestrial constraint watercourses intersect lower level features, while low terrestrial constraint watercourses currently do not provide more than local scale habitat opportunities.

Natural Heritage features in the Boyne Survey study area that conform with one or more of the constraint categories are summarized in Table 3.7.2. The total areas representing constraints include complexes of habitat containing forest, wetland, thicket and/or meadow units with attributes which triggered their inclusion in one or more constraint categories.

The previous subwatershed studies (i.e. Sixteen Mile Creek Area 2&7 Subwatershed Planning Study; Indian Creek Subwatershed Study) contained NHS opportunity figures which addressed each of the current study areas in the SUS; the opportunities previously identified for Boyne Survey are shown on Figures 3.1., 3.2 and 3.3.

Table 3.7.2: Terrestrial Features and Constraint Summary for the Boyne/Phase 3 Lands
Ref. Figures 5.3 (Key Map) And T2 (Polygon Locations)

Key Map #	Area (ha)	Component Vegetation Units	Constraint Factors						
			ESA	Significant Woodland	Wetland	Forest Interior	Significant Valleyland	Linkage	Significant Species/ Potential SWH
A	7.19	216a (SW), 216b (SW), 216c (MM), 216d (MM), 216e (TH), 216f (TH), 216g (ME), P3-28 (ME), P3-64 partial (HR)	No	Yes	Yes	No	No	No	Yes
B	2.80	227a (DF), 227b (M)	No	Yes	Yes	No	No	No	Yes
C	1.89	229a (MM), 229b (M)	No	No	Yes	No	No	Yes	No
D	3.27	225a (MM), 225b (TH), 225c (SWT), 225d (ME), 225e (ME)	No	No	Yes	No	No	Yes	No
E	2.37	31a (ME), 31b (P), 31c (DF)	No	Yes	No	No	No	Yes	Yes
F	61.92	108a (DF), 108b (W), 108c (MM), 118 partial (HR), 125a (W), P3-21 (AG), P3-24 (ME), P3-46 (ME), P3-47 (ME), P3-48 (ME), P3-49 (ME), P3-75 (P), P3-78 (ME), P3-79 (ME), P3-80 (ME), P3-81 (TH), P3-82 (DF), P3-83 (DF), P3-84 (DF), P3-85 (MM), P3-86 (MM), P3-88 (MM), P3-89 (MM), P3-90 (MM), P3-91 (SWT), P3-92 (SWT)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
G	8.50	123a (ME), 123b (MM), 213a (HR), 602 (HR), P3-73 (HR)	No	Yes	Yes	No	No	Yes	Yes
H	6.45	124 (SW), P3-39 partial (ME)	No	Yes	Yes	No	No	Yes	Yes

Total Complex Habitat Coverage: 94.39 ha (buffers not included)

ESA

"Yes" indicates that portions of the feature are part of an Environmentally Sensitive Area

Significant Woodland

"Yes" indicates that portions of the feature meet the criteria for Significant Woodlands as set out in the Halton Region Official Plan (2006)

Wetland

"Yes" indicates that portions of the feature have been identified as a wetland by Dougan & Associates. "Yes*" indicates that these wetlands are part of an evaluated wetland; evaluation submitted to OMNR in November 2011).

Forest Interior

"Yes" indicates that based on size and shape, portions of identified terrestrial feature could support forest interior species

Significant Valleyland

"Yes" indicates that portions of the feature are located within the well-defined valleys for the Main Branch of Sixteen Mile Creek

Linkage

"Yes" indicates that the feature provides a linkage function along a primary or secondary stream corridor, or rail corridor.

Significant Species

"Yes" indicates documented occurrence(s) of plant or animal species considered rare or uncommon on a regional, provincial or national scale

DF = Deciduous Forest MF = Mixed Forest W = Woodland	PL = Plantation TH = Thicket ME = Meadow		SWT= Swamp Thicket SW = Swamp M = Marsh MM=Meadow Marsh

The previous subwatershed studies (i.e. Sixteen Mile Creek Area 2&7 Subwatershed Planning Study; Indian Creek Subwatershed Management Strategy) contained NHS opportunity figures which addressed each of the current study areas in the SUS; the opportunities previously identified for Boyne Survey are shown on Figures 3.1., 3.2 and 3.3.

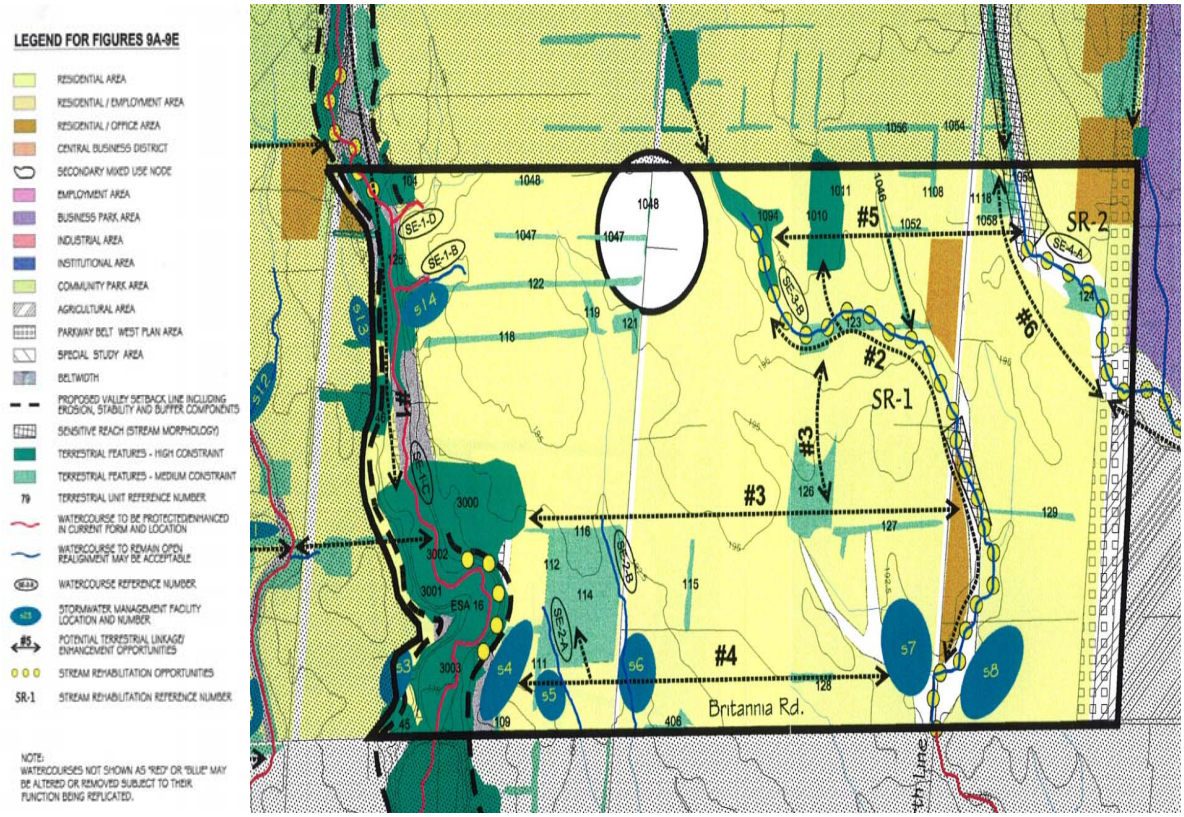

Figure 3.1: Boyne Survey Area NHS Opportunities (Philips Engineering Ltd. 2000)

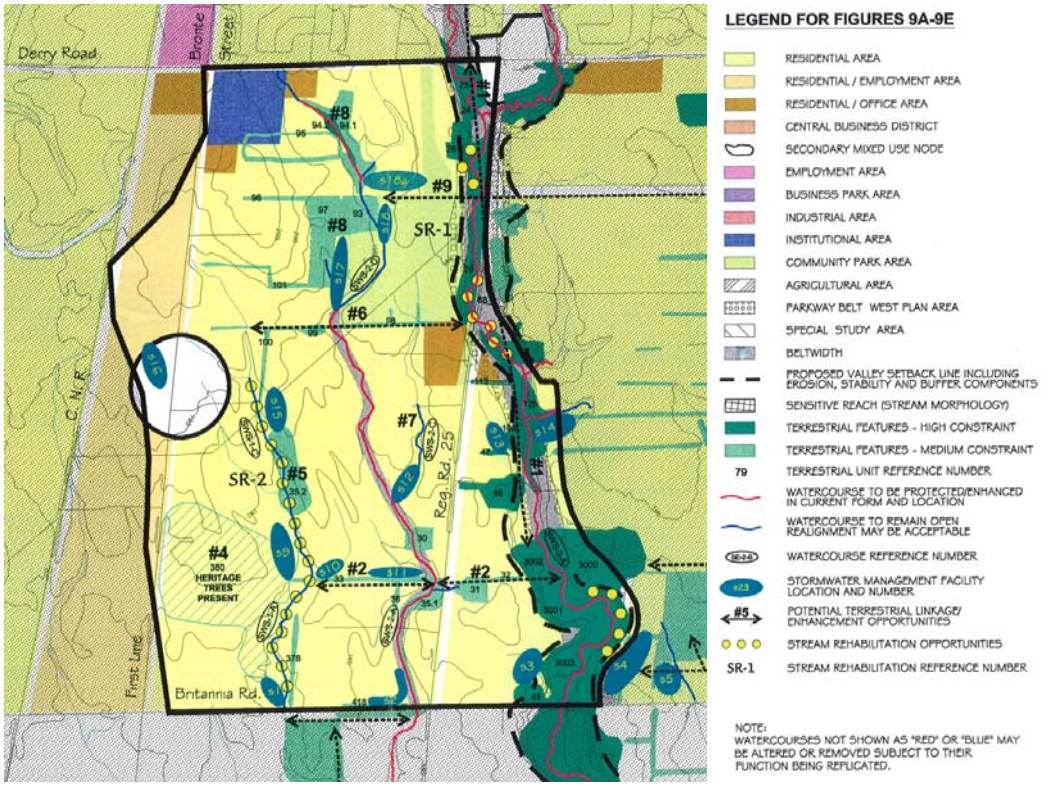

Figure 3.2: Boyne Survey Area NHS Opportunities (Philips Engineering Ltd. 2000)

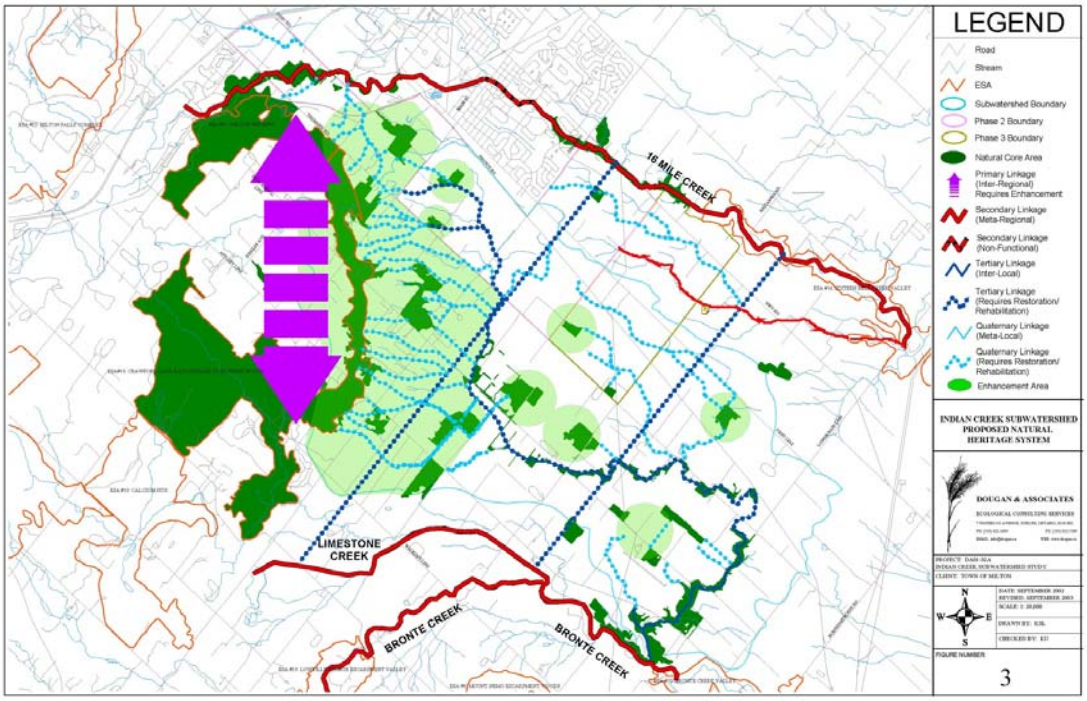

Figure 3.3: Indian Creek SWS NHS Opportunities (Philips Engineering Ltd. 2004)

The following is a brief summary of existing resources in the Boyne Survey study area that offer key features that could become future core habitats, and major/local linkages and other opportunities. Significant features are summarized in Figure T5 in Appendix 'F'.

Core areas:

- Natural cover outside of the Main Branch valley of Sixteen Mile Creek is very limited both in extent and in terms of available linkages.
- Five small woodlots that qualify as Significant Woodlands were identified; the ESA also contains forested features that constitute Significant Woodland.
- Two individual wetlands, and a complex comprised of two small wetlands, have been evaluated as locally significant in the study area; the complex could potentially be added to the Indian Creek PSW Complex, which is located in the Greenbelt. .
- The data records for two wetland evaluations in the Boyne Survey study area (ref. Figure T5 in Appendix 'F') were submitted to OMNR in November of 2011, but the Town has received no comments at date of publication. The first evaluation (SMC-1) contains one Swamp Maple Mineral Deciduous Swamp (polygon 124) located along the corridor of the Centre Tributary of Sixteen Mile Creek. The evaluation scoring indicated that the wetland is locally significant. The second evaluation includes several wetland pockets (polygons 216a, 216b, 216c, 216d, 216h, 216i, 216j, 216k, 225a, 225c, 227b, 229a, 229b) located within 750 m of the Indian Creek PSW Complex. The draft data record indicates that either as part of the existing PSW Complex or as a stand-alone evaluation, this complex could be considered provincially significant; however the final assignment of status has not been released by OMNR (October 2011 staked wetland mapping yet to be confirmed by OMNR).

Corridors and Linkages:

- There are limited connections to features located beyond the study area, apart from the Main Branch and Centre Tributaries, which afford significant linkage opportunities.
- The Main Branch of Sixteen Mile Creek meets criteria for Significant Valleylands.
- Other linkage opportunities are confined to improvements to watercourse connections (existing are largely poorly defined due to flat topography);
- The CN railway corridor provides topographic form and traverses wetlands and watercourses in the study area and southward.
- Workable east-west linkage opportunities are very limited and hypothetical rather than feature based, due to existing and future road crossings.

Significant Wildlife / Significant Wildlife Habitat: (see preceding discussion on SWH approach)

- Specialized Habitat for Wildlife, i.e. foraging habitat presence of abundant mast is present in the ESA and in smaller Significant Woodlands.
- Bobolink, Barn Swallow, and Eastern Meadowlark (provincially Threatened 'open country' birds) are present in Boyne; this requires consultation with OMNRF regarding strategies and potential permitting.
- Western Chorus Frog breeding evidence was observed in several features, one of which was removed between 2002 and 2008; two sites provide potential summer habitat in the

immediate vicinity of breeding pools and warrant further study; frog populations are apparently small and not currently supported by habitat linkages to other habitats (locations not provided in this report to protect the species in question; Conservation Halton staff and OMNR are in possession of the data on these locations).

- Eastern Wood-Pewee, a forest breeding bird species, was documented in three small woodlots included in the NHS. Long-term presence will depend on mitigating direct and indirect impacts.
- The Main Branch would qualify as supporting habitat for Species of Concern, and as an Animal Movement Corridor under the OMNR SWH guidelines; is also potentially a deer wintering area.

Enhancement Opportunities:

- The enhancement and extension of the Sixteen Mile Creek ESA represents a significant opportunity to enhance core habitat functions, and the diversity of cover.
- Degraded primary and secondary watercourse corridors offer major opportunities for enhancement.
- Smaller features warrant consideration for enhancement and improved habitat linkage

Comments:

- There are opportunities for specialized habitat restoration within the Main Branch valley north of the existing ESA; this would be compatible with the NAI (2006) recommendation to extend the regionally-designated ESA northward.
- The integration of Western Chorus Frog breeding habitats, which are generally small, isolated features, will be a significant challenge, and other options such as habitat creation and species rescue will need to be explored.
- While Sustainable Halton does not apply to the Boyne lands, features and linkages, when enhanced and buffered, would in most cases meet key criteria for Sustainable Halton, including upland forest, meadow and wetland components.
- Isolated specialized habitats support amphibians located outside of key natural features (locations shown on Figure NHS-2 in Appendix ‘F’).
- Developments within 120 m of Greenbelt (located immediately south of Britannia Rd.) have specific natural heritage evaluation and buffer requirements.

3.8 Watercourse Constraints

The *Sixteen Mile Creek Subwatershed Update Study – Areas 2 & 7, November 2015* provides a summary of the watercourse constraint rankings within the proposed Boyne Survey Secondary Plan area. As indicated in that document, each watercourse has been assessed on a reach-by-reach basis, based upon various environmental factors and considerations, and a “consensus” constraint rating has been developed accordingly, as well as the proposed management strategy for each watercourse in the study area.

The following disciplines have been considered in this process/assessment:

- Fisheries
- Terrestrial
- Stream Morphology
- Hydrology and Hydraulics

A fisheries high constraint relates to perennial watercourses that supports, or has the potential to support, high quality habitat, whereas a medium constraint has been assigned to reaches exhibiting intermittent flow conditions which have been observed to support fish habitat. A low fisheries constraint is assigned to watercourses that are not considered fish habitat, or have little potential to contribute to fish habitat based on the flow regime identified.

Natural heritage constraints relate to whether or not the watercourse flows through or directly adjacent to significant terrestrial habitat complexes, as well as whether or not the feature provides a linkage function or opportunity. With respect to watercourses ranked as high or medium terrestrial constraint, these watercourses may be relocated (subject to overall ranking) but the terrestrial linkage functions should be maintained or enhanced.

Morphological constraints relate to both the geomorphological form of the reach and its function in terms of flow and sediment supply downstream.

Flooding constraints are high if the reach has a regulated floodplain associated with it, and the conveyance capacity cannot be easily replicated artificially. The watercourse constraint rankings for the Boyne Survey Area, as provided in the Subwatershed Update Study, are summarized in Table 3.8.1 and are presented graphically in Drawing 10.

The net constraint ranking for the watercourses within the Boyne Survey area has identified a reach (ref. Watercourse BP-4-C) as a High Constraint with Rehabilitation Potential. This reach has been subject to frequent alteration historically, and the observed low flow conditions for this reach have been attributed to the extended duration of discharge from upstream stormwater management infrastructure as opposed to baseflow resulting from natural groundwater discharge. Consequently, the constraint ranking and associated management alternatives for this reach are recognized to differ from these associated with high constraint watercourses with permanent flow conditions sustained by natural groundwater discharge.

Table 3.8.1: Watercourse Constraint Rankings for Boyne Survey					
Watercourse ID	**Fisheries/ Water Quality**	**Terrestrial Resources**	**Stream Morphology**	**Flooding/ Conveyance**	**Net Rating**
Tributary 1-NE-2A					
I-NE-2A	MEDIUM	HIGH	LOW	LOW	MEDIUM
I-NE-2A-1	MEDIUM	HIGH	LOW	LOW	MEDIUM
I-NE-2A-2	LOW	LOW	LOW	LOW	LOW
I-NE-2A-3	MEDIUM	HIGH	LOW	LOW	MEDIUM
I-NE-2A-4	LOW	HIGH	LOW	LOW	LOW/HIGH[3.]
I-NE-2A-5	LOW	LOW	LOW	LOW	LOW
I-NE-2A-6	LOW	LOW	LOW	LOW	LOW
I-NE-2A-7	LOW	LOW	LOW	LOW	LOW
Tributary 1-NE-1B					
I-NE-1B-1	MEDIUM	MEDIUM	LOW	MEDIUM	MEDIUM
I-NE-1B-2	LOW	LOW	LOW	LOW	LOW
Tributary SWS-4A					
SWS-4-A	LOW	LOW	LOW	LOW	LOW
Tributary SWS-1					
SWS-1-A	MEDIUM	HIGH	LOW	MEDIUM	MEDIUM
SWS-1-A-2	LOW	LOW	LOW	MEDIUM	LOW
SWS-1-B	LOW	LOW	LOW	LOW	LOW
Tributary SWS-2					
SWS-2-A	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM
SWS-2-A-1	LOW	HIGH	LOW	LOW	LOW/HIGH[3.]
SWS-2-B	LOW	LOW	LOW	LOW	LOW
SWS-2-C	LOW	LOW	LOW	MEDIUM	LOW
2-II					
2-II	HIGH	HIGH	HIGH	HIGH	HIGH
SWS-5-A	MEDIUM	HIGH	MEDIUM	LOW	HIGH[3.]
SWS-5-B	LOW	MEDIUM	LOW	LOW	LOW
SE-5-A	MEDIUM[5.]/LOW	HIGH	LOW	LOW	HIGH[3.]/LOW
Tributary SWS-3					
SWS-3-A	LOW	LOW	LOW	LOW	LOW
Tributary SE-2					
SE-2-A	LOW	LOW	LOW	LOW	LOW
SE-2-B	LOW	LOW	LOW	LOW	LOW
SE-2-D-1	LOW	LOW	LOW	LOW	LOW[2.]
SE-2-D-2	LOW	LOW	LOW	LOW	LOW
Tributary SE-3					
SE-3-A	LOW	MEDIUM	LOW	LOW	LOW
SE-3-B	MEDIUM	HIGH	LOW	HIGH[1.]	MEDIUM[1.]
SE-3-B-1	LOW	LOW	LOW	MEDIUM	LOW
SE-3-C	LOW	LOW	LOW	LOW	LOW
SE-3-G	MEDIUM	MEDIUM	LOW	LOW	MEDIUM
Tributary SE-4					
SE-4-A	LOW	LOW	LOW	LOW	LOW
BP-4-C					
BP-4-C	HIGH	HIGH	MEDIUM	MEDIUM	HIGH[4]

1. Note: “High” ranking for flooding /conveyance reflects requirement for offsite risk management due to presence of downstream Flood Damage Centre, which is satisfied by the stormwater management flood control strategy and requirements provided in this FSEMS. Net constraint ranking for watercourses within Boyne Survey is “Medium”.
2. Drainage Density function of Watercourse SE-2-D-1 is to be replicated as part of development, as outlined in Appendices ‘E’ and ‘J’ and supporting direction in this FSEMS. Feature is not required to be maintained as a regulated open watercourse.
3. Reaches within woodlots are designated as a High Constraint by virtue of their location within a High Constraint Terrestrial feature.
4. Reaches represent High Constraint with Rehabilitation Potential
5. Reach designated medium fisheries constraint within Sixteen Mile Creek Valley and low fisheries constraint on tableland.

3.9 Summary of Constraints and Issues

The updated subwatershed characterization as per the SUS has included ranking of resources and identification of constraints and opportunities as outlined in the *Sixteen Mile Creek Subwatershed Update Study - Areas 2 & 7, November 2015.* These characterization activities identified the following for the Boyne Survey Secondary Plan Area:

Key General Constraints

Watercourses

- Drainage density, prevalence of undefined low-order drainage features, and form/habitat requires that certain reaches remain open
- Localized erosion along Main Branch and higher order tributaries requires on-site and possibly off-site attention
- Highly altered nature of existing drainage features

Fisheries

- The developing fisheries resources of the permanently flowing Centre Tributary will require protection and targeted rehabilitation to reach its full potential.
- The Main Branch of Sixteen Mile Creek, which bisects the Boyne Survey area from north to south, requires the highest level of protection.
- The remaining Boyne Survey area watercourses become dry during most summers, and have poor instream habitat.
- Existing watercourse flows must be protected or enhanced to maintain and benefit fisheries resources.
- Four watercourses containing seasonal fish habitat, either traverse, or almost traverse, the Boyne Survey area from north to south.

Terrestrial

- Terrestrial resources are limited in extent due to agricultural uses, and natural cover is well below optimal levels
- Eight habitat features or complexes, including the ESA were identified containing one or more of Significant Woodlands, wetlands / wetland complexes, forest interior habitat, linkage features, habitat supporting locally to regionally significant plant or wildlife species, and Significant Wildlife Habitat.
- The Main Branch valley of Sixteen Mile Creek is a regionally-designated Environmentally Sensitive Area that provides a primary wildlife movement corridor and is considered Significant Wildlife Habitat; it offers the opportunity for expansion northward as recommended in regional studies.
- Other tributaries (except for Centre Tributary) are weakly defined and riparian cover is currently minimal.
- The CN rail corridor offers linkage opportunities based on topography and drainage features, and the features and corridors that are intercepted are located south of the study area

- Existing road infrastructure (2013) exposes terrestrial wildlife to significant risks; design of infrastructure and habitat interfaces should consider improvements to reduce risks to wildlife, in terms of practicality, location and character of wildlife within an urban context.

Stormwater

- Potential flood susceptibility due to increased flows, particularly during less frequent events downstream.
- Potential downstream issues of erosion along Sixteen Mile Creek Middle Branch.
- Limited culvert capacity for the existing conveyance structures within the Boyne Survey study area.
- Areas of increased infiltration potential (Area B, ref. Drawing 2); potential requirement to infiltrate 'clean' runoff.

Key Storm Servicing and Environmental Management Issues/Opportunities

a) All stormwater quality management for newly developing areas which discharge to the Sixteen Mile Creek and its tributaries would need to be designed to the *Enhanced* standard for pollutant removal performance, as well as mitigation of thermal impacts.

b) There are areas (ref. Drawing 2 - Area B) where increased infiltration capacity may be possible. Slightly enhanced infiltration may be possible through the shallow fractured till/clay, relative to the thicker till/clay, where underlying sands and gravels or fractured shallow shale exist. **On-site infiltration is to be promoted in areas identified through site specific study (i.e. SIS) as part of the next level of planning application**. Infiltration storage should be subtracted from overall water quality and quantity (erosion control) requirements for stormwater management facility designs. Infiltration of roof top drainage (only), through rear yard ponding or dry wells and other LID BMP's, may be implemented. Due to concerns regarding potential for contamination of groundwater resources, infiltration of runoff from roads and parking areas would not be recommended.

c) Road right-of-ways provide major system conveyance function during less frequent storm events and serve to provide some flood protection for private properties by containing the flood flow within the Municipal right-of-way. Right-of ways are to be designed in accordance with current Town standards in order to provide the appropriate conveyance capacity for the major system (i.e. no reduction to right-of-ways are permitted).

d) Opportunities to apply Low Impact Development Best Management Practices (LID BMP's) are available throughout the study area, in order to provide the requisite stormwater quality and erosion control. As indicated above, those techniques which promote infiltration within the areas exhibiting higher infiltration potential should be used in conjunction with other techniques for pre-treatment (i.e. treatment train approach). Designated LID BMP's are preferred to be within public as opposed to private control.

e) Opportunities to provide post-to-pre control for the Regional Storm (Hurricane Hazel) should consider the potential to achieve the requisite flood protection for downstream properties within proposed off-line storage areas (e.g. stormwater management facilities, and adjacent complementary lands). On-line storage for the Regional Storm event can be considered, if it is adequately demonstrated to all regulating authorities, that off-line control measures are not feasible or practical, and that the impacts due to on-line controls as related to water temperature, fish and terrestrial passage and aquatic and terrestrial habitat, and fluvial geomorphological functions can be appropriately managed.

f) Opportunities to lower (and flatten) existing streams to improve outlet depth for urban servicing needs to consider the impacts on sediment transport and potential for aggradation, as well as impacts to fish and fish habitat.

g) Department of Fisheries and Oceans will require a Conceptual Fisheries Compensation Plan which would include the evaluation of stormwater and watercourse management opportunities to ensure that the basis for subsequent mitigation or compensation is incorporated in the subwatershed management strategies for the Boyne Survey area. The requirement for a Fisheries Compensation Plan is identified in the *Sixteen Mile Creek Subwatershed Update Study, AMEC, November 2015*. The mitigation/ compensation may include; enhancement of on-site watercourses/habitats in accordance with the opportunities identified in the Subwatershed Update Study, downstream function replication through stormwater management, off-site compensation; or other forms of management. The Conceptual Fisheries Compensation Plan has been prepared under separate cover as a Technical Appendix to the Subwatershed Update Study.

h) Sustainable Halton identifies a larger Regional Natural Heritage Strategy to guide local scale actions. The general intent of that program has been considered, although its application in the Study Area in not required. Enhancement of linkages with local resources to the Main Branch corridor will provide the greatest benefits to this regional system.

i) The Main Branch of Sixteen Mile Creek supports regional wildlife corridor functions; these form a primary connection of the regional natural heritage system to the Natural Heritage System within Boyne Survey development area.

j) Opportunities to protect and integrate the remaining natural habitats and linking them through the development fabric should be considered as follows:

- Protect and integrate terrestrial features that have been identified as significant based on the terrestrial resource analysis,
- Restore degraded natural features, develop and implement management strategies for invasive plant species, provide buffers, and integrate connections with buffered riparian corridors and other terrestrial linkages,
- Provide adequate wildlife passageways at road crossings
- Integrate stream corridors with railway corridor for habitat and linkage benefits (where feasible),

- Initiate land stewardship programs,
- Integrate the natural system with supportive land uses where feasible.

k) Smaller isolated features occur along watercourses and provide nodes along riparian and other linkages.

l) Some hedgerows and other cultural features offer linkage opportunities where watercourses are not present or will not be retained.

m) Watercourses identified to remain offer significant linkage opportunities through the future urban landscape. Terrestrial elements can be included such as floodplain wetlands and seasonal wetland pools; clean runoff sources from adjoining land uses can help to sustain more sensitive plant and wildlife species. Manage urban drainage design to provide appropriate hydroperiods in wetland habitats associated with tributaries.

n) Provide adequate wildlife passageways at road crossings.

o) Some urban land uses can support natural heritage functions such as habitat cover and linkage/connectivity. These uses include parks, trail linkages, and stormwater management blocks; buffers are addressed later in the FSEMS.

p) Stewardship programs can encourage landowners and the Town to incorporate principles of habitat management for woodlands and successional habitats, and to consolidate smaller fragments into larger habitat blocks.

q) Factors affecting linkages include extensive agricultural activities, existing urban development, and existing roadways which fragment natural features and corridors:

- Ensure that Regional and Town Policies (Secondary Plans and Subwatershed Management Plans) reflect the Provincial Policy Statement on Natural Heritage.
- Maintain and enhance remaining linkage features (stream corridors, valleys, hedgerows, etc.)
- Utilize rail corridor as habitat linkage.
- Re-establish functional corridors and linkages, including crossings adapted to safe use by terrestrial wildlife
- Establish buffers around existing natural features and setbacks along watercourse corridors.
- Integrate Natural Heritage System with Regional system beyond the Study Area.

r) For the surface watercourses that will remain, it is vital that a suitable corridor is provided that will permit natural channel migration, while ensuring the channel is functionally connected to its floodplain. One of the best means of accomplishing this, is by providing a corridor bottom width that matches the meander belt width for the particular reach. The corridors should be integrated where possible to provide seasonally pooled areas supplied with clean runoff.

s) Many smaller tributaries of Sixteen Mile Creek and Indian Creek lack physical form, riparian cover, and permanent streamflow.

- For medium and high constraint streams, establish minimum riparian corridor width standards through future development areas
- Low constraint streams where preserved would not require a regulated corridor.
- Reinstate wetlands where possible given the proposed urban conditions to extend the hydroperiod in habitats associated with tributaries.
- Establish low-flow refugia within road and rail culverts.

t) Habitat diversity has been reduced in the Study Area. Wetlands, ponds, mature woodlands and successional meadows and thickets are very limited in extent.

- Reinforce existing habitat fragments through regeneration and active restoration.
- Develop stewardship programs to promote reforestation and wetland creation.
- Protect and restore habitats associated with the Main Branch valley system as these have a high potential to sustain diverse habitats and species.

u) Existing woodlands have been regularly disturbed by grazing or logging, and are now dominated by immature growth.

- Develop stewardship programs to encourage landowners to incorporate principles of habitat management for remaining woodlands and successional habitats, and consolidate smaller fragments into larger habitat blocks.

4. DEVELOPMENT AND ANALYSIS OF PREFERRED MANAGEMENT STRATEGY

4.1 Objectives, Targets, and Criteria

The Sixteen Mile Creek Subwatershed Update Study (AMEC et al, November 2015) provides a detailed discussion of the current legislation, policies, and guidelines which are to be applied in the development of Objectives, Targets, and Criteria for the analyses and establishment of stormwater and watercourse management systems, and the development of Natural Heritage Systems.

The following outlines the Objectives, Targets, and Criteria for managing the impacts associated with the development of the Boyne Survey Secondary Plan Study area related to:

- flooding
- stream morphology and erosion
- hydrogeology
- water quality
- aquatic habitat
- fisheries
- vegetation and wildlife
- Natural Heritage System.

The Town of Milton, Regional Municipality of Halton, Conservation Halton, Ministry of Natural Resources, Ministry of Transportation Ontario, Ministry of the Environment, and Department of Fisheries and Oceans each have criteria and guidelines pertaining to drainage and natural resource areas within the study area. In addition to each agencies' specific policies, the *Sixteen Mile Creek Watershed Plan* and the *Indian Creek/Sixteen Mile Creek Sherwood Survey Subwatershed Management Strategy* identified:

- watershed and subwatershed goals and objectives
- watershed and subwatershed management strategies
- subwatershed issues and objectives, and
- sizing criteria for stormwater management facilities.

4.1.1 Secondary Plan Policies

As part of the Secondary Planning process for the Boyne Survey Area, the Town of Milton has developed policies to guide the implementation of the natural heritage and stormwater management systems for the Boyne Survey Area. Relevant excerpts from the current Secondary Plan Policies are included in Appendix 'H'. It is recognized that the current Secondary Plan Policies are subject to change prior to endorsement by Milton Council. Hence, the final Secondary Plan Policies for the Boyne Survey Area, as endorsed by Milton Council, shall govern the planning and design of the Boyne Survey Lands.

The Secondary Plan Policies recognize the following specific objective of the Official Plan regarding the development of the Natural Heritage System:

> *To protect and enhance existing natural heritage features as part of a linked natural heritage and open space system, generally in accordance with the SUS, FSEMS and CFCP".*

The Secondary Plan Policies also recognize that all development within the Secondary Plan be consistent with the requirements and recommendations of the supporting studies and documents, specifically the Subwatershed Update Study, the Conceptual Fisheries Compensation Plan, and this Functional Stormwater and Environmental Management Strategy. In addition, the Policies recognize that the planning (i.e. siting) of stormwater management facilities, watercourse corridors, and the overall NHS may be implemented in a manner different from that which is depicted on the Secondary Plan which would nevertheless satisfy the requirements and recommendations of these supporting studies. Consequently, the Secondary Plan provides policy direction to guide the future development for the Boyne Survey Area. The intent of the policies is to provide flexibility in the siting and planning for the environmental and stormwater management systems, provided that the requirements and objectives of the environmental management system as outlined in the supporting documents are addressed.

To facilitate this process, Subwatershed Impact Studies (SIS's) would be completed in support of the Tertiary Plans for specific development areas. The level of planning detail available for the Tertiary Plans and the Subwatershed Impact Studies also provides an opportunity to assess the requirements of the environmental management system at a greater level of detail than is currently available at the current Secondary Planning level. As such, it is a requirement that the Tertiary plans for lands in Boyne Survey define and establish the location, size and general configuration of stormwater management facilities, as well as any refinements to the Natural Heritage System based on the policies of the Secondary Plan and supporting studies.

4.1.2 Implementation Principles

Through the course of the FSEMS, the stormwater and watercourse management systems and the natural heritage systems advanced in the Conceptual Plans developed by the Landowner Group have been provided for review and testing by the Subwatershed Study Team for compliance with the criteria advanced in the FSEMS. Through this process, a consensus position has been reached between the Town of Milton, the Landowners Group, Conservation Halton, and Halton Region regarding the planning and siting of various components of the Environmental Management System, criteria for the design and implementation of components of the Environmental Management System, and requirements for future studies. Implementation Principles for the Boyne Survey Area have been formed based upon this consensus position, and are included in Appendix 'I'.

The accompanying Schedules to the Implementation Principles have been based on a Tertiary Plan with no status and as such represent one potential concept for the application of the Secondary Plan Policies in the development of the Boyne Survey Area. It should be clearly noted that the final Secondary Plan Policies for the Boyne Survey Area govern the planning and design of the Boyne Survey Lands; nevertheless, the Implementation Principles and the accompanying Schedules are considered to be in compliance with the Secondary Plan Policies.

4.2 Stormwater Management

Subsequent to the completion of the Sixteen Mile Creek Watershed Plan and the Indian Creek/Sixteen Mile Creek Subwatershed Management Study, Provincial, Regional, Local and Conservation Authority policies and guidelines have been updated by the respective agencies. Many of these policies and guidelines have been predicated upon Provincial or Federal legislation, and provide direction regarding the objectives and specific targets for the environmental management system within the Boyne Survey Area. Further details regarding the applicable legislation, policies and guidelines are provided in Section 2 and 4 of the Subwatershed Update Study.

4.2.1 Stormwater Management Objectives

Based on the foregoing, as well as the recent subwatershed characterization work conducted in 2007-2009 as part of the Subwatershed Update Study, the following objectives have been identified specifically for the Boyne Survey area:

i) Maintain/enhance baseflow to the receiving regulated watercourses

ii) Post to Pre-development peak flow control (as a minimum) would be required to achieve flood control objectives for all events up to and including the Regional Storm event.

iii) Control (storage) of stormwater runoff to maintain existing flow-duration exceedance characteristics in the receiving regulated watercourses.

iv) Stormwater Quality treatment of runoff from developing areas is required to mitigate surface water quality impacts in accordance with Ministry of Environment guidelines, to an Enhanced standard.

v) Address requirements for mitigation of thermal impacts from storm runoff.

vi) Low Impact Development Best Management Practices are encouraged to effectively treat stormwater at its source.

vii) Overall sub-basin water balance should be addressed for developing areas in accordance with the targets based on the results of the HSP-F continuous simulation.

viii) Riparian rights of downstream landowners, specific to the use and enjoyment of water across their property (i.e. approved water taking) should be respected.

4.2.2 Stormwater Management Requirements

Subwatershed Plan Management Approach

The majority of the inventory and analysis for the study area has been completed as part of the January 2000 Sixteen Mile Creek Areas 2 & 7 Subwatershed Study, the July 2010 Sixteen Mile Creek Subwatershed Update Study, and the December 2004 Indian Creek/Sixteen Mile Creek

Subwatershed Management Study. The analysis completed for these areas included the provision of stormwater facility sizing criteria in order to meet subwatershed based objectives and performance targets for:

- *Stormwater quality management (habitat protection requirements)*
- *Erosion control*
- *Flood Control*
- *Water Balance*

The January 2000 Subwatershed Planning Study was primarily initiated in support of the Secondary Planning Process for the Milton Phase 1 Area (Bristol Survey), hence the analyses and recommendations advanced within that study incorporated a higher level of detail for that area. The recommendations included specific stormwater management facility sizing criteria (i.e. unitary storage volumes) for erosion and flood control, based upon the impervious area discharging to the respective facility, as well as unitary discharge rates based upon the total contributing drainage area to the facility. That study also provided similar criteria for sizing stormwater management facilities within the balance of the Milton Urban Expansion Area, including the Boyne Survey area, although the supporting analyses were not completed to the same level of detail as for the Bristol Survey area.

The hydrologic analyses completed for the January 2000 Subwatershed Planning Study indicated that, under future land use conditions within the Milton Urban Expansion Area, flow rates during the Regional Storm event (Hurricane Hazel) were anticipated to increase compared to existing conditions. Current standards of practice include requirements to control flows during the Regional Storm event to pre-development levels downstream of the study area. Opportunities to mitigate these impacts by increasing the size of the designated stormwater management facilities were considered prohibitive due to the onerous volumetric requirements (i.e. more than double the size required to achieve post-to-pre control for all events up to and including the 100 year frequency storm). Similar observations were noted in the Indian Creek/Sixteen Mile Creek Sherwood Survey Subwatershed Management Study (Philips Engineering Ltd., December 2004); ultimately, flow rates for the Regional Storm event were to be controlled to pre-development levels at designated downstream Flood Damage Centres through the construction of a Regional Flood Control Berm online the Indian Creek and the utilization of designated storage within the Indian Creek corridor upstream of the Berm east of Tremaine Road.

Performance requirements and objectives for stormwater management facilities within Boyne Survey have been established originally as part of the January 2000 Sixteen Mile Creek Areas 2 & 7 Subwatershed Planning Study, and carried forward and refined as part of the 2004 Indian Creek/Sixteen Mile Creek Subwatershed Management Study and the 2013 Sixteen Mile Creek Areas 2 & 7 Subwatershed Update Study. As per the recommendations of those studies, the stormwater management facilities within the Boyne Survey area are required to:

- Provide stormwater quality control to an Enhanced (formerly Level 1) standard of treatment,
- Provide erosion control as required for local and subwatershed-scale erosion targets,
- Provide stormwater quantity controls as required for local and Subwatershed-scale targets in order to control post-development flows to pre-development levels.

The *Subwatershed Planning Study Sixteen Mile Creek Watershed - Areas 2 & 7,* and the *Indian Creek/Sixteen Mile Creek Subwatershed Management Study* defined stormwater management facility sizing criteria for the Milton Phase 3 area. These criteria related primarily to mitigation of flood, erosion and quality of stormwater impacts.

Stormwater Quality Control Design Criteria

Design criteria for stormwater quality control facilities to satisfy Provincial standards for stormwater quality control are currently provided by the Ontario Ministry of the Environment. The sizing criteria depend upon the type of stormwater quality facility, the agreed level of treatment, and the imperviousness of the contributing drainage area. Where the size of the contributing drainage area is sufficient, and where stormwater quantity control facilities are not required, stormwater quality control within end-of-pipe facilities are generally preferred due to the opportunity to integrate these into the design and footprint of the stormwater quantity facility, as well as the efficiencies and economics which are generally gained through the implementation of these facilities.

Table 4.2.1 provides a summary of the stormwater quality storage requirements for the Boyne Survey Area, which complies with current Provincial standards for stormwater quality control as established by the Ministry of the Environment.

Table 4.2.1: Water Quality Storage Requirements (From MOE 2003)

Protection Level	SWMP Type	Storage Volume (m^3/ha for Impervious Levels)			
		35%	55%	70%	85%
Enhanced (Level 1)	Infiltration	25	30	35	40
	Wetlands	80	105	120	140
	Wet Pond	140	190	225	250
	Hybrid	110	150	175	195

Mass balance modelling has been completed in order to determine the change in mass loadings of various contaminants as a result of the proposed development with stormwater quality control to an Enhanced standard of treatment, as well as the benefits derived from the application of stormwater management practices. The spreadsheet analyses are provided in Appendix 'C' of this report, and the results are summarized in Table 4.2.2.

Table 4.2.2: Water Quality Mass Balance Assessment Summary (kg/yr)

Contaminant	Land Use		
	Existing	Future Uncontrolled	Future with Enhanced Stormwater Quality Treatment
Ammonia	2144	515	391
Fecal Coliform	9.15 E13	2.04 E14	6.61 E13
Total Phosphorus	915	316	184
Total Suspended Solids	7.39 E5	2.76 E5	1.11 E5
Copper	11	56	26
Total Kjeldahl Nitrogen	5283	2628	2045

The results in Table 4.2.2 indicate that, in the absence of stormwater quality controls, mass loadings of fecal coliforms and copper would be anticipated to increase as a result of the conversion of agricultural land use to prominently urban residential, whereas the remaining parameters would be reduced as a result of the conversion of land use. The results further indicate that under future land use conditions with stormwater quality controls to an *Enhanced* standard of treatment, the mass loadings of all contaminants, with the exception of copper, would be further reduced compared to future uncontrolled conditions and would be below the mass loadings under existing land use conditions. While the mass loadings would remain above existing levels under future land use conditions with stormwater management, the application of stormwater quality controls to an *Enhanced* standard of treatment would afford a reduction to the mass loadings compared to future uncontrolled land use conditions.

Flow Rate Assessment - Proposed Development without SWM Controls

Hydrologic analyses for the future development within the Boyne Survey Area have been completed previously as part of the Sixteen Mile Creek Areas 2 & 7 Subwatershed Planning Study (Philips Planning and Engineering Limited, January 2000) in order to characterize the hydrologic impacts associated with the future development within the area. The hydrologic analyses completed as part of that study were predicated upon more generic and conceptual land use information within the area, and thus represented a higher level hydrologic assessment for the area. Nevertheless, the results of the analyses indicated that storm event peak flows would be anticipated to increase within the downstream reaches as a result of the future urban development within the Boyne Survey Area, thus demonstrating that the flood risk and erosion potential within the downstream reaches would be anticipated to increase as a result of the future development.

The hydrologic effects of the currently proposed development of the Boyne Survey Area on peak flow rates have been analyzed through hydrologic simulation and frequency analysis. The subcatchment discretization through the Boyne Survey Area has been revised based upon anticipated drainage boundaries at key features (i.e. roads and lot boundaries), although it has been assumed that contributing drainage areas to the various watercourses would be comparable to the existing conditions; the subcatchment boundary plan for future land use conditions is presented in Drawing 5. The impervious coverage for the future land use conditions would be anticipated to range from 0 % (+/-) for the undeveloped lands, 50 % (+/-) for the low density residential areas, 10 % (+/-) for the community and district parks, and 70 % (+/-) mixed use areas. The HSP-F hydrologic model for the existing land use conditions have been revised in order to simulate the future land use conditions within the Boyne Survey Area. Consistent with the methodology which has been applied for the hydrologic analysis of the existing land use conditions, the model has been executed for a 42 year continuous simulation, and frequency analyses have been completed using the simulated annual maximum flows and applying the Log Pearson Type III Distribution. In addition, the Regional Storm (Hurricane Hazel) event has been simulated as a discrete storm event, and the simulated peak flow has been obtained. The results of this assessment are presented in Table 4.2.3.

Table 4.2.3: Proposed Land Use without SWM Frequency Flows (m^3/s)									
Node	Location/Description	Frequency (years)							
		1.25	2	5	10	20	50	100	Regional
8.530	West Indian Creek Outlet	2.26	3.13	4.27	4.98	5.64	6.46	7.05	16.90
9.120	East Indian Creek Outlet	2.38	3.29	4.46	5.18	5.84	6.65	7.23	16.10
2.402		0.25	0.37	0.52	0.61	0.69	0.79	0.86	1.43
2.509	West 16MC Outlet	2.13	3.36	5.12	6.30	7.43	8.89	9.97	17.30
2.514	West Central 16MC Outlet	2.35	3.70	5.64	6.94	8.18	9.77	11.00	19.80
2.802	East Central 16MC Outlet	3.35	4.99	7.04	8.27	9.35	10.60	11.50	19.10
2.009		0.82	1.26	1.83	2.17	2.48	2.86	3.11	5.14
2.100	16 Mile Creek Main Branch	18.30	27.20	40.70	50.50	60.50	74.40	85.40	378.00
7.302	Omagh Tributary Outlet	2.48	3.62	5.00	5.90	6.75	7.76	8.47	19.40
7.111		1.01	1.64	2.71	3.54	4.43	5.72	6.79	31.90

The results indicate that typically, without stormwater management, flow rates within the Boyne Survey development area would increase significantly for all storm events under conventionally draining conditions (i.e. all runoff from all storms would be directed to the same outlet from the development area to the receiving watercourses, predicated upon maintaining existing drainage areas post-development). The results also indicate that, in the absence of stormwater management, flow rates along the Sixteen Mile Creek Main Branch would remain at approximately existing levels.

Additional analyses have been completed in order to evaluate the increased erosion potential to the receiving watercourses under the future land use scenario. For this assessment duration analyses have been completed for the existing and future uncontrolled land use condition in order to determine the total duration (in hours) if flows in excess of the critical erosive flow within the receiving watercourse. The results of this assessment are presented in Table 4.2.4.

Table 4.2.4: Duration Analysis Summary for Erosive Flows (Hours)				
Node	(m^3/s)	Duration of Erosive Flows		% Increase
		Existing	Future Uncontrolled	
8.530	0.47	1,163	2,751	137%
9.120	0.46	1,088	3,297	203%
2.402	0.05	2,602	637	76%
2.509	0.06	27,549	22,529	-18%
2.514	0.10	28,845	21,497	-25%
2.802	0.31	2,511	6,928	175%
2.009	0.11	2,338	4,423	89%
7.302	0.03	61,611	62,695	2%

The results indicate that under future uncontrolled land use conditions within the Boyne Survey Area, the erosion potential within the downstream receiving watercourses would be anticipated to increase compared to existing conditions.

Current approaches for stormwater management in the Province of Ontario include the need for efforts to promote surface water recharge to the groundwater, in order to work towards maintaining the overall water balance following development. The HSP-F hydrologic model for the study area has been used in order to assess the groundwater recharge under existing and proposed land use conditions within the Boyne Survey Area, to determine the anticipated average reduction in groundwater recharge associated with the proposed development and thereby offer information on the potential impact and the need for compensating management. For this assessment, the model has been modified in order to report the simulated groundwater recharge to the Watershed Data Management (WDM) file for the 42 year continuous simulation, and the average recharge, in millimetres, has been determined for existing and proposed land use conditions. The results of this assessment indicate that the average annual groundwater recharge would be anticipated to be reduced from 202.5 mm per year to 72.6 mm per year (i.e. reduced by 64%) as a result of the proposed development. The results are consistent with findings in other jurisdictions for similar soil conditions which exhibit a low recharge potential.

4.2.3 Water Quality Diversion Area

Initial analyses of the servicing requirements for the Boyne Survey Area were completed by the Development Proponents in 2007. The results of these analyses identified that conventional storm servicing of these lands would require the importation of substantial amounts of fill, particularly within the portion of the Boyne Survey lands draining toward the Omagh Tributary. The volume of fill material required was considered to be cost and functionality prohibitive, hence alternatives were advanced by the Development Proponents in order to address the grading constraints and storm servicing requirements of these lands.

The first alternative advanced consisted of off-site lowering of the receiving watercourses. While initial assessments of the grading requirements indicated that this alternative may be functionally feasible, the unknowns and specific requirements for the implementation of this alternative were considered too constraining (i.e. lack of 4 season data, non-motivated landowners, uncertain future land use), and hence was considered incompatible with the practical schedule for the implementation of the Secondary Plan for Boyne Survey.

Consequently, an alternative strategy was advanced by Development Proponents, for consideration in this study, whereby the extended detention component of specific stormwater management facilities within the Boyne Survey lands would be diverted toward the deeper Sixteen Mile Creek Main Branch via a dedicated trunk sewer, with the flood storage component (i.e. the portion above the extended detention cell) continuing to discharge to the Omagh Tributary. Hydrologic, hydraulic, and scoped environmental assessments have been completed in order to assess and refine the spatial extent of this diversion scenario, and consultation with representatives from the various stakeholders on the Steering Committee for this study was held at key points in the process (ref. Appendix ‘A’). Through this process of incrementally evaluating the hydrologic impacts associated with the implementation of a partial diversion concept, the limits of the area in which water quality diversions could be applied has been refined; ultimately, only the drainage area to the Omagh Tributary has been advanced as the

portion of the Boyne Survey Area for which water quality diversions would be considered. The following section has been prepared in order to summarize the characterization of the area for the diversion assessment as well as the receiving system, and the analyses which have been completed in order to provide direction for the establishment of stormwater management requirements for the area. A detailed Impact Assessment and review of management alternatives for the Water Quality Diversion Area is provided in Appendix 'A'.

Stormwater Erosion and Quantity Control Criteria

The *Subwatershed Planning Study Sixteen Mile Creek Watershed - Areas 2 & 7,* and the *Indian Creek/Sixteen Mile Creek Subwatershed Management Study* provided preliminary volumetric requirements for extended detention (erosion control) and flood control, on an impervious hectare basis, and corresponding unitary discharge rates, based upon the total contributing drainage area, for the Boyne Survey Area at the outlets to the receiving watercourses within the Sixteen Mile Creek Watershed and the Indian Creek Subwatershed. These requirements have been updated based upon the detailed hydrologic analyses completed in support of the Secondary Plan for the existing and future uncontrolled land use conditions. Based upon the results of the impact assessment, the following stormwater management strategy has been evaluated:

- Erosion controls for all future development within the Boyne Survey Area based upon subwatershed targets for the Indian Creek Subwatershed and local targets established within Subwatersheds 2 & 7 of the Sixteen Mile Creek Watershed.
- Stormwater quantity controls for the Boyne Survey Area to each of the Study Area outlets at Britannia Road, as well as the portion of the Boyne Survey Area which discharges to the Centre Tributary.
- No stormwater quantity controls (flood management) for the areas discharging directly to the Sixteen Mile Creek Main Branch
- Stormwater quantity controls for the directly draining area to the Omagh Tributary.

The HSP-F hydrologic model which was developed for the future land use condition within the Boyne Survey Area has been used in order to determine the requisite unitary storage and discharge criteria which would be necessary in order to satisfy the requirements for flooding and erosion control. Routing elements have been added to the outlet of each subcatchment representing the future urban development within the Boyne Survey Area. The Water Quality Diversion strategy for the drainage area to the Omagh Tributary (ref. Outlet Node 7.302) has been incorporated into the model for the sizing of the stormwater management facilities.

The unitary storage and discharge criteria for erosion and flood control have been iteratively adjusted until the requisite erosion and flood control has been achieved. The unitary volume at each outlet of the Boyne Survey Area has been adjusted by incremental multiples of 25 m^3/imp. ha, recognizing the assumption regarding the drainage area boundaries to each drainage outlet for the Boyne Survey Area.

The storage requirements for the Boyne Survey Area are presented in Table 4.2.5.

Table 4.2.5: Stormwater Management Facility Sizing Criteria		
Quantity Component	**Cumulative Unitary Volume (m^3/impervious ha)**	**Unitary Discharge (m^3/s/ha)**
Node 8.530		
Erosion	375	0.0004
25 Year	600	0.012
100 Year	825	0.024
Node 9.120		
Erosion	375	0.0004
25 Year	600	0.01
100 Year	850	0.023
Node 2.402/2.509		
Erosion	400	0.0003
25 Year	750	0.01
100 Year	975	0.024
Node 2.514		
Erosion	400	0.0003
25 Year	750	0.01
100 Year	975	0.035
Node 2.100		
Erosion	400	0.002
25 Year	650	0.015
100 Year	800	0.035
Node 7.302 [1.]		
Erosion	550/0	0.0005/0
25 Year	745/400	0.0015/0.0013
100 Year	795/800	0.08/0.035
Node 7.111		
Erosion	430	0.0011
25 Year	704	0.010
100 Year	795	0.034
Node 2.802		
Erosion	400	0.0003
25 Year	625	0.01
100 Year	975	0.035

NOTE: [1.] Values to left represent requirements for facilities with diverted extended detention volumes; values to right represent requirements for conventional facilities which would discharge to Omagh Tributary for all events.

Continuous simulation and frequency analyses have been completed for the hydrologic analyses, and the Regional Storm has been simulated as a discrete storm event in order to obtain the instantaneous peak flow rates at key locations throughout and downstream of the study area under future land use conditions with stormwater management. Table 4.2.6 and the percent change compared to the pre-developed land use conditions within the Boyne Survey Area are presented in Table 4.2.7.

Table 4.2.6: Proposed Land Use with Proposed SWM Criteria (m^3/s)									
Node	**Location/Description**	**Frequency (years)**							
		1.25	**2**	**5**	**10**	**20**	**50**	**100**	**Regional**
8.530	West Indian Creek Outlet	0.61	0.99	1.59	2.03	2.47	3.09	3.59	10.70
9.120	East Indian Creek Outlet	0.55	0.86	1.38	1.77	2.18	2.77	3.25	10.80
2.402		0.04	0.06	0.10	0.14	0.18	0.24	0.30	1.87
2.509	West 16MC Outlet	0.51	0.82	1.36	1.79	2.26	2.97	3.57	9.72
2.514	West Central 16MC Outlet	0.70	1.11	1.86	2.49	3.20	4.29	5.26	16.00
2.802	East Central 16MC Outlet	0.65	1.01	1.69	2.28	2.97	4.08	5.10	11.70
2.009		0.18	0.29	0.48	0.66	0.86	1.19	1.50	4.03
2.100	Sixteen Mile Creek Main Branch	18.30	27.20	40.90	50.80	60.90	74.80	86.00	378
7.302	Omagh Tributary Outlet	0.37	0.91	2.19	3.13	4.00	5.06	5.80	20.50

Table 4.2.7: Percent Change in Peak Flows Compared to Pre-development Conditions (%)									
Node	**Location/Description**	**Frequency (years)**							
		1.25	**2**	**5**	**10**	**20**	**50**	**100**	**Regional**
8.530	West Indian Creek Outlet	-4.7	-3.9	-2.5	-1.9	-1.6	-1.3	-0.8	0.0
9.120	East Indian Creek Outlet	-6.8	-8.5	-8.0	-6.8	-5.2	-3.1	-1.2	8.0
2.402		-60.0	-62.5	-61.5	-58.8	-59.1	-60.0	-60.0	0.0
2.509	West 16MC Outlet	-8.9	-4.7	-1.4	-1.1	-1.3	-2.0	-2.7	0.0
2.514	West Central 16MC Outlet	-19.5	-15.9	-11.4	-8.8	-7.0	-5.1	-3.8	0.0
2.802	East Central 16MC Outlet	-3.0	-3.8	-4.0	-3.8	-3.9	-3.3	-3.0	0.0
2.009		-21.7	-19.4	-21.3	-19.5	-19.6	-19.0	-18.5	0.0
2.100	Sixteen Mile Creek Main Branch	-0.5	-0.4	-0.2	-0.2	-0.3	-0.4	-0.3	-0.8
7.302	Omagh Tributary Outlet	-68.9	-47.4	-18.4	-7.7	-4.8	-6.6	-10.5	0.0
7.111	Centre Tributary Outlet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

The results in Tables 4.2.7 indicate that the proposed stormwater management strategy for the Boyne Survey Area would control post-development flows to pre-development levels at all outlets for all events up to and including the 100 year storm event. The results also indicate that Regional Storm event peak flow rates would be controlled to pre-development levels at all outlets; this is predicated upon the application of Regional Storm quantity controls, which is discussed later in this section. The results further indicate that over-control may occur at certain locations (i.e. Nodes 2.402, 2.009, 7.302) due to the reduction in drainage area compared to the existing condition. At the SIS stage, the stormwater management requirements will be verified based upon the detailed drainage and stormwater management plans for the contributing drainage areas to the SIS outlets.

An erosion assessment has been completed in order to verify the effectiveness of the proposed stormwater management criteria. For the portions of the Boyne Survey Area which discharge to the tributaries of the Sixteen Mile Creek for which critical flows have been established under the Subwatershed Update Study, these analyses have consisted of comparisons of the duration exceedance of the critical flow under existing and future land use conditions with proposed stormwater management, which is considered to provide a conservative assessment of the erosion impacts under proposed conditions and hence the associated requirements for erosion control within the stormwater management facilities; for the areas discharging to the Sixteen Mile Creek Main Branch (including the water quality diversion areas), these analyses have applied a more robust methodology based upon the methods developed by MacCrae and Rowney (ref. *The role of Moderate Flow Events and Bank Structure in the Determination of Channel Response to Urbanization*, 1992) and shear force relationships outlined by Lorant (ref. *Vulnerability of Natural Watercourses to Erosion due to Different Flow Rates*, 1982), which accounts for the shear force exceedance in addition to the duration of exceedance of the critical shear. The analyses have been completed for existing land use conditions within Boyne Survey and future controlled land use conditions within Boyne Survey. The results of the assessment for the Sixteen Mile Creek Tributaries, based solely upon the duration exceedance of the critical flow rate compared to existing conditions, are summarized in Table 4.2.8, and the results of the assessment for the Sixteen Mile Creek Main Branch, based upon the duration and critical shear exceedance compared to existing conditions, are summarized in Table 4.2.9.

Table 4.2.8: Erosion Assessment Summary for Local Erosion Sites (Hours Duration Exceedence)

Reference Node	Land Use Condition Within Boyne Survey		Percent Difference Compared to Existing Conditions
	Existing	Future with SWM	
8.530	1,163	1,041	-10%
9.120	1,088	1,089	0%
2.402	2,602	376	-86%
2.509	27,549	23,065	-24%
2.514	28,845	21,946	-26%
2.802	2,511	2,880	-13%
2.009	2,338	1,726	-26%
7.302	61,611	53,650	-13%

Table 4.2.9: Erosion Assessment Summary For Site R7IX (kg/m^2 x hours)

Channel Bed/Bank Station	Land Use Condition Within Boyne Survey		Percent Difference Compared to Existing Conditions
	Existing	Future with SWM	
Channel Bed	2104	2148	2
Total Bank Shear	1091	1115	2
0.2 x bankfull depth	841	863	3
0.5 x bankfull depth	511	526	2
0.8 x bankfull depth	94	97	4
1.0 x bankfull depth	17	17	0

The results in Table 4.2.9 indicate that the proposed stormwater management criteria would control the residual increase along the Sixteen Mile Creek Main Branch to within an acceptable tolerance. The results in Table 4.2.8 indicate that the sizing criteria would control the duration of erosion flows to below existing levels with over-control achieved in certain locations.

As indicated in the SIS Terms of Reference (ref. Appendix 'M') and the Implementation Principles (ref. Appendix 'I'), the final sizing criteria of the stormwater management facility is to be verified at the SIS stage, based upon the more detailed information for the drainage areas and land use to each outlet of the Boyne Survey Area.

4.2.4 Evaluation of Stormwater Management Strategies

Screening of Component Stormwater Management Techniques

Stormwater management techniques considered for this assessment can be classified according to the following general categories:

(i) "Do Nothing" - Future Uncontrolled Development
(ii) Source and Conveyance Controls (Low Impact Development BMP's)
(iii) End-of-Pipe Facilities

1. "Do Nothing" - Future Uncontrolled Development

Build-out of the Study Area, without controls, would lead to degraded runoff water quality, and potential reduction in base flow with associated impacts on downstream habitats. Previous Studies (ref. *Sixteen Mile Creek Areas 2 & 7 Subwatershed Planning Study, Indian Creek/Sixteen Mile Creek Subwatershed Management Study*) have confirmed the potential impacts of uncontrolled development. The erosion assessment undertaken as part of the *Sixteen Mile Creek -Watershed Plan, Sixteen Mile Creek Subwatershed Planning Study – Areas 2 & 7*, the *Indian Creek/Sixteen Mile Creek Subwatershed Management Study,* as well as the refined characterization provided within the *Sixteen Mile Creek Subwatershed Update Study*, also indicate that erosion potential would increase without controls. In addition, this alternative would not meet the objectives of Provincial and Municipal programs for environmental protection, nor the erosion and stormwater quality objectives of the Watershed and Subwatershed Plans. Therefore, this alternative is considered to be unacceptable. Notwithstanding, it has remained part of this assessment as a benchmark for assessment of the effectiveness of other proposed stormwater management strategies as required by the Municipal Engineers Association (MEA) Class Environmental Assessment Procedures.

2. Source and Conveyance Controls (LID BMP's)

The use of source and conveyance controls would rely on providing measures within the context of site development to promote infiltration and pollutant removal on a local site by site basis. These measures rely on eliminating the direct connection between impervious surfaces such as roofs, roads, parking areas, and the storm drainage system, as well as the promotion of infiltration on each development site. General design guidelines and considerations for source and conveyance controls have been advanced since 1994 as part of the Ministry of the original Environment Best Management Practices Guidelines.

Subsequent to the 1994 MOE Guidelines, technologies and standards have been developed for the application of source and conveyance controls. These have evolved into a class of BMP referred to as Low Impact Development (LID) practices, which have developed as an integrated form of site planning and storm servicing to maintaining water balance and providing stormwater quality control for urban developments. Initial results from studies in other settings have demonstrated that LID practices may also provide benefits by way of reducing the erosion potential within receiving watercourses and thereby reducing end-of-pipe storage requirements. In addition, due to volumetric controls afforded by LID BMP's, water quality would also be improved. The benefits from LID practices are generally focused on the more frequent events of lower volumes, as opposed to the less frequent events with higher volumes. It is also recognized that the forms of LID which promote infiltration or filtration through a granular medium also provide thermal mitigation for storm runoff.

Guidelines regarding the application of LID practices and techniques have been developed within various jurisdictions in the United States and Canada. Recently, the Toronto and Region Conservation Authority and Credit Valley Conservation released a manual for the design and application of LID measures (ref. *Low Impact Development Stormwater management Planning and Design Guide Version 1.0,* CVC and TRCA 2010). Various LID techniques, as well as their function, are summarized in Table 4.2.10. While LID includes additional planning practices to reduce surface runoff and promote infiltration (i.e. reduced road widths), the information provided in Table 4.2.10 specifically addresses those techniques and technologies related to stormwater management practices. Current practice within the Town of Milton prefers to retain LID BMP's within public control versus private control, in order to better ensure that these techniques operate and function as per the design condition.

Table 4.2.10: Source And Conveyance System Stormwater Management Technique Screening

Technique	Function
Bio-retention Cell	• Vegetated technique for filtration of storm runoff • Stormwater quality control provided through filtration of runoff through soil medium and vegetation • Infiltration/water balance maintenance and additional erosion control may be achieved if no subdrain provided
Cistern	• Rainwater harvesting technique • Storm runoff volume reduced through capture/interception of runoff • Stormwater quality provided for captured runoff • Effectiveness is contingent upon available volume within cistern
Downspout Disconnection	• Effectiveness dependent upon soils and supplemental conveyance techniques • Storm runoff volume reduced by promoting infiltration through reducing direct connections of impervious surfaces • Benefits to stormwater quality control and erosion control are informal.
Grassed Swale	• Vegetated technique to provide stormwater quality control • Stormwater quality control provided by filtration through vegetated system • Runoff volume reduction may be achieved by supplementing with soil amendments
Green Roof	• Vegetated technique for reducing storm runoff volume • Informal stormwater quality control provided through reduction in runoff volume • No benefits provided by way of infiltration

Table 4.2.10: Source And Conveyance System Stormwater Management Technique Screening	
Technique	**Function**
Infiltration Trench	• Infiltration technique to provide stormwater quality control and maintain water balance • Erosion controls may be achieved depending upon soil conditions
Permeable Pavers/Pavement	• Infiltration technique to reduce surface runoff volume • Benefits to stormwater quality and erosion control are informal
Rain Barrel	• Rainwater harvesting technique • Storm runoff volume reduced through capture/interception of runoff • Stormwater quality provided for captured runoff • Effectiveness is contingent upon available volume within cistern
Rain Garden	• Vegetated technique for infiltration of storm runoff • Stormwater quality control provided through filtration of runoff through soil medium and vegetation • Infiltration/water balance maintenance and additional erosion control may be achieved if no subdrain provided
Soil Amendments	• Technique for reducing runoff volume through increased depth of topsoil • Stormwater quality control provided through increased soil storage and associated interception of storm runoff • Increases water balance compared to existing conditions when applied in areas with low permeability soils • Possible erosion control benefits
Pervious Pipes	• Technique to reduce storm runoff through the implementation of perforated pipes within storm sewers • Promotion of infiltration maintains water balance and provides stormwater quality and erosion control benefits

3. End-of-Pipe Facilities

End-of-pipe facilities typically do not replicate natural hydrologic conditions as favourably as source controls or conveyance controls. Nevertheless, the implementation of end-of-pipe facilities offer a number of significant practical benefits in terms of providing Municipal control, ease of maintenance, ability to serve large drainage areas, and a high degree of effectiveness in runoff management, as required for mitigation of flooding, erosion and water quality impacts. Moreover, it is recognized that end-of-pipe facilities represent the most reliable and efficient means of achieving stormwater quantity control.

End-of-pipe facility techniques are comprised of wet ponds, wetlands or hybrids (which may be designed to provide stormwater quality, erosion, and quantity control) and dry pond facilities (which may be designed to provide erosion and quantity control, but do not provide substantive stormwater quality control). Maintaining water balance or promoting infiltration within the end of pipe facility is typically achieved via modifications to the system near the facility outlet (i.e. construction of sand filter, pervious pipe at the facility outlet infiltration cells, enhanced infiltration (RIB's/RIC's)). Generalized standards for evaluating the effectiveness of infiltration/water balance provided within an infiltration cell at the facility outlet versus that provided via source controls establish target infiltration volumes, drawdown times related to the infiltration potential of the constructed medium or the local soils, and storage depths (i.e. 10 mm capture within a total storage depth of 0.5 m which is discharged over a period of 7 days) in order to determine land base requirements. Similarly, thermal mitigation may be achieved within stormwater management facilities either through the orientation/alignment of the facility (i.e. longer length), higher canopy cover, or through modifications to the outlet structure (i.e. sand trenches, bottom draws, cooling trenches).

"Short-Listed" Stormwater Management Techniques

In summary, the following component stormwater management techniques have been carried forward as elements of alternative stormwater management solutions:

(i) Localized Diversions

- While current practices by Conservation Halton seek to avoid drainage area diversion wherever possible, 'Optimized' Diversion of minor system flow between subcatchments may be acceptable, subject to maintenance of baseflow volume and duration to important downstream habitats.

(ii) Source Controls/LID BMP's

- The application of LID techniques to provide stormwater quality control and maintain the water balance is recommended particularly in those areas with appropriate soil conditions.
- Increased topsoil depth of suitable quality within select green space (i.e. schools, parks, residential lots)
- Roof leader discharge to pervious surfaces
- Oil Grit separators as a supplemental water quality measure, specifically for management of spills in high risk areas

(iii) End-of-Pipe Facilities

- Wetlands, wet ponds, and hybrids

Stormwater and Environmental Management Concept Development

A Preliminary Stormwater and Environmental Management Concept has been developed for the Boyne Survey Area based on the current Preferred land use plan for the area and application of the short-listed stormwater management techniques listed above. This Preliminary Concept Plan has been developed in conformance with previous and current studies, most notably the Sixteen Mile Creek Areas 2 & 7 Subwatershed Update Study, 2015.

There are a number of factors which will influence specific elements of the preferred plan, within each development area as follows:

- ***External Drainage Conveyance***

The study area receives runoff from upstream external areas along the north limit of the Boyne Survey area. The upstream drainage areas to the respective watercourses receiving runoff from external lands range from 50 ha +/- to over 400 ha at the Sixteen Mile Creek Centre Tributary and more than 10,000 ha at the Sixteen Mile Creek Main Branch. With the exception

of the Sixteen Mile Creek Main Branch, the upstream drainage area is fully or partially urbanized, with stormwater management facilities; upstream of the Sixteen Mile Creek Main Branch, the contributing drainage area is mostly rural, with prominently uncontrolled conditions within the contributing urban drainage area. The opportunities for conveyance of external drainage through the study area depend upon the constraint ranking applied to the existing drainage feature conveying runoff. The watercourses which convey runoff from the external lands north of Boyne Survey have been generally assigned a *Medium/High* net constraint ranking, and are to remain open and enhanced As such, these features will continue to convey runoff from the external lands through the Boyne Survey area.

- ***Foundation Drainage Standard***

Depending on the available outlet depth (i.e. watercourses, culverts and storm sewers), there would be two general types of foundation drainage:

(i) Shallow storm sewer system (i.e. typically 1.2 m or deeper) or roadside swales collecting road runoff with Foundation drainage via sump pumps discharging the surface.

(ii) Deeper storm sewer systems (i.e. typically 2.6 m or deeper) which accommodate gravity drainage of foundations: generally restricted to those areas draining directly to the deeper Sixteen Mile Creek valley.

The key determinant related to the foregoing would be based on minimizing imported fill material. Based upon the preliminary analyses completed for the FSEMS, it is anticipated that shallow storm sewer systems would be required throughout the development area. Deeper foundation drains should be considered, where feasible and subject to approval from the Town of Milton.

- ***Stormwater Facility Type and Location***

Recognizing that the proposed development within the Boyne Survey Area consists of residential land uses, end-of-pipe stormwater management facilities are anticipated to consist primarily of hybrid facilities, due to the hazard potential associated with potential public access to the area, as well as more contemporary design practice which encourages a deeper permanent pool in order to limit the potential for undesirable or nuisance species (i.e. mosquitoes) which are perceived to be associated with facilities with shallower permanent pool volumes. Notwithstanding, it is recognized that as detailed design proceeds, there may be sufficient cause for the implementation of different end-of-pipe facilities. In such instances, the following site-specific rationale for constructing wetland, wet pond, or hybrid systems, which has been applied in previous studies, is suggested for guidance:

(i) Wetlands are considered to be more productive in terms of environmental benefits, typically providing more organic matter and food material for receiving watercourse habitats. Wetlands are also considered more compatible than wet ponds where the facility is located adjacent to, or provides a linkage to, a watercourse, or terrestrial habitat (natural heritage systems) or open space system.

(ii) Wet Ponds are considered more appropriate as features in the urban landscape where they are relatively isolated from terrestrial/watercourse habitats or in tableland settings. Wet Ponds are also preferred over Wetlands under current Town of Milton standards, as they are generally recognized to reduce the number of nuisance species (i.e. mosquitoes) due to the deeper permanent pool.

(iii) Hybrid facilities combine the benefits of Wet Ponds and Wetlands, affording linkage opportunities to watercourses and terrestrial habitats or open spaces, as well as reducing the number of nuisance species compared to constructed Wetlands. Hybrid facilities are currently preferred by the Town of Milton over Wetland and Wet Pond facilities.

(iv) Low Impact Development techniques are particularly well-suited for small sites which may be surrounded by infrastructure (i.e. roads) and/or proximate to environmental features, or which may be adjacent to deep valley features which do not currently include a drainage feature from the table land to the valley floor. An appropriate application of LID practices could satisfy requirements for stormwater quality and potentially erosion control, however these practices are generally recognized as having little, if any, benefit, with respect to flood control; as such, these techniques are particularly well-suited for areas not requiring flood control for stormwater management.

- ***Establishment of Drainage Boundaries Between Catchment Areas***

Generally the location of subcatchment boundaries with the Study Area would be maintained in accordance with current practice by Conservation Halton. However there may be opportunities or requirements to allow limited diversion of the minor or major system flow, or both, to adjacent outlets. Any such a diversion would need to address the following:

(i) Diversions must not negatively affect the flood potential of downstream lands. This may lead to a requirement to provide additional storage to control flow rates to the pre-development peak flows at each location.

(ii) Diversion should consider the capacity of downstream systems (i.e. where additional capacity is available, diversion of flow may be appropriate).

(iii) Minor systems diversions require consideration of the impact of such diversion on baseflow within the receiving watercourse, as well as the length and importance of the habitats affected (positively or negatively). These impacts are to be further evaluated as part of the environmental monitoring program.

(iv) Riparian rights of downstream landowners should be considered in establishing diversions as part of a stormwater management plan.

Each of the foregoing factors has been considered as they relate to each subcatchment within the Secondary Plan Area.

As indicated previously, a need to incorporate partial (i.e. water quality) diversions into the management plan for portions of the Boyne Survey Area draining to the Omagh Tributary has been identified through the planning process, in order to minimize the volume and associated cost of importing fill in order to provide conventional storm servicing for the area.

4.2.5 Regional Storm Flood Control Criteria

Current stormwater management practice for the Boyne Survey Area requires that peak flow rates for the Regulatory Event be controlled to pre-development levels downstream of the proposed development area (i.e. at Britannia Road). A hierarchical approach is recommended for establishing the Regulatory (Regional Storm) flood controls for the Boyne Survey Area, which has been established in consultation with Conservation Halton. Under this hierarchal approach, the preference is for off-line management through the use of off-line stormwater management facilities and any other feasible and practical measures. Analyses have been completed as part of the Boyne Survey FSEMS in order to obtain a preliminary indication of the anticipated requirements which would be associated with providing Regulatory (Regional Storm) flood control entirely within the off-line end-of-pipe facilities within the Boyne Survey Area. The results of this preliminary assessment have indicated that the flood control volume(s) within the off-line end-of-pipe facilities to achieve instream post- to pre- control for the Regulatory (Regional Storm) event would be significantly greater than that which would be required in order to provide local quantity control up to the current 100 year design standard (i.e. 100% more +/-). These findings need to be verified by the local proponents at the SIS stage.

In the hierarchal approach, consideration should also be given for the use of complementary land (not active urban uses) for Regional Storm flood control storage (i.e. including backwater in linkage zones, parks, or other open spaces) given that the flood frequency would be extremely low (200 years or greater) and subject to approval from the Town of Milton. As noted, off-line storage is preferred by Conservation Halton and the Town of Milton.

Subject to screening the foregoing, the hierarchal approach would follow with consideration of on-line storage through stabilizing proposed or existing roadway embankments and culverts, or the construction of online controls within the watercourse corridor. Conservation Halton's preference would be toward floodway encroachments (i.e. pinch points in valley versus standard culvert (orifice) and embankment controls, hence proponents would need to evaluate the feasibility and effectiveness of these techniques in advance of proposing alternate structural approaches). In the hierarchal approach, these would preferably be considered in combination with off-line storage.

Regional Storm flood control requirements for the Boyne Survey Area have been determined, premised upon the concept of online Regional Storm storage as per the Implementation Principles, and the siting of a Regional Storm flood control facility at the outlet of each of the tributaries at (or near) Britannia Road. The results of this assessment are summarized in Table 4.2.11.

Table 4.2.11: Summary of Preliminary Regional Storm Flood Control Volume Requirements for SIS Areas

SIS Area	Outlet Node (ref. Drawing 1)	Drainage Area (ha)[1.]		Regional Flood Control Volume (m^3/Imp. ha)[2.]	
		Existing	Future	Total (m^3)	Unitary Storage (m^3/Imp. ha)
1	8.530	156.12	154.98	72,500	1125
2	9.120	152.63	155.48	67,500	825
3	2.402	16.93	10.07	0	0
	2.509	133.81	151.67	91,000	1325
4	2.514	249.99	239.06	57,000	600
6	2.009	35.31	36.20	9,000	550
	2.802	102.82	133.61	75,000	1050
5b	7.303	12.56	0	0	0
	7.302	236.09	183.50	0	0

NOTES: 1. External drainage areas assumed as per approved developed land use condition under both existing and future conditions scenarios; as such, Regional Storm controls pertain to Boyne Survey Area only.
2. Volumes are in addition to 100 year storage requirements.

The foregoing analysis for Regional Storm flood control requirements has been completed based upon conceptual facility locations for the purpose of estimating flood storage volume requirements, and does not represent preferred or specific locations for the implementation of Regional Storm online flood controls. The final approach and related siting for Regional Storm flood control facilities and the associated warrants for interim and ultimate controls and strategies would be completed as part of the SISs. The preferred approach should be established in consultation with Town and Conservation Halton staff, and proposals for Regional Storm flood control would be required to follow the prescribed hierarchical approach and satisfy Town and Conservation Halton policies and criteria for analysis and design. As noted, the analyses will need to be refined as part of subsequent Subwatershed Impact Studies and Functional Servicing Reports, including preliminary design of the Regional Storm storage facilities, and would necessarily need to consider the grading of the off-line stormwater management facilities and lands adjacent to the on-line storage area, requirements for fish and terrestrial passage and aquatic and terrestrial habitat, potential for thermal impacts and mitigation, and potential for fluvial geomorphological impacts and mitigation.

4.3 Natural Heritage Strategy

4.3.1 Policies Guiding NHS Approach

Provincial Policy Statement (2014) and MNRF Technical Guidelines

The approach to be undertaken for the Functional Stormwater and Environmental Management Strategies for Boyne Survey (including the Natural Heritage System), must “be consistent with” the Provincial Policy Statement (2014) which provides clear direction on the adoption of an ecosystem approach, and the protection of resources that have been identified as ‘significant’: wetlands and, habitats of endangered or threatened species, and the avoidance of any negative impacts proposed within or adjacent to other significant features (i.e. fish habitat, woodlands, valleylands, wildlife habitat, and areas of natural and scientific interest).

Natural heritage systems are currently defined under the Provincial Policy Statement (PPS) as follows:

> *"a system made up of natural heritage features and areas, and linkages intended to provide connectivity (at the regional or site level) and support natural processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species, and ecosystems. These systems can include natural heritage features and areas, federal and provincial parks and conservation reserves, other natural heritage features, lands that have been restored or have the potential to be restored to a natural state, areas that support hydrologic functions, and working landscapes that enable ecological functions to continue. The Province has a recommended approach for identifying natural heritage systems, but municipal approaches that achieve or exceed the same objective may also be used."*

In March 2010, the Province released the finalized Second Edition of the Natural Heritage Reference Manual (NHRM), which is intended to guide the implementation of the PPS (2005). The first edition NHRM reflected the focus and wording of the 1997 PPS, which was strengthened significantly in 2005, explicitly recognizing linkages "*between & among natural heritage features & areas, surface water features & ground water features, & hydrological functions*" which are necessary for the ecological and hydrological integrity of watersheds. The 2005 and 2014 PPS also identified watersheds as an "*ecologically meaningful scale for planning*".

The 2010 NHRM suggests an approach to the identification of Natural Heritage Systems that builds on the 1999 version in referencing the system approach first identified in Riley and Mohr (1994), however there is increased detail and reference to more current scientific information to support the suggested approach. The NHRM updates the treatment of specific PPS-identified categories, including habitat of endangered and threatened species [now subject to a strengthened provincial Endangered Species Act (2007)], significant wetlands (now with greater focus on 'linkage' to hydrological regimes, and subject to strengthened protection under updated Conservation Authority Regulations), significant woodlands (now recognized in some upper tier municipal Official Plans and subject to region-specific identification criteria), significant valleylands (now recognized as having cultural heritage value in addition to ecological and hydrological significance), significant wildlife habitat (planning authorities still encouraged to identify SWH on a comprehensive rather than site-by-site basis), significant areas of natural and scientific interest, and fish habitat.

The 2010 NHRM also provides helpful guidance on development of Natural Heritage Systems in settlement areas, whether in existing built-up areas, or in "*designated growth areas*" as defined in the PPS (2005 and 2014); this has direct application to the future development areas addressed in the Subwatershed Update Study and in the associated secondary planning processes.

The updated NHRM will be applied to guide the NHS development for the subject lands.

Species at Risk Act (2005)

This legislation provides the federal mandate for the protection of species identified as Endangered, Threatened or Special Concern at the federal level. While these are only fully protected on federal lands, they may receive protection as Significant Wildlife Habitat under the PPS (2005 and 2014).

Endangered Species Act (2007)

This legislation provides the provincial mandate for the protection of species identified as Endangered, Threatened or Special Concern at the provincial level. Habitats of provincially Endangered and Threatened species are specifically protected from development in the PPS, and habitats of provincial Special Concern species are recognized under the Province's Significant Wildlife Habitat categories.

Migratory Birds Convention Act (1994)

This federal legislation protects the nests an offspring of listed migratory bird species from destruction or disturbance. In its application, it requires best management practices to detect and avoid disturbance to active nests during development activities.

Greenbelt Plan (2005)

The Greenbelt Act (2005) designated a Greenbelt Plan area containing Protected Countryside, which contains rural lands and a natural heritage system. Although the Greenbelt does not extend into the areas approved for urbanization in the Town of Milton, designated lands are located to the immediate south of Boyne. Where future development abuts portions of the Greenbelt NHS, the approach to the protection of the natural features and functions will need to conform to the natural heritage policies of the Greenbelt Act, and take direction from the technical guidelines that have been prepared by the Ministry of Natural Resources.

The Greenbelt Plan defines '*vegetation protection zone*' as:

> "*A vegetated buffer area surrounding a key natural heritage feature or key hydrologic feature within which only those land uses permitted within the feature itself are permitted. The width of the vegetation protection zone is to be determined when new development or site alteration occurs within 120 m of a key natural heritage feature or key hydrologic feature, and is to be of sufficient size to protect the feature and its functions from the impacts of the proposed change and associated activities that will occur before, during, and after, construction, and where possible, restore or enhance the feature and/or its function.*"

The Greenbelt Plan requires a minimum 30 metre vegetation protection zone for wetlands, seepage areas and springs, fish habitat, permanent and intermittent streams, lakes, and significant woodlands. MNRF has prepared guidelines in support of the Plan which address Key Natural Heritage features identification criteria, Significant Woodlands Criteria, and Significant Habitats of Endangered, Threatened and Special Concern Species. Figure T7 in Appendix 'F'

consists of the Province's mapping of the legal boundary of the Protected Countryside in the vicinity of the Boyne Secondary Plan area.

Conservation Halton Regulations (2006)

This document provides policy direction related to Conservation Halton's review of Permit applications made pursuant to Ontario Regulation 162/06 as well as the review of planning applications circulated to Conservation Halton for review by watershed municipalities, provincial agencies and other organizations. Regulatory policies pertain to wetlands, watercourses, erosion hazards, flooding hazards, shoreline hazards and other areas identified by the Conservation Authorities Act and Ontario Regulation 162/06. Planning policies pertain to all aspects of the Provincial Policy Statement Natural Heritage and Natural Hazards policies as well as some specific policies related to larger planning applications such as golf courses.

Region of Halton Official Plan

The Halton Regional Plan (2006) incorporated key natural features under categories including 'Escarpment Natural Area', 'Environmentally Sensitive Area', and 'Greenlands A and B'. The Region has also approved policies regarding the identification of Significant Woodlands as defined under the PPS (2005). The Town of Milton Official Plan (2001) reflects the Halton Region categories, and identifies Environmental Linkage Areas which are primarily watercourse-based. The Sustainable Halton Plan (approved under ROPA 38 by Regional Council in December 2009 and under appeal) identifies a Regional Natural Heritage System, which will supplant the existing Greenlands system for areas outside the current urban boundaries. This is discussed in more detail below, as it has relevance to the development of NHS for the designated urban lands within the Sixteen Mile Creek and Indian Creek subwatersheds.

North Oakville Creeks Subwatershed Study (2006)

Conservation Halton staff has recommended consideration of the NHS methodology utilized in the North Oakville Creeks Subwatershed Study (2006). This was a relatively recent example of a systems-based approach undertaken under the Provincial Policy Statement (2005). The North Oakville systems approach as described in the North Oakville Creeks Subwatershed Study Management Report (TSH et al., 2006) identified core areas which consist of relatively large, compositionally diverse habitat features, readily linked to other features, containing significant features and attributes, and overall watershed functionality with respect to hydrological processes. The core areas are woodlands and/or wetlands that may be associated with semi-natural successional features. Primary and secondary linkages were defined, with primary linkages serving to connect the major core features with primarily forested linkages of 100 m width, and secondary linkages of more variable habitats and widths, determined by stream corridors and floodlines. Potential linkages could take advantage of smaller features and hedgerows as well as stream corridors.

The SUS study team recognizes that there are key differences between the North Oakville landscape, and the portions of the Peel Plan that contain the study areas within the Town of Milton. Key differences include the number of large habitats in the North Oakville Study Area, substantially greater existing natural cover (approx. 4.5% in Boyne, vs >16% in North Oakville), and the presence of more varied physiographic conditions (i.e. Trafalgar Moraine). Notably, the

North Oakville study rationalized the removal of some features including Significant Woodlands. The North Oakville approaches have been considered, in the light of comparing approaches to the original SWS 2&7 approach, Indian Creek Subwatershed approach, and other contemporary examples of NHS planning underway in the Peel Plain. As discussed earlier in this section, the second edition of the Natural Heritage Reference Manual (OMNR 2010) recognizes that "*every natural heritage system will be different*".

Sustainable Halton Plan (2010)

The Sustainable Halton Plan is a growth management planning project initiated in May 2006, intended to promote the concept of sustainable development, which is defined in the 2004 Policy 25 of the Regional Official Plan as "*meeting the needs of the present without compromising the ability of future generations to meet their own need*". The policy also states that "*planning decisions in Halton will be made based on a proper balance among the following factors: protecting the natural environment, enhancing its economic competitiveness, and fostering a healthy, equitable society*". The overall goal is to enhance the quality of life for all people of Halton. The Growth Management Strategy and the supporting resource management strategies that make up the Sustainable Halton Plan were completed in 2009, and adopted under ROPA 38.

The Sustainable Halton Plan does not apply directly to the detailed study areas for the Subwatershed Update Study. It does, however, provide some guidance on the principles currently considered important for natural heritage system planning in the Region of Halton.

Documents in support of Sustainable Halton were first circulated by the Region of Halton in June 2008. This phase identified an evaluation framework to assess growth options. The Framework Theme Area relevant to natural heritage, "Protect What is Valuable", identified the following principles (RMOH, 2008):

1.1 Protect a resilient and self-sustaining Natural Heritage System (NHS) integrating an 'ecosystem-based' approach that encompasses a connected system of cores of sufficient size to maintain or improve biological diversity and ecological function.

- *a. Identify and protect core natural areas.*
- *b. Identify and protect centres of regional biodiversity of sufficient area to allow the permanent protection of regional biodiversity.*
- *c. Identify and protect centres of regional biodiversity that represent the two main landscapes in Halton "above" and "below" the escarpment.*
- *d. Provide ecologically functional connections between Halton's NHS and the greater landscape in which the Region is situated.*
- *e. Protect existing designated natural heritage.*

Enhance the NHS to strengthen habitat areas and reduce the impact of new development.

- *a. Promote existing natural heritage features within a connected system of cores, linkages and watercourses.*
- *b. Promote existing natural heritage features within a connected system of cores, linkages and watercourses (evaluated by different measures than in 1.2.a).*
- *c. Provide alternate connections among natural heritage features.*

The Phase III NHS report (April 2009) entitled *Natural Heritage System Definition & Implementation - Sustainable Halton Report 3.02, s*ummarized the system standards recommended.

Feature size thresholds used to guide the development of the Sustainable Halton NHS considered the following minimum core areas as defined by Environment Canada (2004):

- ***Core Area Woodlands***: 20 ha
- ***Core Area Wetlands***: 10 ha for marsh/thicket and 20 ha for treed swamp
- ***Core Area Open Habitat***: 15 ha
- ***Centres for Biodiversity***: 200 ha

Linkage corridors in the Sustainable Halton NHS meet the following guidelines:

- ***Regional Linkage***: 300 to 400 m width
- ***Local Linkage***: 60 to 100 m width

The Sustainable Halton NHS includes the following minimum buffers intended to protect natural heritage features as follows:

- ***Woodland Buffer***: 30 m
- ***Wetland Buffer***: 30 m

The Sustainable Halton NHS also proposes buffers along watercourses based on the following criteria:

- all watercourses located within the Regulatory Floodline have a 30 metre buffer on both sides
- watercourses located outside the Regulatory Floodline that are determined to provide an important ecological linkage function have a 30 metre buffer on both sides

The Sustainable Halton NHS does not apply to the detailed study areas for the Boyne Survey. Most lands were included within the current urban boundaries of the Region in the Halton Urban Structure Plan, a previous growth management study. Sustainable Halton provides guidance on the principles currently considered important for future natural heritage system planning in the Region of Halton. It represents a 'high level' systems approach; detailed NHS planning studies for new development such as those within the Boyne Survey will be informed by elements of the Sustainable Halton NHS, but will rely upon accepted principles of natural heritage planning more fully informed by detailed site specific data collection and analysis.

Watershed / Subwatershed Studies (Sixteen Mile Creek, Bronte Creek, Indian Creek, Sixteen Mile Creek Areas 2&7)

These legacy documents contain goals and objectives, data and analysis which form a major component of the background data and natural heritage approaches (including feature protection, buffer recommendation, and corridor enhancement) that were in effect at the time they were completed.

Region of Halton Natural Areas Inventory (2006)

This document provided detailed updates for identified and proposed Environmentally Sensitive Areas as defined under the Region of Halton Official Plan (2006).

Conservation Halton Landscaping and Tree Preservation Guidelines

These guidelines provide guidance on considerations for habitat restoration planting design. Alternative standards are discussed later in this report.

Updated NHS Objectives

The following updated objectives and targets build upon those previously defined for the Natural Heritage System in the Sixteen Mile Creek Area 2 & 7 Subwatershed Study (Philips Engineering Ltd., 2000). They have been updated based on the current study approach, available Natural Heritage System policies, and further refined based on comments received from Conservation Halton staff.

a) Identify and classify natural/semi-natural terrestrial features and assess their significance according to their conformity with significance categories established by the Province, Region and Conservation Authority, based on criteria regarding size, biophysical attributes and ecological functions for the purposes of developing a sustainable natural heritage system for the urban and rural portions of the watershed.

b) Given the depleted, degraded and fragmented state of existing terrestrial resources in the subwatershed study area, **the key objective of the subwatershed plan is to achieve a 'net gain' in terms of the extent of natural terrestrial habitat and associated functions and linkages. The goal is a well-linked system within the urban setting which promotes the maintenance and enhancement of key subwatershed resources.**

c) All identified 'Significant' terrestrial features should be protected and enhanced within a recommended Natural Heritage System, to be defined as part of the Secondary Plan processes.

d) The Subwatershed Update Study and Functional Stormwater and Environmental Management Strategy (FSEMS) will define standards for protection and linkage of these resources. These protection and enhancement requirements will be integrated into detailed Subwatershed Impact Studies (SIS).

e) Other terrestrial features not meeting policy-based significance criteria should be integrated into a linked system which optimizes their integrity and functions within the future urban landscape. The system can be further enhanced with habitat restoration, and integration of protected natural areas with land uses that support the functionality of natural features (such as parkland, golf courses, school campuses and other uses that can incorporate naturalized elements). (ref. Fig. NHS-2, Table 3.7.2 and Sect. 5.2.2; see also Implementation Principles)

f) All identified linkage features in the subwatershed study area represent constraints to future land uses and are to be protected and enhanced. Within the Milton Business Park / Derry Green and Phase 3 / Boyne Survey urban expansion areas, some linkage features may be modified, and their relocation and enhancement should place a high priority on natural heritage system objectives wherever feasible and practical in the urbanizing landscape.

g) The functioning components of linkages should be protected and enhanced. Terrestrial linkage features can be used to accommodate trail systems.

h) Stormwater management facilities should generally be integrated outside the NHS but due to their related hydrologic functionality, contribute complementary landscape connectivity functions and naturalized cover that is routinely utilized by wildlife.

i) The SIS for each detailed study area will refine desirable riparian corridors and other linkage features following an integrated multi-disciplinary assessment. This will include recommended corridor dimensions as well as structural components to be considered at subsequent planning and design stages. The identified terrestrial system should also accommodate existing and new wetland and pond features that can support identified species of concern in the urban setting.

In the original Sixteen Mile Creek Areas 2 & 7 Subwatershed Study, and the Indian Creek/Sixteen Mile Creek Sherwood Survey Subwatershed Management Study, relatively aggressive programs were outlined which targeted an overall 'net gain' principle in terms of protection of natural cover and enhancement of functions over existing conditions. The application and refinement of this principle in the Boyne Survey study area represents the only feasible means to maintain and improve Natural Heritage features and functions. Cumulative change to habitat quality and functions is considered largely inevitable as the future development areas are converted from rural to urban uses.

NHS Targets

The development of identified targets for optimal levels of natural cover has been the subject of study by federal and provincial agencies for more than a decade. In 2004 a document entitled "*A Framework for Guiding Habitat Rehabilitation in Great Lakes Areas of Concern*" was released jointly by Environment Canada, the Ontario Ministry of Natural Resources, and the Ontario Ministry of Environment; it was updated in 2013. This document included general guidelines for the establishment of forest and wetland targets in watersheds and subwatersheds. These included the identification of the following watershed-based targets (as of 2004 version):

- Ten percent of a watershed, and six percent of any sub-watershed should be comprised of wetlands
- The Critical Function Zone and Protection Zone (i.e. buffer) of a wetland should be naturally vegetated
- 75% of stream length should be naturally vegetated
- Streams should have a minimum 30 m wide naturally vegetated lands area on both sides, greater depending on site specific conditions

- A minimum forest cover target of 30% is desirable for watersheds
- Forest patches should be circular or square in shape
- Forest patches should be within two kilometres of one another
- At least 10% of watersheds should consist of forest cover with more than 100 m from the forest edge; 5% of the watershed should have forest cover with more than 200 m from the forest edge
- Watershed forest cover should be representative of the full diversity of forest types found at that latitude
- Corridors designed to facilitate species movement should be a minimum of 50 to 100 m wide
- Less than 10 percent of an urbanized watershed should be impervious

The application of these guidelines to highly fragmented landscapes in southern Ontario, which have been under intensive use for agriculture for more than a century, has been challenging, and jurisdictions (such as TRCA with its Terrestrial Natural Heritage System Strategy) have generally applied these targets outside of urbanizing areas. The importance of balancing environmental, social and economic objectives and satisfying important growth and infrastructure renewal efforts initiated by the Province, has required and allowed for a balanced approach to planning in urbanizing jurisdiction. In this regard, the Second Edition of the Natural Heritage Reference Manual (OMNR 2010) advises (ref. Section 3.4.6.2):

> *"Every natural heritage system, however, will be different. There is no minimum size for a system or minimum percentage of a planning area or its natural features that must be included in the system. Therefore, the extent of the natural heritage systems identified in the noted examples represents what was appropriate and achievable in those situations."*

Therefore, while the Environment Canada guidelines represent useful considerations in defining watershed priorities for natural heritage protection, their application in designated growth areas that are already highly fragmented may not be feasible except where opportunities exist to integrate highly functional lands within identified development areas. The restoration of the Main Branch valley upstream of the existing ESA represents a logical opportunity to achieve a higher level of restoration given the existing concentration of features and functions.

In the case of the Boyne Survey lands, existing limitations of the landscape (e.g. 4.5% existing natural cover; 1.2% wetland cover) must be recognized, while approaches for habitat enhancement and diversification are identified, based on opportunities to protect and link viable natural features, as well as reinforcement of the NHS with complementary existing and future land uses that support important ecological functions. Based on contemporary subwatershed experience in similar landscapes of the Peel Plain and South Slope Physiographic Regions, the NHS as identified in Figure NHS-2 will achieve a substantial increase in natural cover within the Boyne study area that reflects the protection of significant features based on policy, the net gain in riparian corridor cover, and the degree to which habitat restoration is feasible to enhance existing functions and sustain key species guilds. This does not include long term NHS supportive land uses (i.e. stormwater facilities, rail corridor, other NHS Supportive uses).

4.3.2 Natural Heritage System Management Strategy

This section builds upon the general process for NHS identification to be applied in the areas which were identified for future urbanization in the HUSP (1996) process. The NHS which are developed in these future urban areas are intended to encompass existing features and functions, with reinforcement to ensure their continued presence and function, and where feasible, their restoration and enhancement. The key legislation, policies, and guidelines, and the updated subwatershed objectives that form the basis of this approach are summarized in Section 4.2. The future Natural Heritage System needs to conform to the guiding policy frameworks and objectives, as well as integrate with the Natural Heritage Systems within adjoining developed areas, and the regional scale system.

Table F1 in Appendix 'F' summarizes the evaluation of actions and options, and the recommended approach at each step in the NHS identification process, with general implications for the Secondary Plan and subsequent SIS level studies. The details related to the recommended NHS and its implementation are summarized in Section 5.2 of the FSEMS.

4.4 Watercourse Management

4.4.1 Watercourse Management Objectives

The most encompassing legislation addressing aquatic habitat and fisheries is the Policy for the Protection of Fish Habitat (Department of Fisheries and Oceans; 1986), under the auspices of the Federal *Fisheries Act*. The policy is based on the guiding principle of "no net loss of the productive capacity of fish habitat" and "net gain" of habitat where feasible. No habitat which is required for the support of any aspect of a fishery or its productivity (feeding, nursery, spawning, migratory or general living habitat) can be destroyed, altered or otherwise deleteriously affected without permission of the Minister, subject to substantial fine and/or imprisonment penalties.

Any assessment of a fishery resource and the constraints that the presence of a fishery resource has upon development activity, must frame the assessment within the federal and provincial legislation designed to protect the fishery resource and species at risk. Federal protection of all fish habitat is provided under the *Fisheries Act*. Federal protection for species at risk is provided under the *Species at Risk Act*, for species listed in Schedule 1 of the Act. Provincial protection of species at risk is provided under the Ontario *Endangered Species Act* (2007).

The Fisheries Act defines fish as: "parts of fish, shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals".

The Fisheries Act defines fish habitat as: "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes".

The Fisheries Act states "no person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat (Section 35(1))" unless authorized by the Minister of Fisheries and Oceans, or under regulations made by the Governor in Council

under this Act (Section 35(2)). As well, "no person shall deposit or permit the deposit of any deleterious substance into water frequented by fish" (Section 36(3)). Stemming from the Fisheries Act, the Department of Fisheries and Oceans (1986) Policy for the Management of Fish Habitat has the objective of creating a net gain of habitat for Canada's Fisheries resources. The guiding principle to realize this end is "no net loss" which requires that if the productive capacity of a fish habitat is reduced, then a compensating increase in fish production must be made to occur. The hierarchy of preferences for applying this principle to development, or other activities, is as follows:

1. Maintain, without disruption, the natural productive capacity of fish habitats through relocation, redesign or mitigation.

2. If the former proves impossible or impractical, then compensation by either creating new habitat, or by increasing the productive capacity of existing habitat, will be considered. It should be noted, however, that compensation may not be acceptable in some cases where the habitats in question are deemed especially important or sensitive. It should also be noted that an Authorization under the Fisheries Act triggers the Canadian Environmental Assessment Act, so that screening under this Act also becomes necessary.

Administration of the policy at the local level has been delegated to Conservation Halton through an agreement with DFO. Typically, Conservation Halton reviews the implications of the policy through subdivision approval, Environmental Assessment and other relevant processes. Conservation Halton's responsibilities include determination of whether or not potential habitat impacts can be mitigated to an acceptable level. If it is deemed that impacts cannot be mitigated, and the proposal involves compensation, applications to the Minister of Fisheries for approval of the relevant habitat impacts must be made, in conjunction with an acceptable plan for compensation of the proposed habitat impact/loss.

As presented in Section 3.5 (Fisheries), all watercourses within the Boyne Survey Secondary Plan Area were evaluated with respect to the criteria provided in the document *Evaluation, Classification and Management of Headwater Drainage Features: Interim Guidelines* (ref. CVC and TRCA, March 2009). This document also provides general management recommendations for each class of watercourse as follows.

1. Protection – Permanent Fish Habitat, Critical Habitat and Species at Risk (SAR).

Protection 1 ***(High Constraint)*** – permanent, critical fish habitat or habitat associated with species at risk. Generally associated with permanent groundwater discharge or wetland storage – either habitat and/or flow source characteristics may be difficult to replicate or maintain.

- Preserve the existing drainage feature and groundwater discharge or wetland in-situ, particularly if species at risk are present;
- Maintain external drainage;
- Incorporation of shallow groundwater and base flow protection techniques such as infiltration treatment;
- Use natural channel design techniques or wetland design to restore and enhance existing habitat features, if necessary; realignment not generally permitted;

- Drainage feature must connect to downstream watercourse/habitat;
- Stormwater management (e.g. extended detention outfalls) are to be designed and located to avoid and/or minimize impacts (i.e. sediment, temperature) to fish habitat;
- Examine need to incorporate groundwater flows through infiltration measures (i.e. third pipes, etc.) to ensure no net loss and potential gain.

Protection 2 ***(High Constraint with rehabilitation potential)*** – permanent fish habitat generally with permanent standing surface water associated with a wetland and/or pond flows.

- Preference is to maintain existing surface water source;
- Maintain external drainage or if catchment drainage has been previously removed due to diversion of stormwater management flows, restore lost functions through enhanced lot level controls (i.e. restore original catchment using clean roof drainage) as necessary;
- Replicate on-site surface water sources including wetland creation and incorporating extended detention outlets, if necessary;
- Use natural channel design techniques to replace and enhance existing habitat features only if features are easily replicated;
- Drainage feature must connect to downstream watercourse/habitat;
- Examine need to incorporate groundwater flows through infiltration measures (i.e. third pipes, etc.) to ensure no net loss and potential gain.

2. Conservation – Seasonal Fish Habitat.

Conservation 1 ***(Medium Constraint)*** – seasonal fish habitat associated with seasonally high groundwater discharge or seasonally extended contributions from wetlands potential permanent refuge habitat may be provided by a storage feature.

- Maintain existing seasonal groundwater or wetland surface flows,
- If catchment drainage has been previously removed due to diversion of stormwater management flows, restore lost functions through enhanced lot level controls (i.e. restore original catchment using clean roof drainage), as feasible;
- Replicate on-site seasonal groundwater or surface flows using infiltration measures and/or wetland creation, if necessary;
- Maintain external flows,
- Use natural channel design techniques to replace existing habitat features to maintain overall fish productivity of the reach;
- Drainage feature must connect to downstream habitat.

Conservation 2 ***(Medium Constraint)*** – seasonal fish habitat associated with intermittent surface flows.

- Replicate on-site surface flows;
- Maintain external flows; or if catchment drainage has been removed restore lost functions through enhanced lot level controls, as feasible;
- Use natural channel design techniques to replace existing habitat features to maintain overall fish productivity of the reach;
- Drainage feature must connect to downstream habitat.

3. Mitigation – Contributing Fish Habitat

Mitigation 1 ***(Medium Constraint)*** – Complex contributing fish habitat: flows conveyed through natural vegetation communities that support complex, contributing fish habitat i.e. influences water quality, sediment, organic matter, food and nutrients to the downstream habitat.

- Replicate functions through enhanced lot level conveyance measures, such as well-vegetated swales (herbaceous, shrub and tree material) to mimic online wet vegetation pockets, or replicate through constructed wetland features;
- Replicate on-site flow and outlet flows at the top end of system to maintain feature functions. If catchment drainage has been previously removed due to diversion of stormwater management flows, restore lost functions through enhanced lot level controls (i.e. restore original catchment using clean roof drainage);
- Feature form and flow that connects directly to downstream fish habitat (i.e. direct connection to other drainage features/watercourse or wetlands);

Mitigation 2 ***(Medium Constraint or Low Constraint)*** – Simple contributing fish habitat: flows that support simple contributing fish habitat, i.e. influences flow conveyance, attenuation and storage to downstream reaches.

- Replicate functions by lot level conveyance measures (e.g. vegetated swales) connected to the natural heritage system, as feasible and/or Low Impact Development (LID) stormwater options (refer to TRCA's Water Management Guidelines for details);
- Replicate on-site flows and outlet flows at the top end of vegetated swales, bioswales, etc. to maintain feature functions.

4. No Management Recommendation Required *(Low Constraint)* – Not Fish Habitat.

- The pre-screened drainage feature has been field verified to confirm that no feature and/or functions associated with headwater drainage features are present – generally characterized by evidence of cultivation, furrowing, presence of a seasonal crop, and lack of natural vegetation.

5. Recharge Protection – Recharge Zone - No direct habitat or indirect habitat providing surface flow, sediment transport, or allochthonous contribution to downstream fish habitat.

- Maintain overall water balance by providing mitigation measures to infiltrate clean stormwater, unless the area qualifies as a Significant Recharge Area under the Source Water Protection Act. These areas will be subject to specific policies under their respective legislation.

The objectives of the above policies and guidelines are to provide an overall gain in functioning fish habitat, and to improve the quality of aquatic habitat to the extent feasible. The primary tools used to attain these objectives within the Boyne Survey Secondary Plan Area will be the rehabilitation of degraded watercourse structure, the potential increase in flow duration through stormwater management, and the application of adequate riparian vegetative buffers. Flow duration is likely the greatest limiting factor to fisheries in the Boyne Survey tributaries of

Sixteen Mile and Indian Creeks. Major improvements to fish habitat have occurred in the adjacent Phase 1 area where these methods have been applied, and it is anticipated that similar gains may occur within the Boyne Survey area.

Discussion with DFO (Cynthia Mitton-Wilkie – Coker. Pers. Comm.) indicates that the treatments associated with low, medium and high constraint watercourses are generally appropriate and are unlikely to trigger the requirement for an Authorization under the *Fisheries Act*. However, the proposed treatment associated with watercourses classed as "high constraint with rehabilitation potential", which in the Boyne Survey area applies only to Reach BP-4-C, would trigger the requirement for an Authorization if the treatment involves reconstruction. Recently, the *Fisheries Act* has undergone revision, scheduled to come into effect on January 1, 2013. As a result of these revisions it is uncertain whether reconstruction of Reach BP-4-C would trigger a *Fisheries Act* Authorization. However, the exact nature of how the *Fisheries Act* changes will affect the protection of fish habitat within the Boyne Survey Area are not currently defined, and will likely not become fully apparent for some time, therefore it is suggested that the status quo be considered going forward until such time as an updated process has been adopted by DFO and its partners.

4.4.2 Watercourse Management Opportunities

Geomorphic Constraint Ranking and Management Options

The role of the stream corridors is multipurpose from a geomorphic standpoint. It not only provides flow and sediment storage during high flow events, it also acts as a filter to prevent sediment and particulate inputs from surface runoff from embedding coarse substrates within the streams. The maintenance of riparian vegetation within the stream corridor acts to stabilize banks and also provides inputs of organic materials and debris which aid in creating a diverse morphology. It is also acknowledged that riparian vegetation can provide aquatic habitat in the form of cover. However, plantings alone cannot necessarily improve channel functions and that some direct restoration of the channel form may be warranted. The meander belt width incorporated into the corridor allows the channel to migrate naturally within its floodplain without the loss of property or structural integrity. For the purposes of this study, a constraint ranking system was developed based on the findings of the desktop and field assessments (ref. Section 3.6). The constraint system identifies three categories of high, medium and low constraint which essentially establish the preferred management approach of the stream on a reach basis from a geomorphic perspective. The basis for each category of geomorphic constraint level and associated recommended management strategy is described in Table 4.4.1:

Table 4.4.1: Summary of Geomorphological Constraints & Management Strategies		
Ranking	**Definition**	**Management Strategy**
High	Reaches that comprise a defined channel with well-developed channel morphology (i.e., riffle-pool) and/or a well-defined valley. These reaches possess both geomorphological form and function and are high-quality systems that could not be re-located and replicated in a post-development scenario.	Watercourse to be protected/enhanced in current form and location. Modification through enhancement may be acceptable.
Medium	Reaches that may or may not have a well-defined morphology (form) but do maintain geomorphic function and have potential for rehabilitation. In many cases, these reaches may exhibit evidence of geomorphic instability or environmental degradation due to historic modifications and land use practices.	Watercourse to remain open. Enhancement is recommended and relocation/restoration is acceptable, provided maintenance and enhancement of channel functions occurs.
Low	Ephemeral headwater systems that lack defined bed and banks (form) but do perform a geomorphic function through the conveyance of flow and sediment.	Watercourse may be eliminated and drainage incorporated into SWM systems, if not required to meet drainage density targets. Alternatively, watercourse may remain open and realignments would be acceptable, if it is required to meet drainage density targets; no riparian corridor or setbacks required.

Management options for Medium geomorphological constraint streams build upon the fisheries strategies described above (and potentially High constraint streams where modification through enhancement is acceptable) include:

- Do nothing: leave the corridors in their present condition and develop outside of their boundaries. It is preferable that streams are not altered. If required from a fisheries management strategy, enhancement to the riparian vegetation may be required.

- Enhance existing conditions: maintain the present location of the corridor but enhance existing conditions (e.g. re-establish a meandering planform, connect channel to functioning floodplain, establish a low-flow channel, restore riparian vegetation). Again, this builds upon the fisheries strategy and must address channel functions, such as the effective conveyance of flow and sediment. Instream structures, such as pools and riffles could be added to provide a more diverse form. Care must be taken to ensure the sediment balance is considered (which may in fact result in some local bank erosion).

- Re-locate and enhance existing conditions: many of the reaches within the study area have undergone extensive straightening and modification for agricultural drainage purposes. As such, they are not as sensitive to re-location and would benefit from enhancements such as the re-establishment of a meandering planform with functioning floodplain and development of a riffle-pool morphology. In the event that these reaches are re-located, the corridor width associated with each reach must, at a minimum, be maintained.

Management options for Low geomorphological constraint streams include:

- Do nothing: leave the drainage feature intact and develop the surrounding lands, with a minimal buffer (a corridor width is not prescribed for these systems).

- Combination of stormwater management and open conveyance techniques: the function of headwater streams can be mimicked through the combined implementation of stormwater management techniques with sufficient maintenance of open conveyance systems such as swales to meet drainage density targets. The swales in the post development setting should be part of a public open space and may also include the outlet channel from a SWM facility. A corridor width is not prescribed for these systems.

- Open conveyance techniques: the function of the ephemeral swales is replicated entirely through a system of open conveyance techniques. A corridor width is not prescribed for these systems.

- Watercourse may be eliminated and drainage incorporated into SWM systems, if not required to meet drainage density targets. Alternatively, watercourse may remain open and realignments would be acceptable, if it is required to meet drainage density targets; no riparian corridor or setbacks required.

It should be noted that the net constraint rankings in all cases are equivalent or greater than the geomorphological constraint rankings. Therefore the management strategies as described above or better are applicable on a reach basis.

In addition to the stormwater management techniques and strategies discussed in the foregoing, each development area has specific environmental management opportunities which, should be integrated into the land use and stormwater management plans, where possible. Generally, these opportunities include the following (ref. Figure NHS-1 of Appendix ‘F’):

Table 4.4.2: Aquatic Habitat Considerations For Boyne Survey Area	
Reference	**Considerations**
Indian Creek	
I-NE-2A	Medium fisheries constraint. Classed as Seasonal in the downstream portion, and Complex Contributing in the upstream portion. Intermittent flow. Fish have only been found as far upstream as the culvert at Britannia Road. Should be retained as an open system, but could be realigned subject to using natural channel design principles and its fish habitat function being retained.
I-NE-2A-1 I-NE-2A-3	Medium fisheries constraint. Classed as Simple Contributing. Intermittent flow. Should be retained as an open system, but could be realigned subject to using natural channel design principles and its fish habitat function being retained.
I-NE-2A-2 I-NE-2A-4 I-NE-2A-5 I-NE-2A-6 I-NE-2A-7	Low fisheries constraint. Not classed as fish habitat. Ephemeral flow. Watercourse may be eliminated subject to meeting stormwater management and drainage density targets. No riparian corridor or setbacks required if system remains open. . Reach of I-NE-2A-4 within the woodlot is classified as a high constraint by virtue of the location within a high constraint terrestrial feature, not based on its aquatic character.
I-NE-1B-1	Medium fisheries constraint. Classed as Seasonal. Intermittent flow. Fish have been found at isolated locations, at a fence row, and within an online pond, in the early spring. Should be retained as an open system, but could be realigned subject to using natural channel design principles and its fish habitat function being retained.
I-NE-1B-2	Low fisheries constraint. Not classed as fish habitat. Ephemeral flow. Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
Sixteen Mile Creek Watershed 2	
SWS-4-A	Low fisheries constraint. Not classed as fish habitat. Ephemeral flow. Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
SWS-1-A	Medium fisheries constraint. Classed as Seasonal. Intermittent flow. Fish have been found at isolated locations in the early spring. Should be retained as an open system, but could be realigned subject to using natural channel design principles and its fish habitat function being retained.
SWS-1-A-2 SWS-1-B	Low fisheries constraint. Not classed as fish habitat. Ephemeral flow. Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
SWS-3-A	Low fisheries constraint. Not classed as fish habitat. Ephemeral flow. Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
SWS-2-A	Medium fisheries constraint. Classed as Seasonal. Intermittent flow. Fish have been found only within the Britannia Road culvert. Should be retained as an open system, but could be realigned subject to using natural channel design principles and its fish habitat function being retained.
SWS-2-A-1	Low fisheries constraint. Classed as Simple Contributing. Intermittent flow West of RR# 25, stream is to remain open as a terrestrial connection and as such can be realigned; no riparian corridor or setbacks required. Reach SWS-2-A-1 within the woodlot is classified as a high constraint by virtue of its location within a high constraint terrestrial feature, and thus cannot be altered.
SWS-2-C	Low fisheries constraint. Classed as Simple Contributing in downstream portion, and not fish habitat in upstream portion. Ephemeral flow. Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
SWS-2-B	Low fisheries constraint. Not classed as fish habitat. Ephemeral flow. Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
2-II	High fisheries constraint. Classed as Permanent. Must be retained and protected in its current form.

Table 4.4.2: Aquatic Habitat Considerations For Boyne Survey Area	
Reference	**Considerations**
SWS-5-A SE-5-A	Medium fisheries constraint for the reach within the Sixteen Mile Creek Valley. Classed as Complex Contributing. Intermittent flow. Should be retained as an open system, but could be realigned subject to using natural channel design principles and its fish habitat function being retained. Reach SE-5-A east of the Sixteen Mile Creek valley is low fisheries constraint, but may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
SWS-5-B	Low fisheries constraint. Not classed as fish habitat. Ephemeral flow. Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
SE-2-A	Low fisheries constraint. Not classed as fish habitat. Ephemeral flow. Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
SE-2-D-1	Low fisheries constraint. Classed as Simple Contributing. Intermittent flow. Fathead minnows in culvert at Britannia Road. Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
SE-2-D-2 SE-2-B	Low fisheries constraint. Not classed as fish habitat. Ephemeral flow. Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
Sixteen Mile Creek Watershed 7	
SE-4-A	Low fisheries constraint. Not classed as fish habitat. Ephemeral flow. Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
SE-3-B	Medium fisheries constraint. Classed as Seasonal. Intermittent flow. Fish have been found at isolated locations in the early spring, and in the Britannia Road culvert during summer. Should be retained as an open system, but could be realigned subject to using natural channel design principles and its fish habitat function being retained.
SE-3-G	Medium fisheries constraint. Classed as Complex Contributing. Intermittent flow. Should be retained as an open system, but could be realigned subject to using natural channel design principles and its fish habitat function being retained.
SE-3-A SE-3-C SE-3-B-1	Low fisheries constraint. Not classed as fish habitat. Ephemeral flow. Watercourse may remain open, and realignment would be acceptable, subject to meeting drainage density targets. No riparian corridor or setbacks required.
BP-4-C	High fisheries constraint with rehabilitation potential. Is permanently flowing. Though much of these reaches have been channelized in the past, the existing naturalizing channel morphology and riparian conditions provide habitat for a diverse fish community, including spring spawning runs of white sucker. These watercourse reaches would benefit from the rehabilitation of channel form. Realignment of this watercourse will require additional study to ensure instream flow conditions are maintained, and may require Authorization under the *Fisheries Act (subject to potential change as result of new Federal Fisheries Act*)

5. PREFERRED SOLUTION

5.1 Stormwater and Watercourse Management

The preferred stormwater management and watercourse management system, as described in Section 4.2, is presented graphically in Drawing 10 and 11.

The Boyne Survey development area has been subdivided into discrete Subwatershed Impact Study (SIS) areas, based upon the drainage areas to receiving watercourses under future land use conditions. Preliminary site-specific management strategies for each SIS area within the Secondary Planning Study Area, which incorporate requirements for drainage, land use, stream and aquatic habitat considerations and stormwater management have been established through the course of this FSEMS, and would be further refined as part of the subsequent SIS's, based upon more detailed site planning information.

A graphical compilation of the foregoing is depicted on Drawing 12. Stormwater management facilities and watercourse alignments are conceptual only for the purpose of depicting preliminary locations. Estimated capital costs for the primary stormwater management works have been developed as part of this process, and are provided in Appendix 'G'.

The currently proposed stormwater and watercourse system management for each SIS area is summarized in Table 5.1.1.

The January 2000 Subwatershed Planning Study characterized watercourse SWS-2-C as a Medium constraint, based upon the characterization methodologies at the time. That classification was subsequently advanced in the December 2004 Subwatershed Management Study; consequently, the stormwater management plan for Phase 2 Area development north of Louis St. Laurent Avenue in the vicinity of this feature was required to maintain the supply of water to this feature post-development in order to sustain the function of the feature as a medium constraint watercourse. During the course of the Subwatershed Update Study, the watercourse classifications have been established based upon more contemporary criteria; through this process, the classification of watercourse SWS-2-C has been revised from a Medium constraint feature to a Low constraint feature. Consequently, the management practices originally required for this feature, with respect to maintaining the supply of water from the upstream development, is no longer required. Correspondence from Conservation Halton confirming this revision to the management strategy for this feature is included in Appendix 'A'.

Table 5.1.1: Stormwater and Watercourse System Management Summary for SIS Areas		
SIS Area	**Stormwater Management**	**Watercourse Management**
1	End-of-pipe facilities to provide stormwater quality, erosion, and quantity controls.	Watercourses I-NE-2A, I-NE-2A-1, I-and, I-NE-2A-3, to remain open; realignment possible. Watercourses I-NE-2A-2, I-NE-2A-4, I-NE-2A-5, I-NE-2A-6, and I-NE-2A-7 may be eliminated subject to replicating function and accommodating drainage from upstream facilities. Watercourses may be eliminated and drainage incorporated into stormwater systems, if not required to meet drainage density targets. Alternatively, watercourses may remain open and realignments would be acceptable, if it is required to meet drainage density targets; no riparian corridor or setbacks required. Reach of I-NE-2A-4 within the woodlot is classified as a high constraint by virtue of the location within a high constraint terrestrial feature, and thus cannot be altered.
2	End-of-pipe facilities to provide stormwater quality, erosion, and quantity controls.	Watercourse I-NE-1B-1 to remain open; realignment possible. Watercourse I-NE-1B-2 may be eliminated subject to replicating function and accommodating future drainage satisfying NHS requirements from upstream facilities.
3	End-of-pipe facilities to provide stormwater quality, erosion, and quantity controls.	Watercourse SWS-1-A to remain open; realignment possible. Watercourses SWS-4-A, SWS-1-A-2 and SWS-1-B may be eliminated subject to replicating function and accommodating drainage from upstream facilities. Watercourses may be eliminated and drainage incorporated into stormwater systems, if not required to meet drainage density targets. Alternatively, watercourses may remain open and realignments would be acceptable, if it is required to meet drainage density targets; no riparian corridor or setbacks required.
4	End-of-pipe facilities to provide stormwater quality, erosion, and quantity controls.	Watercourses SWS-2-A and SWS-2-A-1 to remain open; realignment possible. Watercourses SWS-2-C, SWS-2-B, and SWS-3-A may be eliminated subject to replicating function and accommodating drainage from upstream facilities. Watercourses may be eliminated and drainage incorporated into stormwater systems, if not required to meet drainage density targets. Alternatively, watercourses may remain open and realignments would be acceptable, if it is required to meet drainage density targets; no riparian corridor or setbacks required. Reach of SWS-2-A-1 within the woodlot is classified as a high constraint by virtue of its location within a high constraint terrestrial feature, and this cannot be altered. Reach of SWS-2-A-1 west of RR25 may be eliminated subject to replicating drainage and linkage function.

Table 5.1.1: Stormwater and Watercourse System Management Summary for SIS Areas		
SIS Area	**Stormwater Management**	**Watercourse Management**
5a	End-of-pipe facilities to provide stormwater quality, erosion, and quantity controls for drainage areas immediately adjacent to watercourses in SIS area; certain stormwater management facilities within SIS area 5b are to divert water extended detention storage for stormwater quality and erosion control toward watercourse 2-II via dedicated trunk sewer..	Watercourse 2-II to remain open and enhanced in-situ. Watercourse SE-5-A and the reach of SWS-5-A both within the Sixteen Mile Creek Valley are high constraint by virtue of their location within a high constraint feature and this cannot be altered. Watercourse SWS-5-B and the reach of SE-5-A outside of the Sixteen Mile Creek Valley may be eliminated subject to replicating function and accommodating drainage from upstream facilities. Watercourses may be eliminated and drainage incorporated into stormwater systems, if not required to meet drainage density targets. Alternatively, watercourses may remain open and realignments would be acceptable, if it is required to meet drainage density targets; no riparian corridor or setbacks required.
5b	End-of-pipe facility discharging to Watercourse BP-4-C to provide stormwater quality, quantity, and erosion controls. Select end-of-pipe facilities are to divert extended detention storage for stormwater quality and erosion control toward watercourse 2-II via dedicated trunk sewer, with volumes above the extended detention level released essentially uncontrolled to the Omagh Tributary. Remaining end-of-pipe facilities to provide stormwater quality and quantity controls for the conventionally draining areas to the Omagh Tributary. Land use planning should optimize coverage of directly draining lands with clean runoff (i.e. open spaces, urban land uses with local BMP's for stormwater quality control and erosion control, rooftop collector systems)	Watercourse BP-4-C to remain open; realignment possible subject to providing enhancements to corridor and maintaining baseflow conditions. Watercourses SE-3-G and SE-3-B to remain open; realignment possible. Watercourses SE-3-A, SE-3-C, SE-3-B-1, and SE-4-A may be eliminated subject to replicating function and accommodating drainage from upstream facilities. Watercourses may be eliminated and drainage incorporated into stormwater systems, if not required to meet drainage density targets. Alternatively, watercourses may remain open and realignments would be acceptable, if it is required to meet drainage density targets; no riparian corridor or setbacks required.
6	End-of-pipe facilities to provide stormwater quality, and erosion controls. .	All watercourses may be eliminated subject to replicating function and accommodating drainage from upstream facilities. Watercourses may be eliminated and drainage incorporated into stormwater systems, if not required to meet drainage density targets. Alternatively, watercourses may remain open and realignments would be acceptable, if it is required to meet drainage density targets; no riparian corridor or setbacks required.

The stormwater quantity management peak flow and storage requirements for the end-of-pipe facilities for each of the SIS areas, as per the preferred stormwater management plan, are summarized in Table 5.1.2.

Table 5.1.2: Summary of Stormwater Quantity Management Peak Flow and Storage Requirements

Facility Reference #	Drainage Area (ha)	Extended Detention		Flood Control			
				25 Year[1.]		100 Year[2.]	
		Storage (m^3/imp. ha)	Discharge (m^3/s/ha)	Storage (m^3/imp. ha)	Discharge (m^3/s/ha)	Storage (m^3/imp. ha)	Discharge (m^3/s/ha)
SIS Area 1							
S1-1	26.57	375	0.0004	600	0.012	825	0.024
S1-2	25.99	375	0.0004	600	0.012	825	0.024
S1-3	41.28	375	0.0004	600	0.012	825	0.024
S1-4	24.33	375	0.0004	600	0.012	825	0.024
SIS Area 2							
S2-1	35.48	375	0.0004	600	0.01	850	0.023
S2-2	49.17	375	0.0004	600	0.01	850	0.023
S2-3	12.61	375	0.0004	600	0.01	850	0.023
SIS Area 3							
S3-1	10.06	400	0.0003	750	0.01	975	0.024
S3-2	27.43	400	0.0003	750	0.01	975	0.024
S3-3	19.19	400	0.0003	750	0.01	975	0.024
S3-4	21.85	400	0.0003	750	0.01	975	0.024
S3-5	22.84	400	0.0003	750	0.01	975	0.024
SIS Area 4							
S4-1	9.12	400	0.0003	750	0.01	975	0.035
S4-2	24.15	400	0.0003	750	0.01	975	0.035
S4-3	16.47	400	0.0003	750	0.01	975	0.035
S4-4	35.42	400	0.0003	750	0.01	975	0.035
SIS Area 5							
S5a-1	29.02	400	0.002	650	0.015	800	0.035
S5a-2	11.42	400	0.002	650	0.015	800	0.035
S5b-1	42.7	N/A	N/A	400	0.013	800	0.035
S5b-2	53.6	550	0.0005	745	0.015	795	0.08
S5b-3	44.5	550	0.0005	745	0.015	795	0.08
S5b-4	26.9	N/A	N/A	400	0.013	800	0.035
S5b-5	38.65	430	0.0011	714	0.01	795	0.034
SIS Area 6							
S6-1	43.51	400	0.0003	625	0.01	975	0.035
S6-2	36.2	400	0.0003	625	0.01	975	0.035
S6-3	51.97	400	0.0003	625	0.01	975	0.035
S6-4	38.11	400	0.0003	625	0.01	975	0.035

1. Corresponds only approximately to return period flow rates/storage.
2. Flow rate at maximum storage condition; emergency overflow to be provided above this corresponding stage.
3. No quantity control required for this facility; emergency overflow to be provided above extended detention stage.

As stated previously in Section 4.2.2, the SIS Terms of Reference and the Implementation Principles for the Boyne Survey Area recognize that the stormwater management facility storage and discharge requirements generated above will be verified at the SIS stage and refined as required in order to satisfy the requirements for flooding and erosion control.

The stormwater management facility location as per the conceptual Tertiary Plans, are conceptually depicted on the Schedules which accompany the Implementation Principles provided in Appendix 'I' of this report. The actual geometry, orientation, thermal mitigation measures, and number of facilities will be determined at the SIS stage and verified for performance with respect to flood and erosion control criteria.

The stormwater management system which has been evaluated as part of this FSEMS reflects the preferred strategy which will consist of an integrated network of end-of-pipe facilities to service the future development within the Boyne Survey Area. Nevertheless, it is recognized

that circumstances may arise whereby it is impractical or infeasible to connect a portion of a site to an integrated end-of-pipe facility. Under such circumstances, the stormwater quantity control requirements for the site may be addressed through the provision of source quantity controls, such a parking lot and rooftop storage. Where the application of source controls for stormwater quantity control is not preferred, consideration for the implementation of source controls for stormwater quantity control will be provided on a case-by-case basis, and the ultimate acceptance of such practices is subject to approval by the Town of Milton.

In addition to the foregoing, the design for stormwater management facilities to watercourses throughout the Boyne Survey Area should incorporate measures to mitigate thermal impacts to the receiving watercourse, where deemed appropriate during the SIS. The assessment should consider, at a minimum, the quality of receiving fish habitat, as well as the anticipated increase in water temperature within the receiving fish habitat, which can be influenced by the volume and seasonality of discharge, as well as the distance between stormwater management facility discharge and downstream fish habitat. These measures may include:

- Bottom draw
- Cooling trenches
- Enhancement of riparian vegetation from outlet to receiving watercourses
- Pond orientation and configuration

As demonstrated by the Impact Assessment in Section 4.2.2, the proposed development of the Boyne Survey Area is anticipated to reduce the average annual groundwater recharge by 130 mm (64%) compared to the pre-developed conditions. More detailed analyses have been completed in order to determine the reduction in groundwater recharge which would be anticipated for each SIS Area as a result of the future development as per the Secondary Plan; the results of this assessment are presented in Table 5.1.3.

Table 5.1.3: Reduction in Groundwater Recharge for SIS Areas from Future Development (mm/year)

SIS Area	Reduction in Groundwater Recharge
1	97
2	103
3	42
4	36
5a	20
6	48
5b	73

Appropriate infiltration practices are required within the Boyne Survey Area in order to maintain the groundwater recharge at existing levels. Enhanced infiltration may be provided within the Boyne Survey Area through the application of Low Impact Development Best Management Practices. As part of the SIS, more detailed analyses would be completed based upon the proposed land use and stormwater management plan, in order to evaluate LID infiltration BMP requirements, and to verify that the existing groundwater recharge would be maintained post-development. It is currently anticipated that these analyses would apply the continuous simulation methodology and subcatchment scale analytical techniques which have been applied for the Northwest Brampton Subwatershed Study (AMEC et al., June 2011). The evaluation of

these opportunities would necessarily require site specific studies in order to verify the suitability of the hydrogeologic regime (i.e. soils and water table elevation) for the selection of appropriate infiltration practices.

As indicated in Section 4.2.2 of the FSEMS and as per the Implementation Principles provided in Appendix 'I', the stormwater management system for the Boyne Survey Area shall include Regional Storm quantity controls. The application of an on-line storage for Regional Storm quantity control through use of online structures is approved in principle as per the analyses provided in Section 4.2.5. The SIS shall demonstrate that the proposed approach satisfies the requirements for peak flow reduction, fluvial geomorphologic requirements, operation and maintenance under Regulatory design conditions as a formal flood control system, and would be implemented in a manner which would provide for fish and wildlife passage as required.

Management practices for the various watercourses have been provided previously in Table 5.1.1, based upon opportunities to enhance the aquatic habitat throughout the Boyne Survey Area. The planning corridor width for each medium and high constraint reach within the Boyne Survey Area has been estimated based upon fluvial geomorphological and fisheries setback criteria. The following have been assumed for this estimation:

- Corridor bottom width to be established based upon fluvial geomorphological criteria.
- 5 m (+/-) width required on each side for grading of valley wall
- 10 m and 15 m setback (i.e. buffer) from stable top-of-bank (i.e. top of valley wall) are required as per the Secondary Plan Policies and the Implementation Principles (ref. Appendix 'I').

The resulting planning corridor widths by reach are summarized in Table 5.1.4. Additional information regarding functional consideration in establishing corridor dimension is provided in Table 3.3 of the CFCP. Corridor widths noted below are preliminary and will be established on the basis of further detailed work at the SIS stage. Buffers noted in Table 5.1.4 have been defined in accordance with the Implementation Principles and Secondary Plan Policies); all other factors are preliminary estimates and are subject to change based upon the detailed analyses at the SIS Stage. The Secondary Plan Policies and the Implementation Principles provide further direction on NHS Watercourse Corridor widths to be established at the SIS stage.

Table 5.1.4: Planning Corridor Widths for Boyne Survey Watercourses						
Reach	**Belt Width[1.] (m)**	**10% Factor of Safety Either Side of Channel**	**Final Belt Width[2.] (m)**	**Side Slopes (m)**	**Buffer[3.] (m)**	**Total Planning Corridor Width (m)**
Tributary 1-NE-2A						
I-NE-2A-3	25	2.5	30	10	25	65
I-NE-2A-1	25	2.5	30	10	25	65
I-NE-2A	25	2.5	30	10	25	65
Tributary 1-NE-1B-1						
I-NE-1B-1	25	2.5	30	10	25	65
Tributary SWS-1-A						
SWS-1-A	25	2.5	30	10	25	65
Tributary SWS-2-A						
SWS-2-A	25	2.5	30	10	25	65
Main Branch						
2-II	100	10	120	varies	25	Varies; See Implementation Principles (FSEMS Sec. 4.1.2 and Appendix 'I')
SWS-5-A (red stream)	n/a	n/a	n/a	Varies	25	
SE-5-A (red stream)	n/a	n/a	n/a	varies	25	
Tributary SE-3						
SE-3-G	25	2.5	30	10	25	65
SE-3-B	25	2.5	30	10	25	65
BP-4-C						
BP-4-C	28	2.8	33.6	10	25	68.6

NOTE:
1. A standard width of 25m has been applied to many of the medium net constraint watercourses throughout the Boyne Survey Area. The value is from SWS-2-A; which was deemed as a suitable surrogate reach. Individual meander belt widths were not calculated for these reaches as they are of low geomorphological constraint. This preliminary meander belt width value matches that reported in Table 3.3 of the CFCP document. Final values to be established through additional stream specific analyses at the SIS stage. This more detailed work may result in differing meander belt widths that will be used to identify corridor widths at the SIS stage.
2. Using the 10% Factor of Safety results in a final meander belt width of 30m. This value is appropriate and matches a traditional fisheries/water quality setback from the watercourse of 15m on either side
3. Based on the Implementation Principle for the Boyne Survey Natural Heritage System, a 10 m buffer and 15 m buffer have been applied from the top-of-bank, resulting in a total buffer of 25 m.
4. The Total Planning Corridor Width value matches that, which has been reported as the "Estimate Corridor Width" in Table 3.3 of the CFCP report.

The planning and design of the open watercourse system within the various SIS areas necessarily requires hydraulic analyses be completed in order to establish grading requirements for the adjacent lands, final corridor dimensions, and the size of hydraulic structures (i.e. bridges and culverts). In addition to hydraulic criteria for the sizing of hydraulic structures, the size of the opening through the structures should also consider requirements for stream morphology, wildlife passage, and fish passage.

Preliminary drainage density assessment of the most current Land Use Plan (June 2010) has been undertaken to verify whether drainage density targets can be met, and identify where additional swales could potentially be incorporated to maintain the channel length required. As part of this assessment, several types of channel have been identified and measured. The different types of channel and the ratings with which they are associated are detailed in Table 5.1.5.

Table 5.1.5: Channel Type and Ratings Identified within Land Use Plan (June 2010)	
Constraint	**Channel Type**
High	Watercourses within NHS (High)
Medium	Watercourses within NHS (Medium)
Low – 1	Existing lengths maintained within the NHS
	New swales within the NHS
	New swales in public lands joining the NHS
	New swales downstream of SWM facilities within NHS
Low - 2	New swales in public lands connected to SWM
	Flow paths through stormwater management facilities

Watercourses within the NHS

The Land Use Plan retains several high and medium constraint streams on their original alignment within the Natural Heritage System (NHS), including greenlands and environmental linkage areas. A Geographical Information System (GIS) was used to measure the length of the retained streams based on the Land Use Plan "Schedule C-10-C Boyne Survey Secondary Land Use Plan" design drawings.

Swale Locations

In order to maintain drainage density, it is also required that swales be constructed within the Boyne Survey lands as part of the land use plan. Potential locations of swales have been identified based on the channel types described in Table 5.1.5. The potential location of the swales was determined using GIS and the ability to locate features within the NHS, public parks, schools, and stormwater management facilities shown in the Land Use Plan "Schedule C-10-C Boyne Survey Secondary Land Use Plan" design drawings. The GIS enabled accurate determination of stream length under each of the categories. The lengths of streams calculated as described above are presented in Table 5.1.6 and are illustrated in Figure 5.1.

Table 5.1.6: Identified Channel Types within Land Use Plan (June 2010)							
Constraint	Channel Type	Sixteen Mile Creek		Indian Creek		Total	
		Existing (km)	Land Use Plan (June 2009) (km)	Existing (km)	Land Use Plan (June 2009) (km)	Existing (km)	Land Use Plan (June 2009) (km)
High	Watercourses within NHS (High)	2.97	2.97	0.00	0.00	2.97	2.97
Medium	Watercourses within NHS (Medium)	6.74	6.58	2.97	3.43	9.72	10.01
	Sub Total- High and Medium	**9.72**	**9.55**	**2.97**	**3.43**	**12.69**	**12.98**
Low - 1	Existing lengths maintained within the NHS		0.23		0.00		0.23
	New swales within the NHS		3.50		1.26		4.76
	New swales in public lands joining the NHS		5.12		1.61		6.73
	New swales downstream of SWM facilities within NHS		1.00		0.36		1.37
Low - 2	New swales in public lands connected to SWM		0.70		0.69		1.39
	Flow paths through stormwater management facilities		1.49		0.55		2.03
	Sub Total - Low	**7.03**	**12.04**	**1.37**	**4.47**	**8.40**	**16.51**
	Total (High, Medium and Low)	**16.74**	**21.59**	**4.34**	**7.90**	**21.09**	**29.49**

N.B. Assessment does not include additional swales in private lands, which could also potentially contribute to drainage density and stream length within the study area.

To aid in understanding this table, especially with respect to the green streams, all of the green streams that have been mapped and classified as summarized in the 'existing' length total. Thus, all of the reaches that have been discussed that could be lost (e.g. SE-2-D-1; SE-3-B-1, etc.) have all been accounted in this existing length value. Thus, if it has been mapped and classified, it has been included in this value. This table clearly indicates that the loss of any green stream can be replicated in the post-development condition

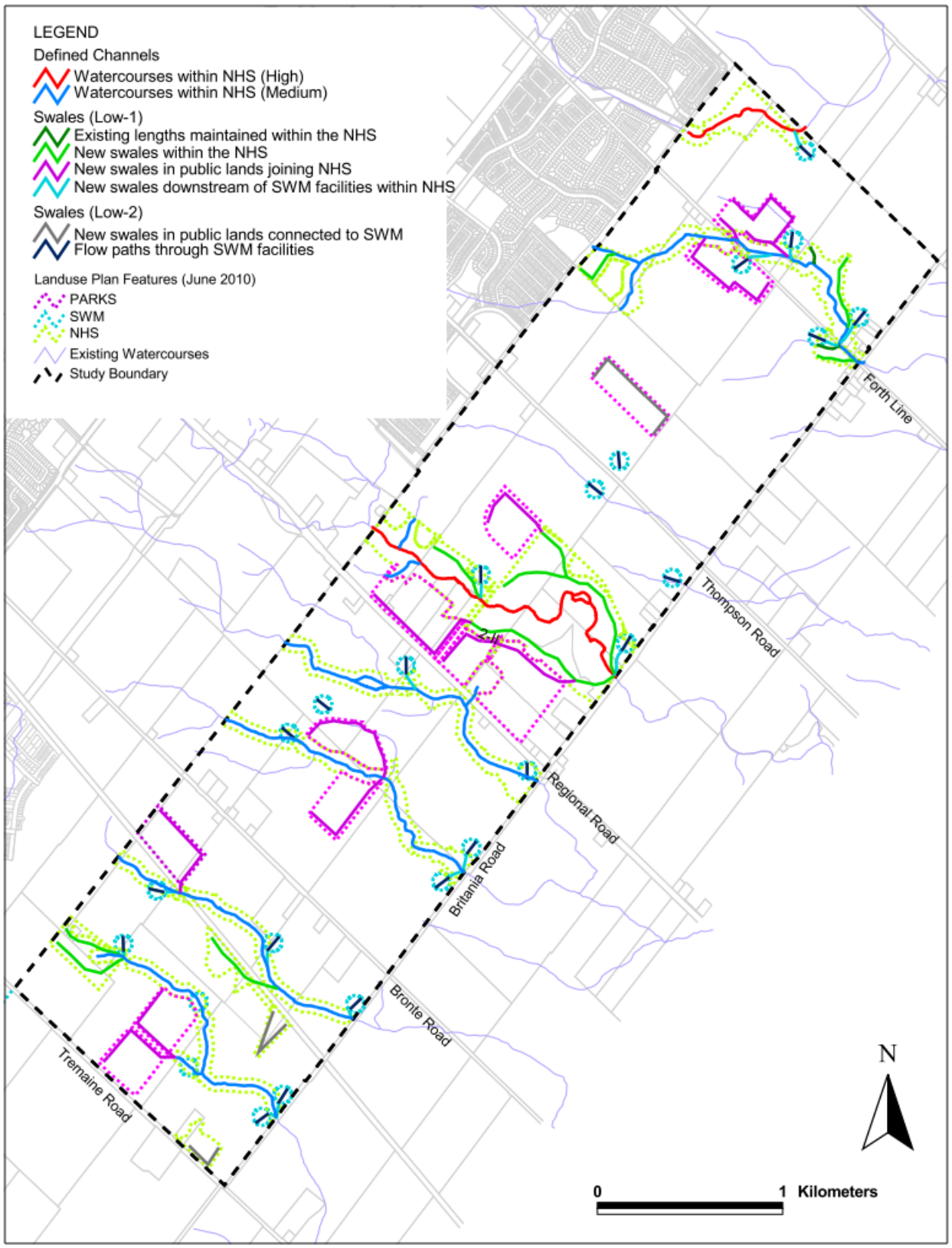

Figure 5.1: Lengths of channel identified within the Land Use Plan

Drainage density assessment

A preliminary drainage density assessment was undertaken based on the potential channel lengths identified in Figure 5.1. The same approach used in assessing the overall management strategy in the *Sixteen Mile Creek Areas 2 & 7 Subwatershed Update Study* was adopted, calculating the stream lengths present in each subcatchment. Detailed results are presented in Table 5.1.7.

Table 5.1.7: Preliminary Drainage Density Assessment of Land Use Plan & Sensitivity Analysis

Basis of analysis	Total Stream length based on this study (km)	Total Stream length based on 1:10 000 OBM (km)	Stream length based on Land Use Plan (June 2010) (km)	Target Stream Length* (km)	Drainage deficit / surplus (km)	Overall Drainage Density (km / km^2)
Sixteen Mile Creek	16.74	15.96	21.59	11.18	+10.40	2.92
Indian Creek	4.34	3.43	7.90	2.70	+5.21	3.15

The findings show that, when all channels are considered, the overall drainage density under the Land Use Plan could potentially far exceed the minimum drainage density target of 1.451 km/km^2 within both watersheds, as well as the regional average drainage density (2.74 km/km^2). Within Sixteen Mile Creek, considering individual subcatchments, the surplus stream length far exceeds the drainage density deficit that is indicated in certain subcatchments. Within the Indian Creek watershed, all subcatchments more than meet the drainage density targets.

It should also be noted that additional swales could be incorporated into the land use plan, including:

- Swales within private property ownership (residential/employment)
- Low Impact Development Best Management Practices

These swales were not identified as part of the preliminary assessment since lengths are currently unavailable and it is possible to meet drainage density targets through swales in public ownership only. Efforts to incorporate such additional swales should be concentrated within the subcatchments of Sixteen Mile Creek that are highlighted as not meeting drainage density targets.

Comparison of Existing and Potential Channel Lengths

As part of the drainage density assessment a comparison of the lengths of High, Medium and Low rated channels has been undertaken. The findings of this comparison are contained in Figure 5.2 (the calculated lengths are also contained in Table 5.1.6).

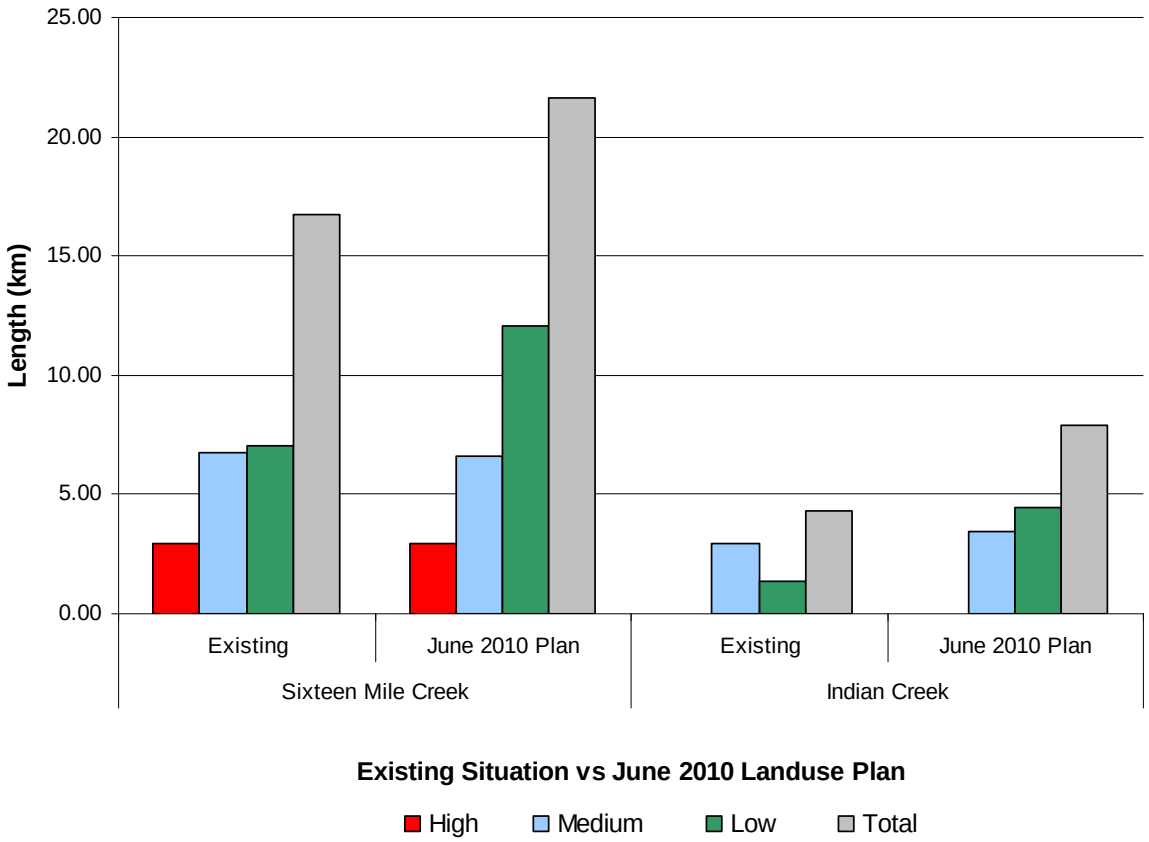

Figure 5.2: Comparison of Existing and Land Use Plan Channel Lengths by Constraint.

Figure 5.2 indicates that, if the approach to locating swales demonstrated in this assessment is adopted, the length of channel designed as part of the Land Use Plan can maintain and exceed existing channel length in both watersheds.

Appendix 'J' has the details associated with the calculations for Drainage Density (DD) for the current conceptual Tertiary Plan. The intent of this exercise was to demonstrate that the plan as proposed, with the protected watercourses, realigned watercourses and swales anticipated to be on the future landscape, would adequately satisfy regional targets on a watershed scale (i.e. for the Indian and Sixteen Mile Creek watersheds). As has been demonstrated by the subject calculations, the current conceptual Tertiary Plan (albeit with no formal status) would adequately meet these objectives.

It is not considered appropriate to conduct Drainage Density calculations at the SIS level of study given that there would be pluses and minuses and as such information from all SISs would need to be in place to conduct a fulsome calculation. Rather, it is recommended that at the SIS stage the respective proponents conduct a calculation of realigned watercourses and open swales on the proposed landscape and compare this with the assumptions in the current conceptual Tertiary Plan. While it is recognized that there will be differences, the current conceptual Tertiary Plan calculation shows that there is a surplus of 39% stream length for the Indian Creek and 24% for the Sixteen Mile Creek. In the event that the Drainage Density calculation for any SIS shows stream length totals less than the values shown in the current conceptual Tertiary Plan by the amount of the surpluses noted above, it would be necessary to

re-visit the plan and provide for additional open water features (i.e. 39% less than existing stream length for Indian Creek and 24% less than existing stream length for Sixteen Mile Creek).

Water Quality Diversion Area

The stormwater management strategy for the drainage areas to the Omagh Tributary is currently proposed to provide conventional stormwater management practices (i.e. end-of-pipe stormwater management for future urban areas discharging to the Omagh Tributary during all storm events) for 90.4 ha of the existing 201 ha drainage area. Stormwater management for 88.1 ha of the lands adjacent to the Omagh Tributary would divert the extended detention component of the facility, which represents the runoff from the more frequent storm events, westward toward the Sixteen Mile Creek Main Branch via dedicated trunk sewers; runoff volumes above the extended detention portion of the facility would be discharged to the Omagh Tributary. The hydrologic analyses have demonstrated that this strategy would maintain the duration and frequency of bankfull flows at key locations within the Omagh Tributary downstream, and would increase the duration and volume of runoff during summer periods when the supply of water to the receiving system is typically the lowest under existing conditions, thereby providing a benefit during periods when the receiving system is typically more stressed (i.e. water-deprived) under the existing land use conditions.

Stream Morphology

Reduced occurrence of bankfull flows that flush materials through the channel may lead to increased propensity for sedimentation and some reduction in channel dimensions. However, integration of new swales within public lands (e.g. parks and schools) joining the Natural Heritage System upstream of the Omagh Tributary would mitigate this impact by maintaining drainage density, channel length and provision of flows downstream.

Furthermore, reach R7-IX is a “medium” geomorphological constraint stream that is impacted by agricultural land use and currently exhibits low stream health according to Rapid Stream Assessment Technique findings. Since the reach is located within Sustainable Halton lands, there is good opportunity for enhancement and realignment of this reach in the future, which would necessarily be designed for the prevailing flow regime. Taking into account these considerations and the already modified nature of the existing feature, the scale of potential change is not anticipated to represent a significant impact on the overall functionality of the system.

Terrestrial Management Implications

The recommended diversion will not affect significant features or functions in the existing riparian zone downstream of Britannia Road. Floodplain events will occur on a less than annual frequency basis under spring freshet conditions. The modelling also indicates that there will be increased floodplain event frequency from May to September, which would extend pool habitat availability for life cycle completion by common amphibian species, and will benefit avian piscivores.

Upstream of Britannia Road, wetland and associated natural cover will be enhanced through the integration of substantial habitat cover within the enhanced riparian corridors as part of the Boyne Survey NHS. According to Sustainable Halton, urban development will eventually proceed south of Britannia Road, and associated enhancement works are expected to extend throughout the Omagh tributary, upstream of the Sixteen Mile Creek ESA. Therefore there will ultimately be much greater availability of wetlands and other functional corridor habitats than exist today under agricultural conditions.

Fish Habitat Implications

The lack of water during the summer low flow period is one of the most limiting aspects to the diversity and productivity of the Omagh Tributary fish and invertebrate communities. While the downstream barrier that presently blocks movement of fish into the Omagh Tributary from the downstream sections of Sixteen Mile Creek may continue to limit fish community diversity for the foreseeable future, the predicted increase in flows during the summer months will likely increase productivity of the fish and invertebrate communities, and diversity of the invertebrate community. The anticipated decrease in flow volumes over the winter and spring are not predicted to have a detrimental effect upon aquatic habitat, as there will still be sufficient water to maintain habitat.

5.2 Recommended Natural Heritage System

The recommended Natural Heritage System for the Boyne Survey Secondary Plan area is presented in Figure NHS-2, located in Appendix ‘F’. The Secondary Plan is intended to provide conceptual direction to general land uses and policy direction. The NHS shown on Figure NHS-2 will be refined through the SIS and site design process in a manner consistent with the Secondary Plan policies. There are instances where proposed roads will potentially impact specific natural features; the implementation of the Plan in these areas will need to address concerns through EA and SIS processes. Key areas of stakeholder discussion to date have included the treatment of the Main Branch of Sixteen Mile Creek, restoration areas, wetlands, and the use of corridors and linkages to address significant features that are currently poorly connected by watercourses.

NHS Implementation Principles and associated Schedules have been prepared which are located in Appendix ‘I’ of this report. These represent refinements to the recommended NHS reflecting the Secondary Plan policies, with specific conditions identified in the Principles. The Principles address a number of NHS design principles including, but not limited to, the treatment of the Main Branch of Sixteen Mile Creek, restoration areas, wetlands, and the use of corridors and linkages to address significant features that are currently poorly connected by watercourses. The Implementation Principles provide specific NHS design direction to be addressed in further detail during the preparation of SIS.

Table F1 in Appendix ‘F’ summarizes the key steps that were followed in the development of the recommended NHS. The NHS builds on frameworks that were first outlined in the 2000 Subwatersheds 2 & 7 and 2004 Indian Creek Subwatershed studies, which has been refined based on updated field data, current environmental legislation, policies, guidelines, and practices. It also reflects the character, opportunities and constraints imposed by the recommended NHS context, i.e. the intended residential uses of the Secondary Plan area.

There has been consideration of existing land uses that will continue, i.e. major roads and a rail corridor. The plan includes restoration and enhancement of ecological features and their functions as envisioned in the PPS, with the emphasis placed on consolidation of natural cover and functions in core areas, maintenance of small linked features, and support of other management strategies (such as stormwater management and drainage density maintenance) to yield land use efficiency.

Table 5.2.1 summarizes the key attributes of the NHS. The table also indicates that the status of the key categories for protection of significant features and functions under the PPS (2005; 2014), based on the recommended Secondary Plan. The following sections describe the key components of the recommended NHS, how specific features and functions are addressed to meet requirements of guiding legislation and policies, the intended approaches for implementation, and the responsibilities of landowners and approval agencies through the development process and post development.

Figure 5.3 is a key map of core habitat complexes and other significant features in the recommended NHS. Table 5.2.2 summarizes the features within the recommended NHS, existing ELC cover and area, documented policy significance, and site specific implementation guidance (e.g. vegetation cover and key wildlife). Existing areas and ELC cover reflect findings at time of SUS fieldwork in 2007-2008; these should be updated as part of SIS studies. Table 5.2.2 includes information on features and complexes that are functionally connected to resources within the study area. In particular, external features located within the Greenbelt are included to ensure that their proximity is addressed.

The stormwater management design for Boyne Survey includes a proposal to divert some flows from the Omagh tributary system into the Main Branch of Sixteen Mile Creek. This is being considered in order to reduce the extent of filling required.

The Region's new Official Plan, known as "Sustainable Halton" was adopted in late 2009 and is currently under appeal at the Ontario Municipal Board. Notwithstanding that Sustainable Halton does not apply to the Boyne Survey Secondary Plan, Conservation Halton has requested that the FSEMS provide some context as to how the recommended Boyne Natural Heritage System compares to the Sustainable Halton Natural Heritage System and related process. Table F3 in Appendix 'F' presents the *"Step by Step Process for the Development of the Sustainable Halton NHS".* The NHS Development Process identified in Table F1 (ref. Appendix 'F') contains the corresponding process used for the recommended Boyne NHS.

Notably, the features that meet the Environment Canada (2004) area thresholds for core features (which are applied in Sustainable Halton), are located in the Main Branch valley. Smaller features within the Boyne Survey NHS have also been denoted as 'habitat complexes' and 'other significant features' based on their significant functional characteristics (ref. Tables 3.7.2 and 5.2.1). The standards used for identification of larger core habitat complexes in Boyne Survey complement the SH standards.

Sustainable Halton identified Regional (300-400m) and local (60-100m) linkage categories. The Main Branch corridor constitutes a Regional linkage in scale with an average width of 250 m and a maximum of more than 600 m in width (including NHS buffers and supporting uses north of the existing ESA). Outside of the Main Branch valley, the spacing of features does not meet

the Environment Canada guideline of 2 km or less due to the general scarcity of natural features.

Sustainable Halton establishes minimum 30 m buffers for woodlands and wetlands; the Boyne Survey Secondary Plan establishes a 10 m buffer standard for woodlands, 15 m for wetlands (non-PSW), and 30 m for PSW's unless otherwise reduced as determined by the OMNR and Conservation Halton in consultation with the Town and Halton Region. Regulated stream corridors incorporate a 10 m + 15 m buffer, with the 15 m applied on one side containing the pedestrian trail. The buffer standards reflect the importance placed on efficient development in 'designated growth areas' in the PPS.

The recommended Boyne Survey NHS largely reflects the conceptual NHS presented in Figure 6 of the Sustainable Halton *Natural Heritage System Definition & Implementation* (2009). Notably, the extension of natural cover in the Main Branch north of the existing ESA is apparent on Figure 6 and is reflected on Figure NHS-2.

Table 5.2.1: Summary of Recommended Natural Heritage System (Boyne Survey)								
Study Area	**Key Approaches**	**Habitat of Endangered and Threatened Species**	**Significant Wetlands**	**Significant Woodlands**	**Significant Valleylands**	**Significant Wildlife Habitat**	**Significant Areas of Natural and Scientific Interest**	**Fish Habitat**
Boyne Survey	Corridor Widths; including 10 + 15 buffers 16 Mile Creek Valley Corridor Width average including NHS supporting uses and buffers: 250 m Outside the Sixteen Mile Creek Valley, three existing wetlands will be protected and new wetlands created in the proposed NHS. Buffers: To be established in accordance with Section C.10.8.5.6 of the Secondary Plan Policy. Habitat Restoration: Recommended NHS includes restoration in 16 Mile Creek Valley/ESA, and creek blocks, wetlands and woodlots elsewhere in Boyne.	Habitat of provincially Endangered or Threatened species is potentially present; to be confirmed with MNRF	Provincially Significant Wetlands potentially present; locally significant wetlands protected or otherwise integrated within recommended NHS	Significant Woodlands present; all retained within recommended NHS	Significant Valleyland present within and immediately downstream of study area (Main Branch of 16 Mile Creek); to be protected and restored	Significant Wildlife Habitat present; protected within recommended NHS.	No Significant Areas of Natural and Scientific Interest within study area; Sixteen Mile Creek Valley Regional and Candidate Provincial Life Science ANSI located >120 m downstream	Intermittent and permanent fish habitat present; protected within recommended NHS; net gain in permanent habitat is expected

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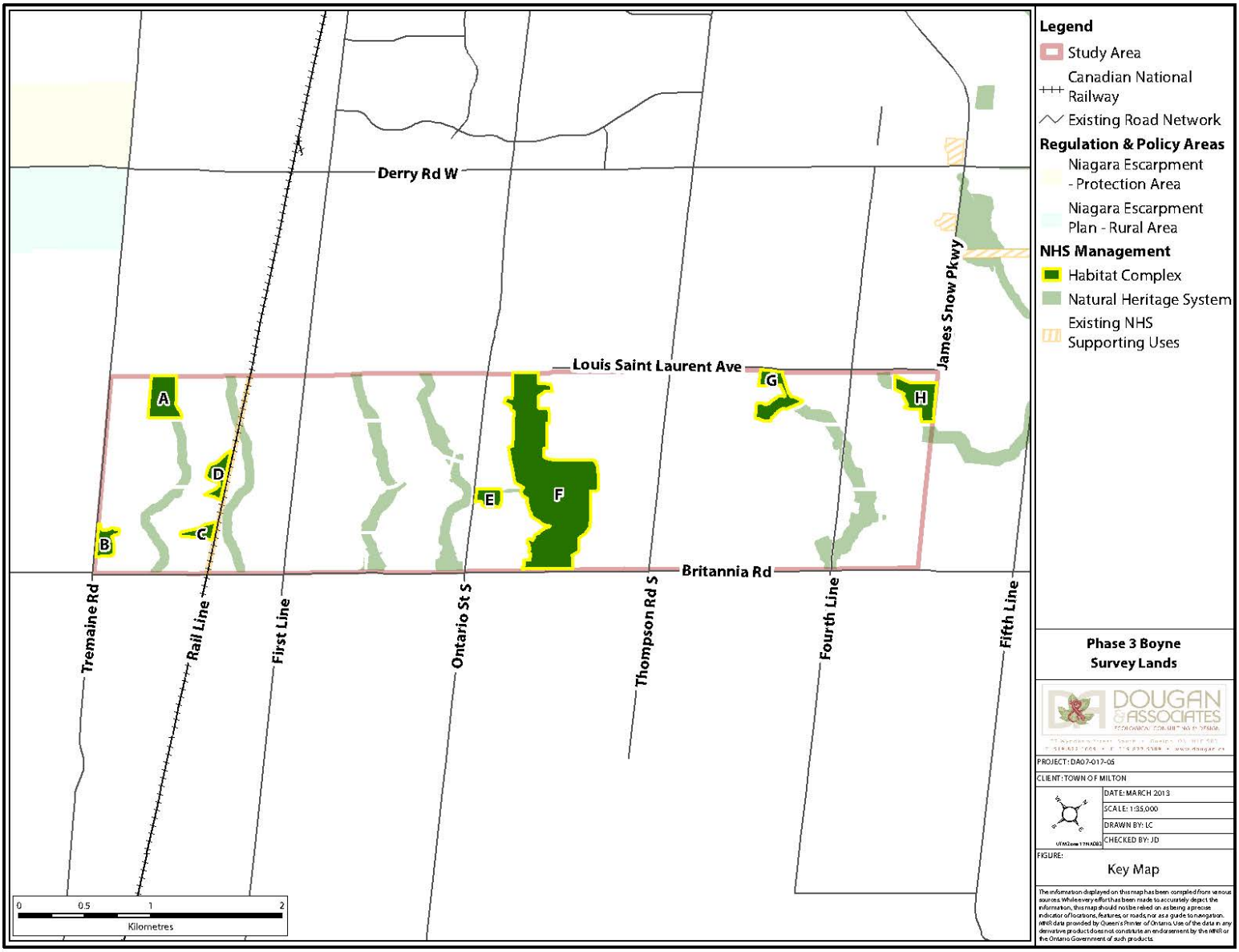

Figure 5.3: Key map of Natural Heritage System Areas.

Table 5.2.2: Management Strategies for Habitat Complexes and Other Significant Features within Boyne
(Ref. Figures 5.3 (Key Areas), and App. 'F' Figs. NHS-2, T2, T4 and T5; App. 'I' Implementation Principles)

Key NHS Area	Natural Heritage Feature Type	Description • Existing ELC Polygons • Policy Significance	Area of Existing Cover Types (Buffers not included)	Goals and Policy Priorities	Cover Targets and Implementation Details
A	Swamp/ Meadow Marsh/ Thicket Complex	Existing ELC: 216a (SW), 216b (SW), 216c (MM), 216d (MM), 216e (TH), 216f (TH), 216g (ME), P3-28 (ME), P3-64 (partial) (HR) Policy factors: • Significant Woodland • Evaluated Wetland • Significant Species	Meadow: 0.92 ha Thicket: 1.53 ha Wetland: 2.50 ha Forest: 0.00 ha Hedgerow: 0.11 ha	***Goal: Protect and restore existing wetland feature and add terrestrial linkage to watercourse corridor to south *.*** • Protect Significant Woodland (*per PPS and RM Halton Policies*) • Apply buffers to wetland *(per Secondary Plan policies);* • Consider existing species of concern (amphibian, invertebrate & flora), hydrology, and Regulations *(per PPS & CH Regulations)* • Protect existing Wetland*;* Avoid impacts to existing riparian habitat and wetland within core feature (*per CH Regulations*) • Integrate core feature with created terrestrial linkage to provide connectivity within Boyne and with downstream riparian system *(per PPS*; • Establish NHS supporting uses *(such as SWM blocks, trails) (per PPS)* • Reinforce feature edges with buffer plantings to add resiliency and diversity *(per PPS)*	• **Cover targets**: Swamp/marsh 50 – 70%; meadow/thicket 30 – 40%; • Maintain biodiversity by providing terrestrial linkage at SE corner. • Implement wildlife crossings where terrestrial linkage intersects with future roads downstream of feature, with standards focused on sustaining movement of small sensitive terrestrial wildlife (see text) • Consider buffering of flanking roads from feature with planted berms and/or directional fencing • Enhance wetlands as primary habitat for amphibians and odonates, and supplement edges with old field and reforested habitat. • Maintain meadow habitat for Monarch (Special Concern in Ontario and Canada). • Breeding and potential summer habitat for Western Chorus Frog (Threatened in Canada – documented in 2002) to be enhanced • Maintain breeding habitat for Spring Peeper • Improve ponded areas as breeding habitat for invertebrates: locally rare Halloween Pennant and locally uncommon Shadow Darner. • Maintain breeding bird habitat for Common Yellowthroat; woodland nesting habitat for Eastern Wood-Pewee (Special Concern in Ontario) and Red-eyed Vireo breeding.

Table 5.2.2: Management Strategies for Habitat Complexes and Other Significant Features within Boyne
(Ref. Figures 5.3 (Key Areas), and App. 'F' Figs. NHS-2, T2, T4 and T5; App. 'I' Implementation Principles)

Key NHS Area	Natural Heritage Feature Type	Description • Existing ELC Polygons • Policy Significance	Area of Existing Cover Types (Buffers not included)	Goals and Policy Priorities	Cover Targets and Implementation Details
B	Forest/ Marsh Complex	Existing ELC: 227a (DF), 227b (M) Policy factors: • Significant Woodland • Significant Wildlife Habitat • Wetland	Meadow: 0.00 ha Thicket: 0.00 ha Wetland: 0.14 ha Forest: 2.09 ha	***Goal: Protect and reinforce existing forest & wetland feature *.*** • Protect Significant Woodland (*per PPS and RM Halton Policies*) • Apply 10 m buffer to upland forest and 15 m to wetland *(per Secondary Plan policies)* • Consider existing species of concern (amphibian, bird, invertebrate & flora), hydrology, wetland status *(per PPS & CH Regulations)* • Protect existing Locally Significant Wetland, part of Complex IC-2 (227b) (may be complexed with PSW by MNRF)*;* Avoid impacts to existing wetland within core feature (*per CH Regulations*) • Protect Significant Wildlife Habitat – Species of Conservation Concern (Western Chorus Frog and Eastern Wood-Pewee) (*per PPS*) Consider functional linkage to nearby riparian corridor to create a more resilient and functional core area *(per PPS); can be achieved through SWM facilities;*	• **Cover targets**: Deciduous forest 80 – 90%; marsh 5 –10%, meadow 5 – 10% • Maintain biodiversity by linkage to nearby riparian corridor through future SWM facility if feasible; • Buffer noise and traffic impacts of Tremaine Road, if feasible (consider noise wall). • Maintain breeding and potential summer habitat for Western Chorus Frog (Threatened in Canada) • Maintain suitable breeding habitat for Yellow-billed Cuckoo (locally rare), Eastern Wood-Pewee (Special Concern), and Indigo Bunting. Encourage Red-eyed Vireo breeding by limiting disturbance.

Table 5.2.2: Management Strategies for Habitat Complexes and Other Significant Features within Boyne
(Ref. Figures 5.3 (Key Areas), and App. 'F' Figs. NHS-2, T2, T4 and T5; App. 'I' Implementation Principles)

Key NHS Area	Natural Heritage Feature Type	Description • Existing ELC Polygons • Policy Significance	Area of Existing Cover Types (Buffers not included)	Goals and Policy Priorities	Cover Targets and Implementation Details
C	Marsh Complex	Existing ELC: 229a (MM), 229b (M) Policy factors: • Wetland • Linkage	Meadow: 0.00 ha Thicket: 0.00 ha Wetland: 0.50 ha Forest: 0.00 ha	***Goal: Remove wetland and create robust NHS west of the rail which includes wetlands.*** • Replicate wetland functions adjacent to/within stream corridor I-NE-2A) to create a more resilient and functional habitat complex *(per PPS);* • Consider existing species of concern (amphibian, invertebrate & flora), hydrology, wetland status, and Regulations *(per PPS & CH Regulations)* • Establish NHS supporting uses (such as parks, SWM blocks, trails) adjacent to created habitat complex; • Integrate drainage density compensation within created NHS west of the rail.	• **Cover targets for Created Habitat:** Meadow 5 – 10 %; Thicket 25 – 35%; Marsh 55 – 65% • Provide for diversify of pool habitat to encourage amphibian species and odonate breeding. • Conduct wildlife rescue and plant salvage. Ensure suitable replacement habitat is available at time of rescue.
D	Marsh/ Swamp/ Thicket /Meadow Complex	Existing ELC: 225a (MM), 225b (TH), 225c (SWT), 225d (ME), 225e (ME) Policy factors: • Wetland • Linkage	Meadow: 0.72 ha Thicket: 0.58 ha Wetland: 1.33 ha Forest: 0.0 ha	***Goal: Remove wetland and create robust NHS west of the railway which will include wetlands.*** • Replicate wetland functions adjacent to/within stream corridor I-NE-2A 4) to create a more resilient and functional habitat complex *(per PPS);* • Consider existing species of concern (amphibian, invertebrate & flora), hydrology, wetland status, and Regulations *(per PPS & CH Regulations)* • Establish NHS supporting uses (such as parks, SWM blocks, trails) adjacent to created habitat complex; • Integrate drainage density compensation within created NHS west of the railway.	• **Cover targets for Created Habitat:** Meadow 5 – 10%; Thicket 25 – 35%; Marsh 55 – 65% • Provide for diversify of pool habitats to encourage amphibian species and odonate breeding. • Conduct wildlife rescue and plant salvage. Ensure suitable replacement habitat is available at time of rescue.
E	Forest/ Meadow/ Plantation Complex	Existing ELC: 31a (ME), 31b (P), 31c (DF)	Meadow: 0.24 ha Plantation: 0.18 ha Wetland 0.0 ha	***Goal: Protect and reinforce existing forest feature, with upland and riparian connection between Main Branch valley and tributary corridor to west *.***	• **Cover targets*:** Forest/plantation 75 – 80%; meadow 10 – 20% • Maintain function as existing significant woodland and linkage to 16 Mile Creek ESA • Prevent uncontrolled pedestrian access,

Table 5.2.2: Management Strategies for Habitat Complexes and Other Significant Features within Boyne
(Ref. Figures 5.3 (Key Areas), and App. 'F' Figs. NHS-2, T2, T4 and T5; App. 'I' Implementation Principles)

Key NHS Area	Natural Heritage Feature Type	Description • Existing ELC Polygons • Policy Significance	Area of Existing Cover Types (Buffers not included)	Goals and Policy Priorities	Cover Targets and Implementation Details
		2 (Hedgerow) Policy factors: • Significant Woodland • Significant Wildlife Habitat	Forest: 1.43 ha	• Protect Significant Woodland (*per PPS and RM Halton Policies*) • Protect Significant Wildlife Habitat – Species of Conservation Concern (Eastern Wood-Pewee), (*per PPS*) • Apply minimum 10 m buffer to forest feature / plantation and hedgerow; *(per Secondary Plan policies)* • Integrate linkage with woodlot and tributary channel (SWS-2-A-1) reinforced with restoration (i.e., upland plantings) to create a more functional linkage between corridors *(per PPS)* • Consider NHS supporting uses (such as parkland, SWM blocks, trails) in adjacent areas; reinforce feature edges with habitat restoration to add resiliency *(per PPS)*	• Enhance wildlife movement at RR 25 interface and consider dry culvert(s) under new local road to support small wildlife movements • Maintain suitable breeding habitat for woodland breeding species such as Eastern Wood-Pewee (Special Concern), Red-eyed Vireo and White-breasted Nuthatch by limiting disturbance from Regional Rd. 25.

Table 5.2.2: Management Strategies for Habitat Complexes and Other Significant Features within Boyne
(Ref. Figures 5.3 (Key Areas), and App. 'F' Figs. NHS-2, T2, T4 and T5; App. 'I' Implementation Principles)

Key NHS Area	Natural Heritage Feature Type	Description • Existing ELC Polygons • Policy Significance	Area of Existing Cover Types (Buffers not included)	Goals and Policy Priorities	Cover Targets and Implementation Details
F	Main Branch ESA/Valley Complex	Existing ELC: 108a (DF), 108b (W), 108c (MM), 118 (partial) (HR), 125a (W), P3-21 (AG), P3-24 (ME), P3-46 (ME), P3-47 (ME), P3-48 (ME), P3-49 (ME), P3-75 (P), P3-78 (ME), P3-79 (ME), P3-80 (ME), P3-81 (TH), P3-82 (DF), P3-83 (DF), P3-84 (DF), P3-85 (MM), P3-86 (MM), P3-88 (MM), P3-89 (MM), P3-90 (MM), P3-91 (SWT), P3-92 (SWT), (Anthro). Policy factors: • ESA • Significant Woodland, Valleyland and Wildlife Habitat • Wetland • Forest Interior • Linkages • Significant Species	Meadow: 10.66 ha Thicket: 1.36 ha Woodland/ Plantation: 5.03 ha Wetland: 4.63 ha Forest: 22.36 ha Agriculture: 13.8 ha Anthro: 3.32 ha	***Goal: Reinforce and extend significant valley core feature (adjoins Greenbelt), with habitat restoration, enhanced buffers and natural heritage-oriented development on adjacent lands.*** • Protect existing Significant Woodlands and forest interior (134, 137a, 137b, 137c, 137e, 137f) (*per PPS and RM Halton Policies*) • Protect Significant Wildlife Habitat – Animal Move-ment Corridor; Specialized Wildlife Habitat, (*per PPS*) • Apply buffers to ESA/Significant Valleyland *(per Secondary Plan policies)* • Establish NHS supporting uses (SWM blocks, Village Square, trails); reinforce feature edges with habitat restoration to add resiliency	• **Cover targets:** To be determined through 16 Mile Creek Master Restoration Plan • Prepare Boyne Lands Sixteen Mile Creek Ecological Restoration Master Plan to guide restoration and management (ref. Appendix 'L' for design goal, objectives and principles). • Target forest breeding bird species, including area-sensitive species: Pileated Woodpecker, White-breasted Nuthatch, Hairy Woodpecker, Northern Flicker, Eastern Wood-Pewee Special Concern in Ontario & Canada), Red-eyed Vireo, Black-capped Chickadee, Wood Thrush (Special Concern), & Rose-breasted Grosbeak; 17 area-sensitive forest species documented in ESA. • Maintain riverine habitats for the variety of locally and provincially significant odonate species present. • Provide additional amphib. breeding habitat by con-structing ponds (vernal &/or permanent) within valley • Plan trail access to avoid sensitive habitats. • Improve Britannia Rd. crossing by adding dry terrestrial connections to accommodate small to medium-sized wildlife. • Address habitat protection and safe wildlife passage when mid-block crossing of Main Branch is planned. • Conduct wildlife rescue and plant salvage from Isolated Specialized Habitat B5.

Table 5.2.2: Management Strategies for Habitat Complexes and Other Significant Features within Boyne
(Ref. Figures 5.3 (Key Areas), and App. 'F' Figs. NHS-2, T2, T4 and T5; App. 'I' Implementation Principles)

Key NHS Area	Natural Heritage Feature Type	Description • Existing ELC Polygons • Policy Significance	Area of Existing Cover Types (Buffers not included)	Goals and Policy Priorities	Cover Targets and Implementation Details
G	Forest / Meadow / Marsh/ Heritage Hedgerow Complex	Existing ELC: 123a (ME), 123b (MM), 213a (HR), 602 (HR), P3-73 (HR), 1010 (DF). Policy factors: • Significant Woodland • Significant Wildlife Habitat • Wetland • Significant Species present	Meadow: 0.77 ha Thicket: 0.95 ha Wetland: 0.41 ha Forest: 1.78 ha Hedgerow: 0.82 ha Agriculture: 5.31 ha	***Goal: Protect existing forest and hedgerow, and create enhanced riparian corridor.*** • Protect Significant Woodland (*per PPS and RM Halton Policies*) • Apply buffers to woodland and hedgerow features as per Sect. C.10.5.8.6. of the Secondary Plan Policies. • Protect Significant Wildlife Habitat – Species of Conservation Concern (Eastern Wood-Pewee), (*per PPS*) • Consider existing species of concern (amphibian, invertebrate & flora) *(per PPS)* • Integrate woodlot, hedgerow, & buffers, and provide connection to realigned naturalized riparian corridor, to create a more resilient and functional habitat complex *(per PPS and Secondary Plan policies)* • Establish NHS supporting uses (SWM blocks, Village Square, trails); reinforce feature edges with habitat restoration to add resiliency	• **Cover targets:** Forest: 70 – 90%; wetland: 10 – 15% • Target habitat for Great Crested Flycatcher and Rose-breasted Grosbeak; encourage other forest species such as Eastern Wood-Pewee (Special Concern), Red-eyed Vireo, Hairy Woodpecker, White-breasted Nuthatch, and Indigo Bunting. • Limit future disturbance to wildlife by limiting trails to edges and actively discouraging informal access to woodlot. • Monarch (Special Concern in Ontario & Canada) documented; include successional habitats in restoration complex.

Table 5.2.2: Management Strategies for Habitat Complexes and Other Significant Features within Boyne
(Ref. Figures 5.3 (Key Areas), and App. 'F' Figs. NHS-2, T2, T4 and T5; App. 'I' Implementation Principles)

Key NHS Area	Natural Heritage Feature Type	Description • Existing ELC Polygons • Policy Significance	Area of Existing Cover Types (Buffers not included)	Goals and Policy Priorities	Cover Targets and Implementation Details
H	Swamp/ Forest	Existing ELC: 124 (SW), P3-39 (ME) (partial) Policy factors: • Significant Woodland • Evaluated Wetland • Significant Species	Successional: 0.00 ha Swamp/Forest: 2.73 ha	***Goal: Protect evaluated wetland feature/significant woodland, with enhanced riparian corridor through surrounding development.*** • Protect Significant Woodland (*per PPS and RM Halton Policies*) • Apply buffers to feature and wetland *(per Secondary Plan policies)* • Consider hydrology, existing species of concern (amphibian, invertebrate & flora) *(per PPS & CH Regulations)* • Protect existing Locally Significant Wetland (*per CH Regulations*) • Integrate wetland/significant woodland feature with naturalized riparian corridor of Centre Tributary to provide connectivity within Boyne and with downstream riparian system *(per PPS)*; • Establish NHS supporting uses (such as SWM blocks, trails);	• **Cover targets:** Forested swamp: 75 – 80%; wet meadow: 5 – 10% meadow/thicket: 15 – 20% • Buffer noise and traffic impacts of James Snow Pkwy • Consider barrier fencing to reduce future road mortality of wildlife. • Provide additional amphibian breeding habitat by constructing ponds (vernal or permanent) within riparian corridor and buffers. • Enhance riparian habitat north & south of woodlot/ wetland to increase diversity of amphibian breeding habitat. • Maintain and enhance habitat for forest breeding bird species. Long-term objective should be to provide habitat for the following species: Eastern Wood-Pewee (Special Concern), Red-eyed Vireo, Hairy Woodpecker, White-breasted Nuthatch, and Indigo Bunting. • Establish limits of feature, considering recent alterations by agriculture practice and construction of James Snow Parkway. Area has been altered since completion of the initial vegetation inventories; the road has impeded drainage and affected some wetland areas. Due to these recent changes, flexibility exists to alter the meadow marsh area north of the woodland and replicate functions in new stream corridor to west.

DF = Deciduous Forest MF = Mixed Forest W = Woodland P = Plantation TH = Thicket
ME = Meadow SWT= Swamp Thicket SW = Swamp M = Marsh MM=Meadow Marsh

*** See Implementation Principles and Schedules (Appendix 'I') for potential wetland removal and creation approach (subject to approval by MNRF) as per Secondary Plan policies**

5.2.1 Key NHS Components

NHS Watercourse Corridors

All watercourses that have been identified to remain through the multi-disciplinary ranking are included within the recommended NHS and identified on Figure NHS-2. Some watercourses may be relocated but in all cases where core natural features are located along the existing watercourses, the intention is that the riparian connections will be maintained and enhanced, and the watercourse reaches located within core natural features will not be significantly disturbed or modified.

The NHS watercourse corridors to be retained within or immediately adjacent to the Boyne Secondary Plan area will be comprised of floodplain, meander belt width plus 10% safety factors, side slopes (3:1 typical but variable slopes and treatments are desirable), and buffers (10+15 m) as specified in the Secondary Plan policies.

A pedestrian trail will be placed within the buffer along only one side of the corridor; it should not be placed in the vicinity of sensitive habitat features, and should be placed close to the periphery of the development edge within the setback. This will help to address potential impacts from dogs, which should always be on a leash. The planning corridors generally achieve minimum stream corridor targets recommended by Environment Canada (2004) (i.e. 50 to 100 m wide to facilitate wildlife passage; minimum 30 m wide naturally vegetated riparian zone on both sides; more than 75% of stream length to be naturally vegetated). The development of enhanced NHS watercourse corridors presents an opportunity to 'recycle' existing bio-diversity materials through salvage of seed banks and plant materials that would otherwise be lost during development. Section 5.2.3 presents a discussion of landscaping standards and targets for riparian corridors. Appendix 'K' of this report includes a *Town of Milton Restoration Framework: Stream Corridors and Natural Area Buffers for the Boyne and Derry Green Sub-watersheds of Sixteen Mile and Indian Creeks* which provides detailed guidance for planting and layout within NHS corridors in Boyne.

Figure 5.4 presents a typical cross-section demonstrating the representative components within a 65 m planning corridor, including habitat enhancements such as snags (dead trees to serve as perches for some bird species) and hibernacula for some snake species (excavated pits above the water table filled with large rocks and logs for snake overwintering). Given the intentions to integrate selective created terrestrial habitats and open water features fed with clean runoff supplemented (where feasible) with water from nearby rooftops or foundation drain collectors, and to integrate corridors with stormwater management facilities and the NHS watercourse corridors, some structural flexibility within the corridor footprint is desirable. Figure 5.5 presents an example where the overall buffer component (total 25 m in all cases) is allocated to provide space for creation of an off-line pool with wetland fringe, suitable for turtles and amphibians. This is shown as an example only and requires both the demonstration of feasibility and sustainability in urbanized conditions and endorsement by the Town and Conservation Halton as a site-specific treatment. The section also indicates how materials may be introduced to provide habitat enhancement (i.e. snags/tree perches, rocks as a basking location for reptiles).

The Boyne Survey Secondary Plan area contains a section of the Main Branch valley of Sixteen Mile Creek. As noted in Table 5.2.2, restoration of valley cover to the north of the existing ESA is recommended as an initiative to provide a major open space resource in the Town of Milton. This recommendation is supported by regional initiatives, and represents the most substantial restoration opportunity in Boyne Survey. The integration of specialized habitat to support target wildlife species, buffers generally 30 m in width (see Implementation Principles), and NHS-oriented land uses (SWM facilities and Village Squares), will reinforce a regionally and provincially significant resource system comprised by the Main Branch ESA and downstream ANSI. Careful integration of roads in the vicinity is required, including the potential new east-west crossing of the Main Branch, and upgrading of the Britannia Rd. crossing. There is a key opportunity to provide a terrestrial linkage across Reg. Rd. 25, to connect to Tributary SWS-2-A via woodlot key feature E (ref. Figs. 5.3, NHS-2 and Table 5.2.2) and an associated unregulated tributary (SWS-2-A-1).

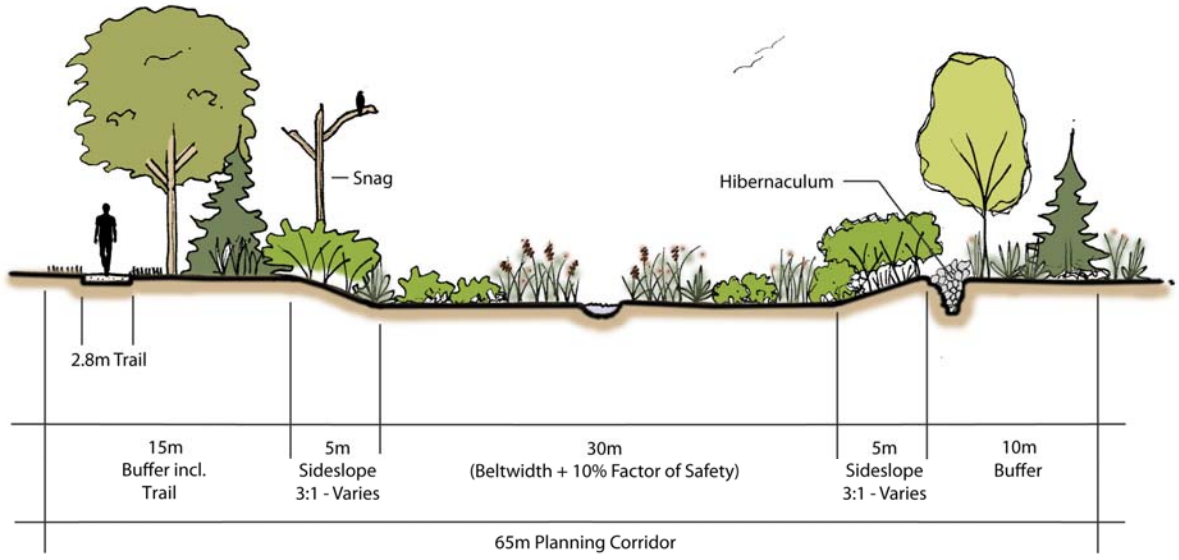

Figure 5.4: Typical Cross-Section of NHS Watercourse Corridor

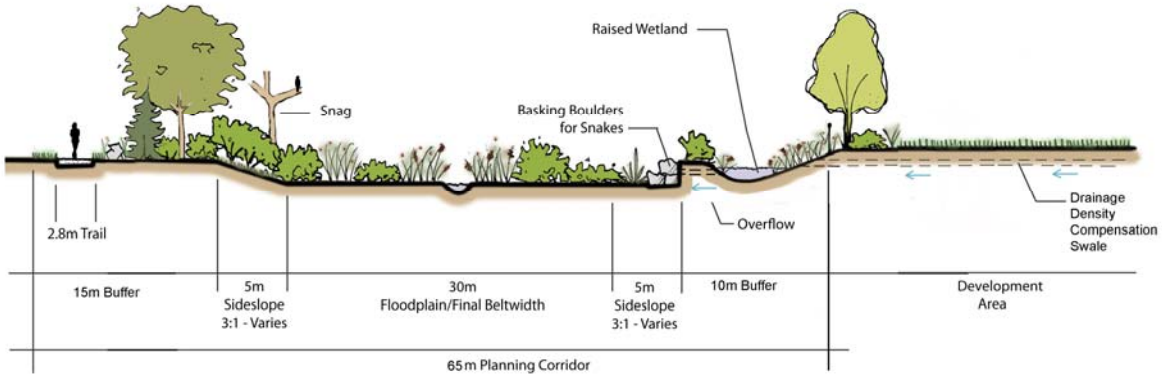

Figure 5.5: Cross-Section Example of NHS Watercourse Corridor with Off-line Wetland Pool

One of the intentions of the recommended NHS is to ensure that Boyne Survey NHS corridors provide for passage, foraging and residency by as many terrestrial species as possible. This necessitates that trails are placed carefully to minimize their impact on the functioning of the overall corridor, and that core habitats and supportive land uses will reinforce the corridor functions in key areas. Small berms and/or more intensive shrub plantings may be warranted to buffer more sensitive features (e.g. natural or created habitats) from trails. Wetland and upland terrestrial habitat elements are suggested to be placed along the corridors at regular intervals to enhance opportunities for seasonal use by species.

A key function of vegetation in urban riparian corridors is the maintenance of water quality through buffering and shading. Although this does not imply that these corridors should be completely forested, regular placement of tree and shrub plantings that will shade the watercourse, is considered essential.

Natural Heritage Features

All natural features and habitat complexes in Boyne that meet significant functional criteria (summarized in Table 5.2.2 and identified on Figure NHS-2 in Appendix 'F') have been protected within the recommended NHS. Table 5.2.2 summarizes the features and complexes, their documented functional significance, the individual feature goals with guiding policies/regulations, and targets/implementation details. Table 5.2.2 includes reference to core habitat complexes (Areas F and G) which are linked functionally to features immediately outside the Secondary Plan area. In particular, provincially and regionally significant features located within the Main Branch are relevant to the NHS planning and actions taken within Boyne.

Fragmented habitats in the vicinity of some significant habitat complexes and those connected to riparian corridors have been consolidated within the NHS; NHS supporting uses to be naturalized (stormwater management facilities, village squares) are identified where enhancement or creation of natural cover is recommended. The complexes have been defined to include diverse habitat elements, and to consolidate functions related to feature shape and area, such as potential forest interior habitat and integration of successional elements. The reinforcement of features will provide benefits to populations of key biota, augmented through provision of riparian-based habitat corridors, supplemented with existing NHS-supportive linkages, and additional new linkages through the built landscape. The merits of core expansion versus corridors were reviewed in Section 5.4 of the SUS. The Implementation Principles and Schedules in Appendix 'I' give general guidance on buffers and specific direction on key habitat complexes.

Objectives for specific restoration areas will be refined as part of SIS, to support the key strategies identified in Table 5.2.2 and the relevant sections of this FSEMS, supplemented with any new data and analysis from SIS studies. As discussed above, the inclusion of wetlands (where feasible and sustainable) within the identified restoration areas is considered a high priority in order to gain a broader range of wetland cover in the landscape.

Buffers

Buffers are to be established in accordance with Section C10.8.5.6 of the Secondary Plan. The features identified as Natural Heritage System on Figure NHS-2 include Significant Woodlands and locally significant wetlands, as well as successional and restoration areas. These areas include a 10 m buffer for tableland woodlots, and 15 m for locally significant wetlands.

Figure 5.6 illustrates the typical application of a minimum 10 m buffer adjacent to a woodland. The 10 m minimum buffer provides an adequate distance for structural integration of most natural features including root zones and immediate interactions with water tables on the fine-textured soils which characterize the study area. Integration of functional attributes requires a current understanding of functions including drainage sub-catchments and hydroperiod, individual species sensitivities, the detailed characteristics of future development in the immediate vicinity, and future connections to other features. Buffer planting and contouring should address critical functions including, maintaining surface runoff regimes, adequately protecting critical habitat of sensitive species, or avoiding trail impacts to core natural features.

Where wetlands are present, water budgets will be required to demonstrate that mitigation measures are adequate to maintain the water balance throughout the year, without unusual flooding, deprivation of surface inflows due to development activities, or requirements for infrastructure (e.g. catchbasins) within the feature. These considerations will be tempered with an understanding that some catchment areas will be modified by development and that the nature of the post-development urban landscape may affect the type and degree of wetland functionality present in existing features. Buffers will reflect the Implementation Principles (ref. Appendix 'I') and their design will be confirmed in consultation with the Town and Conservation Halton through site specific SIS level studies that address the design of the adjoining development areas, trails, significant species and functions relative to potential development impacts, and hydrological integration considerations.

Although the Secondary Plan study area is outside the Greenbelt, the Main Branch of Sixteen Mile Creek is included in the Greenbelt immediately south of Britannia Road. Figure T7 in Appendix 'F' consists of the Province's mapping of the legal boundary of the Protected Countryside in the vicinity of the Boyne Secondary Plan area. Based on the Implementation Principles (ref. Appendix 'I'), buffers along the valley portions of the Main Branch will be generally 30 m from the greater of existing physical top of bank or stable top of bank limit on both sides. Buffers along the upland woodlot portion of the ESA will be 10 m. The Main Branch south of Britannia Road contains resources of regional and candidate Provincial) significance (i.e. ESA and ANSI). The valleylands north of Britannia Rd., as defined by the Implementation Principles, have been addressed in a manner consistent with applicable current Regional and Provincial policies.

It is generally desirable that buffers not be reduced or combined with intensive infrastructure developments (such as stormwater management facility infrastructure; ref Figure 5.7) or intensive recreational uses (i.e. parks). Consideration of integrated buffers related to these adjoining uses has been given to SWM facilities adjacent to 16 Mile Creek. In these locations, consistent with the Implementation Principles recommendations, due to the size of the buffers, SWM facilities are allowed in the outer 15 m of the 30 m buffers. Also, where trails can be

accommodated in SWM facility design, 10m buffers are required to NHS Watercourse Corridors on the side that accommodates a trail.

Buffers should be vegetated at a minimum with early successional old field species; a 'banded' or tiered approach to creating effective edges is desirable to reflect natural edge composition. Appendix 'K' of this report includes the *Town of Milton Restoration Framework* which provides detailed guidance for buffer planting in Boyne.

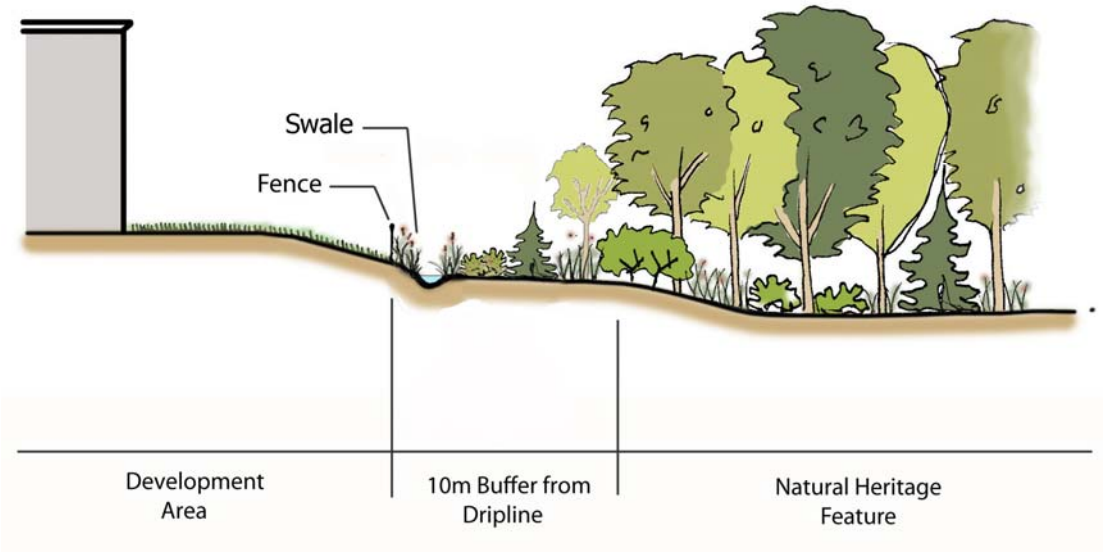

Figure 5.6 – Cross-Section Example of Buffer Adjacent to Natural Heritage Feature (Woodland)

Restoration Areas

Table 5.2.2 identifies recommended treatments and cover ranges in several key locations (i.e. Areas A, E & F, G and H); these are further defined in the Implementation Principles and Planting Guidelines. The intent in these areas is to reinforce existing functions such as forest interior and habitat connectivity, diversify vegetation community cover and successional stages, reduce edge to interior ratio, integrate wetland restoration, provide specialized cover for target species, and reinforce key functions (such as forest interior in the Main Branch). Table 5.2.2 identifies suggested cover ranges and target wildlife species for the overall features. Wetland restoration is recommended as a particular focus where opportunities exist. New wetlands that provide seasonal pools, marsh and swamp adjacent to upland habitats will improve the capacity of the NHS to support sensitive biota such as amphibians and reptiles. Therefore seasonal pools should be located adjacent to summer foraging and overwintering habitat wherever feasible. Appendix 'K' of this report includes the *Town of Milton Restoration Framework* which provides guidance for wetland pool habitat design.

Native plant materials indigenous to the Sixteen Mile Creek watershed should be utilized in restoration plantings, and to provide benefits such as wetland cover. Restoration of agricultural lands and cultural communities to reduce edge effect and to create a more continuous, resilient and functional NHS.

NHS Linkages

Opportunities exist to provide more integrated habitat complexes and linkages in conjunction with the stream corridors and main valley. In particular (ref. NHS key map, Figure 5.3.):

- Area A, where the existing wetland and upland complex can be reinforced with a terrestrial linkage added to connect to regulated watercourse I-NE-2A-3 to the south (ref. Appendix 'I' - Implementation Principles);
- Areas C&D which are recommended to be removed (subject to OMNRF approval), and compensated through wetland creation in the terrestrial linkage south of Area A (ref. Appendix 'I' - Implementation Principles)
- Unregulated watercourse I-NE-1B-2 to be moved to east side and parallel to the rail corridor (ref. Appendix 'I' - Implementation Principles); this feature provides a minor linkage to the SWM facility located north of Louis St. Laurent Blvd.
- Area E where the unregulated portion of watercourse SWS-2-A-1 will form a linkage (watercourse without buffers) connecting a habitat complex comprising a significant woodland and an adjoining hedgerow extending eastward to the protected main valley of Sixteen Mile Creek; the linkage will include culvert access under Regional Road 25, with the linkage continuing westward into the watercourse SWS-2-A corridor (ref. Appendix 'I' – Implementation Principles);
- Area G where a relocated and enhanced riparian corridor, a heritage hedgerow, and existing woodlot can be integrated with buffers, SWM facility, and Village Square placement (ref. Appendix 'I' - Implementation Principles);
- Area H where the existing significant woodland, including a wetland (swamp), can be better linked with upstream and downstream riparian corridor enhancements.

Linkages will provide habitat structure, cover and special features (such as boulder piles and hibernacula) to provide dedicated habitat cover (wetland, meadow, woodland, thicket, hedgerow depending on location) and will also support passage of birds and smaller vertebrates. Linkages will integrate buffers in accordance with Secondary Plan policies, and Implementation Principles.

Enhanced Wildlife Crossings

Standards for road crossings of wildlife corridors are becoming more advanced. In urban and agricultural settings, riparian-based crossings are the most effective from the standpoint of attracting wildlife movements, and managing the crossing from the standpoint of geometrics and cost. There is now a significant body of international research on the design or crossings, and monitoring results (ref. Forman et. al., 2003, ICOET 2001-2013). Key design considerations relate to the need to separate sensitive wildlife from human trail systems, targeting of appropriate (i.e., small mammal, amphibian and reptile species) wildlife species for safe passage, and design considerations to encourage use of passages by target species to avoid their exposure to the busy road network.

Figure NHS-2 identifies Enhanced Wildlife Crossing locations where existing and proposed roads will cross the NHS. These crossings are intended to be designed using current road

ecology science, and equipped to provide safe passage. The new road locations are conceptual and subject to confirmation through the SIS process and related infrastructure planning and design work.

Road crossing design for corridors encompasses aquatic biology, stream morphology, hydrology and hydraulics, plus terrestrial connectivity. The riparian channels specified in Boyne will consist of naturalized corridors. Culverts or small bridge spans may be required based on floodplain characteristics, to be determined in FSEMS and CFCP standards and through detailed design. Finalized road widths and profiles will affect the opportunities for enhanced wildlife passage in each crossing location. The SIS must address all of these subjects and recommend typical crossing profiles in each location based on preliminary design level of detail.

The detailed design of road crossings will need to accommodate approximately 3x the proposed bankfull channel width, as well as satisfying hydraulic criteria for freeboard and depth of overtopping during the Regional Storm event, and considering wildlife passage for small mammals (larger mammals in the Sixteen Mile Creek Valley), amphibians and reptiles. Considerations in crossing design will include provision of fluvial geomorphology through the crossing, benches to permit wildlife movement under low flow to bank-full conditions, planting, and fencing, wing-walls or curbs to direct wildlife movements (amphibians, reptiles, waterfowl, small mammals, potentially deer). Trail crossings may need to be integrated in some locations.

Accommodation of white-tailed deer in crossing structures is not feasible in most of Boyne Survey due to the relatively undefined character of watercourse features through the landscape. The Main Branch valley provides more opportunities in this regard. Deer will use crossing structures 1.5 – 2 m in height particularly if broad, well-defined corridors are employed with directional fencing or features, and adequate terrestrial benches under structures. Structures ranging from 2-4 m wide culverts up to free spans will accommodate deer if headspace is adequate. Smaller wildlife can be fully accommodated at all the crossings identified on Figure NHS-2, if terrestrial benches are provided and protective cover afforded with plantings and strategically placed rock and gravel. Terrestrial benches should permit animal passage under a range of flow conditions, typically from low flow to bank-full. Road signage to warn of the potential presence of wildlife (particularly deer and turtles) at crossings of corridors or linkages is recommended.

Where terrestrial linkages cross larger roads, the design considerations will depend on the intended functions included in a particular linkage. For crossings of multi-lane roads, integration of non-corridor surface drainage crossings with the linkage would enable consideration of dry culverts sized to allow passage of smaller vertebrates, in conjunction with low headwalls or directional fencing. Two-lane roads that receive lower traffic loads warrant culverts where swales or ditches are intercepted. Plantings associated with linkages should be identifiable at the limit of streetscape, providing tree and shrub cover consistent with the balance of the linkage. The SIS will need to address these aspects of the linkage crossings at a preliminary design level of detail.

5.2.2 Features and Supporting Uses Located Outside the Recommended NHS

Isolated Specialized Habitats

Isolated specialized habitats, as identified on Figure NHS-2, are locations where breeding amphibians (including species of conservation concern) were documented in 2008 field studies, which are located outside of key natural features. They are typically dug ponds or small remnant wetlands in the agricultural landscape. They have been identified on Figure NHS-2 to ensure that they are revisited and further documented at the SIS stage and form part of a strategy to rescue sensitive wildlife from the landscape into appropriate habitats within the NHS. It is possible that other such small features are present, and these should be identified through further fieldwork in support of the SIS. The rescue of wildlife for transfer to other habitat areas requires a permit from MNRF.

Plant material in the form of soil seed banks may also be salvaged from these areas where they are of sufficient quantity and quality, and transferred immediately to pre-graded new habitats (including floodplains and created wetland features). This can be accomplished through seed bank salvage and application in the late summer to fall season. The presence of aggressive invasive species may disqualify the use of a seedbank. Appendix 'K' of this report includes a *Town of Milton Restoration Framework* which provides guidance on soil seedbank utilization.

"NHS-Supporting" and other NHS Oriented Areas

Stormwater Management Facility Blocks

Stormwater management facilities are by their nature important features to be considered as adjunct to the NHS because i) they are fundamental linkages between landscape hydrological functions, receiving watercourses, and their corridors; ii) they will occupy a significant area of the built landscape (often 5% or more); and iii) it has been well documented that they are functionally important to, and regularly utilized as habitats by upland, wetland and aquatic biota.

According to their performance objectives, facilities are viewed as posing a potential risk of exposing biota to contaminants. Urban facilities are currently designed to be regularly monitored and managed in the built landscape, and assuming that due diligence is respected in this maintenance, these facilities are intended to provide net functional benefits to the ecosystem. Standards for construction, management and monitoring are regularly reviewed by the Ministry of Environment; progressively smaller and more numerous facilities are being designed, which makes risk detection more transparent, and which has resulted in demonstrated benefits in Milton i.e. the restoration of baseflow in formerly intermittent watercourses located in Phase 1 (Bristol). New initiatives such as Low Impact Development are bringing stormwater management practices into the built fabric, thereby providing green infrastructure opportunities within employment uses. Efforts to better integrate these systems are considered to form a useful adjunct to the recommended NHS, especially as applied on the NHS-Oriented Areas identified in Figure NHS-2.

While stormwater management facilities are generally not included within the recommended NHS, or in terms of 'net gain', they represent nodal opportunities to expand naturalized cover,

buffering, and connectivity in key locations along NHS corridors. SWM facility blocks may encompass over 1 ha in area, and may be shaped and positioned to provide separation of intensive development from corridors or natural features.

Wherever feasible, stormwater management blocks should be massed adjacent to corridors and habitat complexes identified as part of the NHS in in the Secondary Plan, and adjacent to linkages, the utility corridors to provide buffering and habitat opportunities. Facilities may reinforce linkages by integrating Other Wooded Features (ref. Fig. NHS-2) such as hedgerows. It is also desirable to integrate compensation swales within facility footprints to help achieve the drainage density targets. Alignment with suitable development may enable provision of clean runoff from landscaped areas or rooftops on development sites, or supplementary water from foundation drain collectors. The benefits of these elements as linkages, localized wetland pool creation opportunities that contribute to the overall wetland target, and associated plantings, should be given careful consideration in the placement and design of the facility footprints.

The *Conservation Halton Landscaping and Tree Preservation Guidelines* should be used for guidance in the planting of stormwater facilities. Native plant materials indigenous to the Sixteen Mile Creek watershed should be utilized in landscaping of facilities, and to provide benefits such as wetland cover and shading of facility pools. The only caveat to this directive would relate to the availability of stock from the watershed. If certain, desired plant materials are unavailable from nursery facilities in the watershed, stock should be supplied from sources nearby within the same eco-region.

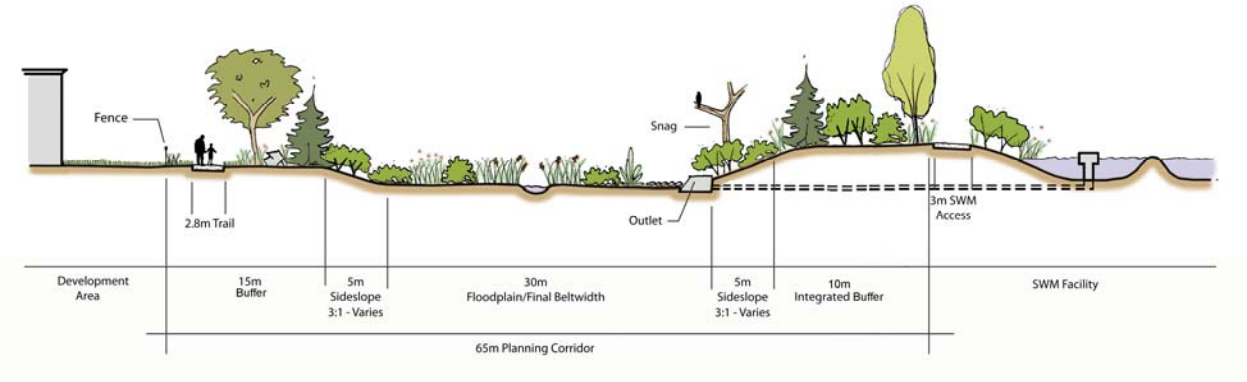

Figure 5.7: Cross-Section Example of NHS Watercourse Corridor Adjacent to Stormwater Facility

Other NHS Oriented Uses

Figure NHS-2 identifies several areas as “Natural Heritage System Oriented Areas” that support NHS functions. NHS-Supporting areas (i.e. NHS Oriented areas) may include stormwater management facilities designed to complement the corridor functions, and village squares/naturalized parks that integrate drainage swales and naturalized elements to promote landscape connectivity immediately adjacent to the corridor. In addition to buffers located on public lands, residential development integrating deeper rear lot setbacks, and enhanced landscape treatments may be considered but in general does not provide equivalent protection of corridor functions.

Evaluation and integration of existing woody cover such as hedgerows and successional edges should be considered. The approaches to lighting (internal and external) should be designed to minimize interference with the natural habitat cover in the vicinity. Extensive opportunities exist to increase functionality for wildlife and native plant species.

Existing NHS Supporting Uses

Due to the primarily agricultural character of the existing landscape, a number of open-country dwelling/area-sensitive breeding bird species will be displaced as the Boyne Survey study area develops. For the most part this loss is unavoidable as the habitats are in hayfields or grazed fields in a variety of conditions conducive as habitat for these species. The Sixteen Mile Creek valley north of the existing ESA, and portions of the ESA itself, are either cultivated or in early stages of succession. With integrated planning in the context of the NHS, these areas offer opportunities to retain open country habitat suitable for some bird species.

The CN rail corridor represents a long term land use that intersects with drainage, and as a result there are several natural features that have developed along its extent, including wetlands, cultural meadow, and upland thickets. There is an opportunity to relocate the adjoining watercourse (NE-1-B-1&2) to parallel the tracks and to provide buffering from adjoining land uses, while benefiting efficient land use. This is addressed in the Implementation Principles and Schedules (ref. Appendix 'I'). The rail corridor intersects with other features, linkages and riparian systems to the north and south of Boyne. Rail corridors provide linkages in many landscapes, due to the presence of associated drainage features, fence line cover, topography, and well-drained banks. Rail traffic is generally less disruptive to wildlife than is urban road traffic.

There is an existing Union Gas pipeline easement located just east of the Main Branch. Portions will likely be integrated to provide a trail connection through the ESA. There is an existing easement north of Louis St. Laurent Blvd., which already contains a walkway.

Other Wooded Features

Figure NHS-2 includes two natural feature complexes within the NHS where hedgerows will be specifically integrated; these are located within features E and G (ref. Fig. 5.3)

Other Wooded Features are present (ref. Fig. T2 in Appendix 'F'), which consist of hedgerows, cultural woodlands, cultural savannah, and small plantations. It is anticipated that extensive grading requirements on the Boyne lands will not allow the integration of existing tree cover outside the NHS within future developments. It is, however, anticipated that the treatment of such wooded features will be discussed in tree preservation reports submitted in support of individual development applications. Details on grading allowances and woody feature integration opportunities (i.e. with stormwater management facilities, or other opportunities) will be provided in the SIS.

5.2.3 Habitat Restoration Targets and Planting Standards

Wetland Creation and Restoration

Environment Canada (2004; updated 2013) identified desirable conditions for wetland cover and configuration in watersheds and subwatersheds located in the vicinity of the Great Lakes Areas of Concern: These cover targets (2004) are generic in nature and need to be considered within the context of a landscape's physiography and land use.

Wetland Habitat:

- *10% of a watershed, and 6% of any sub-watershed should be comprised of wetlands*
- *The Critical Function Zone and Protection Zone of a wetland should be naturally vegetated*
- *Rehabilitation activities should focus on swamp and marsh wetland types*
- *Wetland rehabilitation should be strategically located in a watershed*
- *Swamps and marshes should be of a sufficient size to support habitat heterogeneity and there should be a variety of wetlands across a landscape*
- *Swamps should be regularly shaped with minimum edge and maximum interior habitat*

Wetlands are defined under the Ontario Wetland Evaluation System (1993) as:

> *"Lands that are seasonally or permanently flooded by shallow water as well as lands where the water table is close to the surface; in either case the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic or water tolerant plants."*

Created wetlands and seasonal pools in Boyne should be strategically integrated on-line within the riparian floodplains of enhanced NHS corridors, and off-line within the regulatory setbacks and some adjoining habitat nodes where restoration is recommended. The precise number of these wetlands will depend upon more detailed consideration and the examination of hydrologic conditions in the post development landscape and the optimal siting of such features given proposed adjacent land uses. General and flexible guidance is included in the following.

Given the proposed road network, at least 30 on-line, and 20 off-line wetlands containing pools should be created based on a minimum of one on-line and one off-line wetland/pool complex between road crossings, and spacing of diverse wetlands at 250 to 300 m intervals along NHS corridors. This guidance would address the needs of most amphibians within the Boyne study area. Larger seasonal wetland/pool complexes could be considered in restoration areas associated with the concentration of existing habitats to better meet the full range of seasonal requirements of target biota. Created wetland pools should range in size from approximately 0.005 ha to 0.1 ha and establish variable depths and substrates in order to support a wide range of amphibians, turtles and waterfowl. They can be created singly or more preferably in a cluster where area and suitable conditions permit.

The existing wetland cover in Boyne is estimated at 1.2% of the land area. Based on the proposed NHS areas outside of the Main Branch, floodplain wetlands in naturalized post-development riparian corridors could contribute up to 4.3% in overall wetland cover. The

creation of additional off-line wetlands within NHS corridors and within restoration areas could increase the wetland cover further, depending upon more detailed review and consideration. This represents a substantial increase over existing landscape cover. Additional opportunities for created wetlands may exist within other portions of the NHS. These approaches to wetland creation should be reviewed at the SIS stage in appropriate locations within the agreed upon limits of the NHS as per the Implementation Principles.

On-line wetlands with seasonal pools usually consist of overflow pools and secondary channel areas that are recharged whenever bankfull events are exceeded. Pool depths ranging from 15 to 50 cm are recommended depending on available space, to ensure a mosaic of wetland cover from meadow marsh to critical zone pockets of open water with potential to sustain turtles as well as amphibians. The wetland design must be integrated with natural channel design to achieve the habitat coverage and range of wetland types. Wetlands should be located to avoid scouring by major flows. Diversification of structure can be provided with irregular feature edges, boulders, root wads, and snags.

The water levels in off-line wetland pools should be specifically designed to be sustained on a seasonal to permanent basis with clean surface runoff from swales located in the corridor and adjoining naturalized lands, supplemented with clean runoff from roof drains and foundation drain collectors where this is feasible. Target design species for wetlands and pools should be identified based on the available space and hydrologic opportunities at a given site; Table 5.2.2 identifies species targets related to NHS features and their proximity. Pools for amphibian breeding must maintain water for a sufficient hydroperiod for the development of juvenile stages that are dependent on standing water, typically from early April until mid-June. Pools with standing water depths ranging from 10 to 130 cm deep will sustain a range of frog and turtle species. Deeper pools that retain water throughout the year will likely become populated with minnows and other fish which will predate amphibian eggs and tadpoles, however the provision of shallows, boulder structures and logs will reduce predation levels while providing basking areas. Turtles (i.e. Midland Painted Turtle and Snapping Turtle) will be attracted to deeper permanent pools with adequate basking opportunities and nearby nesting sites. For this reason the range of pool sizes provided, and their structural diversity, is important.

Varying topography along the bottoms of the pools will provide an assortment of depths for the needs of different amphibian species that will be using the habitat. Placement of submerged and emergent boulders and logs will provide basking sites, and refuges from predators. Appendix ‘K’ of this report includes a *Town of Milton Restoration Framework: Stream Corridors and Natural Area Buffers for the Boyne and Derry Green Sub-watersheds of Sixteen Mile and Indian Creeks* which provides guidance on wetland creation, and the Conservation Halton Landscaping and Tree Preservation Guidelines (2010) also provide guidance on hydrologic/moisture zones in created wetlands. Locating the seasonal pools close to existing natural features, such as woodlands and meadows will provide additional connectivity for species that require these habitats as part of their lifecycle. The quality and extent of the habitats in the vicinity (i.e. within 50-500 m) of amphibian breeding pools is key to sustaining more sensitive species. Wherever feasible, seasonal pools should be located adjacent to summer foraging and overwintering habitat such as woodlands and shrubby areas. Trails and active recreational uses should be separated from pool habitats using dense plantings small berms etc.

Other Habitat Creation and Restoration

Table 5.2.2 summarizes general percentage ranges for targeted forest, meadow, thicket and wetland cover, and wildlife indicator species targets. These will serve as guidelines and the SIS will need to present the rationale for the final recommended cover as well as significant wildlife species targets. The design team should utilize these targets in conjunction with any new data on the features obtained during the biological surveys that will be required in support of the SIS.

Sixteen Mile Creek ESA Extension and Enhancement

The ravine systems of the Main and East Branches of Sixteen Mile Creek extend from the Town of Milton to Lake Ontario. Portions of these features were designated as Environmentally Sensitive Area No. 16 by the Region of Halton in 1979. Subsequent studies have reconfirmed that the ESA supports a wide range of habitats and species that are significant at local, regional, provincial and national levels. The 2006 Natural Area Inventory update recommended expansion of the ESA to include other valley and tableland areas. The ESA south of Britannia Road contains a Regional and Candidate Provincial Area of Natural and Scientific Interest, and is protected as part of the Greenbelt.

The portion of the Main Branch north of Britannia Road was included in lands designated as urban as part of the Halton Urban Structure Plan (1996), however it also sustains regionally and provincially significant natural resources. In the north half of Boyne and northward, the Main Branch valley has been impacted by agricultural uses, the Regional Road 25 crossing, channel confinement, and urban impacts. The 2006 update to the Region of Halton's Natural Area Inventory recommended that the valley section between the existing northern limit of the ESA, and Derry Road, be considered for extension of the ESA, and Sustainable Halton maps a strengthened corridor north of Britannia Rd. The existing ESA corridor in Boyne ranges in width from an average of 250 m to more than 600 m; north of the ESA the valley ranges in width from approximately 130 to 250 m (based on air photo measurements). From a functional perspective, regional corridors of at least 300 m in width are considered desirable in areas subject to Sustainable Halton.

The existing ESA area north of Britannia Rd. consists of valley and tableland features which are dominated by deciduous forest, interfaced with cultural meadows and thickets, localized floodplain wetlands, and some active agricultural uses. As discussed in the SUS report (July 2010), the Main Branch natural features meet criteria for significance under the Provincial Policy Statement and Region of Halton policies, including significant woodlands, valleylands, wetlands, fish habitat, and significant wildlife habitat. The ESA contains the only forest interior habitat in Boyne, defined as forested habitat located more than 100 m from an edge. Significant species (local, regional, provincial) are on record and new records were identified in the SUS study and as part of other monitoring.

Given its status as hazard land excluded from potential urban development, and in the context of the high degree of fragmentation of the remaining lands in Boyne, the Main Branch corridor represents the best opportunity to protect and enhance core natural habitat in Boyne. Historically, agricultural activities have encroached to the rim of the valley, and into the valley where rich floodplain soils are available.

Functionally, a major incised valley feature represents varied topography, drainage conditions, aspects and microclimates. Tableland cover effectively complements the range of ecological benefits of the valley and regional corridor, offering well-linked habitat that is better drained, and protecting the valley from microclimate extremes and runoff impacts. Strategically, reinforcement of core areas through consolidation of upland, ravine and riparian habitat (i.e. restoration of diversified forest, successional and wetland cover, enhanced buffering, reduction of habitat edge to interior ratio, strengthening of cover and secondary linkages) has been demonstrated to offer greater gains in function, especially when landscape conditions are scheduled to change, as in urbanization.

The expanded valley/ESA corridor is represented in Figure NHS-2, based on the Implementation Principles. Table 5.2.2 proposes cover and species targets. Key initiatives recommended in the vicinity of the existing ESA include conversion of adjoining farm fields in the valley and in proposed buffers, to forest and successional cover to significantly reduce the ratio of edge to interior habitat in the valley This will expand the extent of forest interior functions. Other opportunities exist to restore floodplain wetlands and successional cover, with the intent to eventually reinforce the extent of diverse forested cover.

The recommended NHS includes integration of NHS-supporting areas (i.e. NHS Oriented areas), which may include stormwater management facilities (designed to complement the corridor functions), and village squares/parks with naturalized cover to promote landscape connectivity of the lands immediately adjacent to the corridor.

The recommended NHS includes a buffer generally of 30 m between new developments and the stable top of bank along the valley. The Secondary Plan Policies and the Implementation Principles provide further detail regarding buffers to the 16 Mile Creek valley. This enhanced buffer standard reflects the functional connection with the Greenbelt, the important PPS designated natural heritage features that are present within the Boyne portion, and the opportunity to enhance and reinforce the corridor northward as part of major open space within proposed development.

Between the north ESA limit and the Louis St. Laurent Blvd. crossing, the existing valley contains cultivated fields, cultural meadow and woodlands, and a farmyard. The floodplain is largely open, and the creek channel is exposed with incised banks and a crossing structure. There are obvious opportunities to enhance water quality and temperature, and improve the availability of food and organic structural elements along the watercourse. The NHS intent is to expand forest cover on the valley slopes, restore floodplain areas as wetland, and to provide an upland fringe within the buffer, to yield an average corridor width of 250 m north of the ESA.

The Main Branch valleyland area was considered to be Significant Wildlife Habitat (SWH) for this study as it meets key criteria in the OMNR SWH Guidelines (2000). It is recommended that the Town of Milton work with landowners, Conservation Halton and the Region of Halton to develop a collaborative restoration and stewardship plan for the area. Table 5.2.2 summarizes general suggested target cover and avifauna. With restoration and active stewardship of open areas, a number of additional significant species may also be attracted to this expansive area. This could include American Kestrel, Eastern Bluebird, Vesper Sparrow, Grasshopper Sparrow,

and Bobolink. There are many opportunities within the ESA and restoration areas to incorporate trails and habitat enhancement features such as snags, compensation swales, and hibernacula.

A significant woodland located just west of the ESA, is within the headwater of a short tributary (SWS-2-A-1) which crosses Regional Road 25 to connect with tributary SWS-2-A (unregulated) to the immediate west. This represents an opportunity to enhance wildlife movement (e.g. grading, fencing, planting) at the Regional Road 25 interface with the reconstructed unregulated tributary to direct wildlife under Regional Road 25.

Existing road crossings of the Main Branch in the vicinity of the Boyne Survey lands include the Britannia Rd. crossing, and the recently constructed Louis St. Laurent Blvd. (LSL) crossing. The Britannia Road crossing consists of a bridge span, however the existing crossing lacks adequate terrestrial benches to accommodate movements of wildlife. When this road is widened, supplementary culverts could be added for terrestrial wildlife. The LSL crossing consists of an open span that was designed to permit adequate floodplain access for wildlife movements, including root wad piles that provide effective cover for smaller wildlife.

The Boyne Secondary Plan indicates a potential road crossing of the Main Branch just north of the existing ESA limit. This is undergoing an Environmental Assessment to examine need and justification, potential crossings, and alternatives to address traffic needs. The EA will address the objectives of enhanced natural cover functions in the valley corridor, and approaches to maintain or improve wildlife habitat utilization.

The proposed Implementation Principles and Schedules for Boyne (ref. Appendix 'I') contain specific principles for the Main Branch Valley, to be designed and implemented as part of SIS studies for adjoining lands. In order to guide this design, a Boyne Survey Lands Sixteen Mile Creek Valley Ecological Restoration Master Plan will be completed as part of the adjacent SIS. The Design Goal, Objectives and Principles are included in Appendix 'I' of this FSEMS.

Restoration Framework: Stream Corridors and Natural Area Buffers for the Boyne and Derry Green Sub-watersheds of Sixteen Mile and Indian Creeks

The *Town of Milton Restoration Framework: Stream Corridors and Natural Area Buffers for the Boyne and Derry Green Sub-watersheds of Sixteen Mile and Indian Creeks* document (ref. Appendix 'K') was prepared to support new development of lands within the Boyne Secondary Plan (including the portions extending into the Indian Creek headwaters), and within the Derry Green Secondary Plan. The Framework addresses implementation of the respective Natural Heritage Systems recommended in the *Sixteen Mile Creek Subwatershed Update Study* (SUS: AMEC et. al 2015), and the *Functional Stormwater Environmental Management Strategies* (FSEMS: AMEC et al. 2015) for individual Secondary Plan areas. The need for a subwatershed specific restoration approach was identified in consultations with the Town, landowners and Conservation Halton during the SUS process, which culminated in the approved Secondary Plans (Boyne and Derry Green). The SUS Natural Heritage System (NHS) study process identified stream corridors with enhanced buffers, an approach supported by Conservation Halton and the Town's SUS Study Team, and ultimately agreed to by landowners, subject (where contained in the specific FSEMS) to Implementation Principles. The final *Restoration Framework* was approved by the Conservation Halton Board of Directors in September 2015.

The Restoration Framework was developed in keeping with the intention of the *Conservation Halton Landscaping and Tree Preservation Guidelines* (CHLTPG 2010), which apply to areas regulated under Ontario Regulation 162/06. These guidelines are intended for use by landscape architects and other practitioners preparing landscaping plans, restoration plans and tree preservation plans. In particular, the CHLTPG states (p. 8):

"*Appropriate planting densities for natural areas should be established through the policies and guidance included in the Subwatershed Studies and Secondary Plans …In the absence of specified planting densities in a Subwatershed Study or Secondary Plan, endorsed by Conservation Halton, the densities outlined in this guideline will be used.*"

This Restoration Framework is endorsed by Conservation Halton and specifically references key concepts and resources in the CHLTPG, including standards for native species selection, ground covers, erosion control, adapting to moisture conditions, invasive species control, and soil treatments. It also integrates knowledge from Town staff and landowner experience in Milton, and fits into the Town's Monitoring and Adaptive Management Program for new development areas. Any plantings or restoration projects within the Boyne Survey Area should adhere to the Restoration Framework. Approval from Conservation Halton under Ontario Regulation 162/06 must be obtained for restoration projects within regulated areas prior to work being carried out.

The Restoration Framework is intended to address the following NHS features and areas:

- Stream corridors along existing tributaries to remain, or to be relocated;
- Buffers adjacent to key NHS features comprising part of the NHS (e.g. existing woodlands, wetlands and hedgerows specified in the NHS); and
- Habitat creation and enhancement areas identified in the FSEMS and Implementation Principles/Schedules (where applicable).

The Restoration Framework supports the FSEMS vision, to implement the recommended NHS with robust habitat corridors, buffers around key natural features, and site-specific restoration in NHS features. Restoration principles, vegetation community targets and planting node densities and materials provide direction to concept plans to be prepared as part of Subwatershed Impact Studies (SIS), and to final Landscaping Plans to be implemented under the terms of Subdivision Agreements. Plans prepared under this Framework are subject to review by the Town and Conservation Halton, with results to be confirmed through the Subdivision Agreement and Milton's monitoring program.

The Restoration Framework does not apply to landscaping of stormwater management facilities; the CHLTPG will continue to apply to those facilities.

Cover Targets

Conservation Halton has requested that the FSEMS provide direction on the identification of general targets for forest and successional cover in the recommended NHS. The targets have

implications for initial planting, and ongoing management over many decades, and therefore the availability of Town resources for future management need to be taken into account.

As a general rule, it should be recognized that southern Ontario's climate and soils are conducive to the eventual establishment of forest cover, except on sites where soil conditions, ecosystem dynamics and microclimate prevent this process (e.g. sand dunes, rocky barrens, prairie). The transition from open soil, to a closed woody canopy, normally occurs over a period of 15-30 years after disturbance by cultivation is terminated. Heavy seed rain from nearby wooded areas, or the presence of woody species that spread aggressively by vegetative means (aspen, sumac etc.) may shorten the transition period significantly. The quality of eventual forest cover is dependent on the species prevalent as seed rain, and the quality of soils (i.e. with intact versus highly altered soil structure and drainage).

The long term maintenance of meadow cover requires either active agricultural practices (grazing or crops), mowing at least every other year to suppress woody species growth, or cultivation (disking) every 3-5 years, which triggers a higher diversity of plant species regeneration than mowing. As part of a strategy for establishment of an urban natural heritage system, areas and corridors where active farming or other vegetation management will continue are key to ensuring that a blend of successional cover types of adequate size and linkage are retained in the landscape over time. Where farming practices are not possible (as within residential areas) periodic management interventions will eventually be required to maintain a pre-determined amount of open country within the urban NHS. Monitoring is required to identify the timing and extent of the management activities, but the techniques described here will ensure that quality habitats are maintained for the long term.

The recommended NHS has identified key areas where some open meadow and country can be introduced through restoration, or maintained due to existing land uses i.e. rail corridor, upper Main Branch valleylands. It is assumed that the Town will eventually manage the Main Branch open space, and a management strategy should be included in the Master Plan developed that reinforces value to target wildlife species (ref. Table 5.2.2) using methods such as mowing and periodic cultivation. The rail corridor undergoes periodic management to prevent the interference of woody growth with rail operations. There is a good opportunity to develop a progressive management plan for the linked natural features adjacent to the corridor, to promote their use by targeted wildlife species.

Table 5.2.2 identifies general cover target ranges for the identified NHS features; the detailed design of these areas should include prescriptions for management based on the finalized target biota and cover for each area. The eventual forest cover within NHS corridors and larger linkages should be in the 60-75% range to achieve a variety of environmental benefits. Reforestation of nodes will trigger woody succession toward the end target. Open country cover should be massed in areas where meadow species are targeted, but wooded perimeters for these areas are desirable for structure and buffering.

The strategies for corridor vegetation planting should include:

- Shading of the watercourse by regular planting of trees and shrubs, especially on the west and south sides of the floodplain; establishment of fast-growing, colonizing species such as native poplars, sumac, dogwoods and willows will be most effective
- Seeding with a blend of native riparian, wetland and upland species
- Species that provide significant food sources for wildlife (mast, berries etc.) should be included in all plantings
- Application of salvaged riparian/wetland soil seed banks to new floodplains; this requires pre-identification of donor and recipient sites, and careful phasing
- Large scale planting of woody material by direct seeding or reforestation techniques
- Focal area plantings in areas where more intensive screening, aesthetic and buffer cover is considered an immediate priority
- Provision for monitoring, and management at regular intervals to adjust for identified problems (such as invasive species)

Appendix 'K' of this report includes the *Town of Milton Restoration Framework: Stream Corridors and Natural Area Buffers for the Boyne and Derry Green Sub-watersheds of Sixteen Mile and Indian Creeks* which presents typical NHS corridor and buffer layout, habitat enhancement details, and planting node specifications to achieve these strategies.

Invasive Species

Invasive plant species have become a serious concern to ecologists since the 1980's. The SUS documentation has identified a number of invasive species of concern. The following are key examples:

- Garlic mustard (*Alliaria petiolata*) invades wooded areas and is present in most of the woodlots in the Town of Milton. Its spread is exacerbated by the movement of topsoil, and human activities that disturb the soil profile. It is extremely difficult to eradicate (5+ years successive treatment with herbicide) and will ultimately require a more focused strategy, such as biological control.
- Common Reed Grass (*Phragmites australis*) is a salt tolerant species that has invaded our region along drainage courses and highways. It forms dense monocultures in wetlands and their periphery, reducing habitat structure and diversity for wildlife cover. Its robust root segments are readily moved when soils are disturbed, and it is also extremely difficult to eradicate.
- Reed Canary Grass (*Phalaris arundinacea*) is a nitrophilic (nitrogen-demanding) species which has spread along floodplains and other areas of imperfect to poor soil drainage. It spreads in response to nutrient concentration and sedimentation, and tends to replace diverse wetland or riparian cover with a dense monoculture.
- Giant Hogweed *(Heracleum mantegazzianum)* is a noxious species which has appeared in the Sixteen Mile Creek Watershed over the past decade. It typically forms patches in floodplain areas and is likely spreading from upstream sources as its seed are water-borne. The plant parts elicit extreme skin reactions in humans, which makes its removal

a high priority. It was detected upstream of Boyne in the Main Branch of Sixteen Mile Creek in 2007.

There are many other invasive species in Halton Region, often spreading from plantings or through movement of soils; Havinga et. al. (2000) provides a comprehensive summary, and rating of each species in terms of the threats they pose to natural areas in southern Ontario. With respect to the planning purposes of the FSEMS, the presence of invasive species, their status within individual features, and potential management strategies, should be assessed as part of site specific studies in support of the SIS. The information on these species and their management is changing rapidly through research, and therefore the most contemporary solutions should be brought forward at the time that designs and management plans are being prepared.

Species at Risk and Significant Wildlife Habitat

The recommended NHS has considered the reported or otherwise documented Species at Risk and provincially rare species in the Secondary Plan study areas, as well as locally to regionally significant wildlife species. The SUS also identified Significant Wildlife Habitats and other features which support some of these species, and which could be further enhanced and managed to ensure that these species remain in the local to regional landscape. See Section 3.7 for a discussion of the level of detail of current Significant Wildlife Habitat delineations; refinement of this level of detail within the NHS limits is required as part of the SIS as dedicated surveys of certain wildlife habitat (such as snake hibernacula) were not undertaken for the SUS, and the potential for additional species of conservation concern to be present is considered likely. While this additional information may influence the design and management elements of the NHS, it is not anticipated to affect the limits (i.e. spatial extent) of the NHS beyond what would be established in accordance with the planning principles advanced in previous sections (i.e. beltwidth, side slopes and grading, buffers, riparian storage). This does not include any supplemental requirements associated with Threatened and Endangered Species. Table F2 in Appendix 'F' provides details on particular Species at Risk (SAR) and rare species, which should be a focus during SIS studies, to provide further information on their occurrence and status. The NHS includes features and connections to more extensive undeveloped landscapes that can sustain some of these species. Table 5.2.2 includes some targeted SAR and rarer species which could be encouraged within the NHS. The guidance in the FSEMS, focused field studies during the SIS preparation, and design considerations through the SIS and individual site plans for development, must consider these species, and their specific needs.

Bobolink, Barn Swallow, and Eastern Meadowlark are migratory bird species that utilize some agricultural fields and early successional areas; they were documented within Boyne Survey. These species were recently listed as "Threatened" in Ontario. The approach to address these species at risk will be determined through landowner consultation with the Ministry of Natural Resources. A permit may be required under the Endangered Species Act for development within the habitat of these species.

Stewardship Programs

As discussed elsewhere in the FSEMS, the recommended NHS provides a framework to achieve conservation, environmental quality, and natural functions. Targets have been set for the range of features, corridors and linkages in the Secondary Plan area, including the Main Branch of Sixteen Mile Creek. Detailed planning of the new and enhanced NHS is required as part of implementation through SIS and site development plans. Subsequently, the Town and landowners will need to engage in monitoring, and management for the long term. Stewardship activities on the part of the Town and landowners, in consultation with Conservation Halton and the Ministry of Natural Resources (where applicable) will be critical. This will entail more regular maintenance of some areas that are to remain in open country conditions, maintenance of NHS infrastructure including trails, and longer term interventions to manage invasive species and prevent hazards as the system matures.

The rail corridor and restoration areas represent a special opportunity in the Secondary Plan area for ongoing stewardship. A Stewardship Plan should be developed for each area as part of SIS in consultation with the Town, landowners and agencies. This would guide actions to maintain cover and functions over time, with specific reference to cover and species targets.

NHS Phasing and Construction Practices

The recommended NHS reflects existing resources and functions associated with the current agriculture-dominated landscape, supported by restoration and enhanced corridors. However, because the implementation of the NHS will be carried out in conjunction with development activities, it is important to recognize that many resources and functions can be lost or heavily disturbed during development, such that NHS goals and targets are less likely to be achieved. In order to address this problem, a clear strategy should be identified in the SIS to protect key resources, and to manage their transition into the finalized NHS. The following should be considered in the strategy:

- Updated information on natural features and species, including focused attention on species at risk, other significant species, and systems known to be sensitive to change and/or to have significant status are fully documented in the pre-development condition;
- Understanding of key reliance of feature and system functions i.e. hydrologic and ecologic conditions that sustain wetlands and woodlands, and the significant attributes;
- Impact assessment and implementation of finalized protection measures (i.e. buffers, hydrologic protection, protective fencing) in consultation with relevant agencies;
- Consideration of adequate interim measures such as development phasing and temporary buffers to minimize disturbance in vicinity of known resources and functions until mitigation, rescue or other measures are in place
- Careful timing of clearing, grading and servicing to avoid key activity periods of species and systems (especially birds, amphibians, turtles etc.);
- Surveys of key biota immediately prior to construction activity, and proactive management to avoid impacts (e.g. isolated significant habitats – ref. Figure NHS-2; nesting birds - the federal Migratory Birds Convention Act prohibits destruction or disturbance of nesting birds);

- Maintenance of alternative connections (e.g. existing watercourses that are to be relocated, hedgerows, expanded interim buffers around natural features) until new corridors and linkages have been constructed, plantings established, and internal elements such as created wetlands and pools are functioning.
- Monitoring of construction activities in the vicinity of features and key corridors, and training of construction staff in best management of any biota that are encountered during construction; an Environmental Management Plan which addresses issues such as spills, tree protection and emergency measures, can also address natural system protection.

6. IMPLEMENTATION PLAN

Guiding principles for the implementation plans are provided in Section 8 of the Subwatershed Update Study, based upon the requirements of the Subwatershed Update Study. The following section provides specific guidance with respect to the implementation of the FSEMS for the Boyne Survey Secondary Planning Area.

6.1 Phasing Plan

Section 8 of the Subwatershed Update Study provides a series of principles for the phasing of new development, which, if applied, would minimize cost, environmental impacts, and requirements for temporary works, and would also avoid liability impacts associated with out-of-phase works. Nevertheless, as indicated in that section of the report, the sequence for implementing new development is not always compatible with the timing and need for major infrastructure projects, particularly drainage works.

The purpose of the Phasing Plan is to identify inter-development timing dependencies for construction of stormwater and environmental management infrastructure which would serve to:

- Minimize overall cost
- Minimize environmental impacts due to repeated construction disturbance
- Minimize requirements for temporary works
- Avoid liability associated impacts of out-of-phase works

Typically, new development does not proceed in a sequence which is compatible with the timing and need for major infrastructure projects; this is particularly true for drainage works. When this occurs, it is necessary to have a good understanding of the dynamics of the proposed system along with all of its interdependencies. Local phasing issues are to be addressed as part of the area-specific Subwatershed Impact Study; detailed considerations should include:

Temporary Works

Where ultimate infrastructure works are too costly for any single proponent, temporary works can be installed which address potential impacts in the short-term. These works must meet/not compromise the functional and environmental objectives of the Subwatershed Study. Where interim works are constructed, the proponent would also need to fund a component share of the ultimate infrastructure works. This is a cost consideration which must be balanced against the cost of constructing the ultimate facility. It is preferable to complete the ultimate works immediately, rather than temporary works due to economic and environmental factors. This is usually dependent on the size and timing of the infrastructure project, as well as the land use and number of development proponents.

Stormwater Management Facility Staging

Environmental compatibility and sensitivity are also factors which should be considered in the determination of a staging plan or critical path. For instance, there are direct and quantifiable benefits to constructing a stormwater management facility in its entirety, prior to or concurrent

with ultimate upstream development. Massive local disturbances would occur only once and as a result, the revegetation would have an enhanced opportunity to stabilize and mature; this point is particularly salient as it relates to water quality facilities which depend to a certain degree on biologic interaction with vegetation, as well as those areas which may require shading for thermal enhancement. The Town's preference is for any interim facility to be constructed in its ultimate location.

Centralization

Centralization and consolidation of stormwater management works is a key overall objective of the Municipality in terms of reducing long term maintenance and liability.

Stream Corridor Management

A *'from the streams out'* phasing approach is recommended where feasible. The establishment of stream corridors, with their associated buffers, including stream re-alignments, should be undertaken at the outset, to allow stabilization to occur and shading vegetation to be established prior to the shift from rural to urban land use.

Sediment loading to streams is typically highest during the construction period. The construction of stormwater management facilities prior to the remainder of the land being stripped, and the redirection of surface flow to these facilities, as a first step in development, allows them to be used as sedimentation basins during this critical phase. This occurs with the knowledge that clean-out will be required following the completion of the development phase.

Fisheries mitigation/compensation measures associated with a development should be undertaken as soon as possible; measures which are associated with specific developments or specific structures will be implemented when those developments occur, or those structures are built.

Maintenance of "out-of-phase" linkages

It is acknowledged that development may not proceed in a downstream to upstream manner, and thus maintenance of critical habitat links may be jeopardized prior to the full development. To maintain the resource base and address potential *Fisheries Act* concerns during the development process, the following principles should be adhered to

- Baseflow, where present, must be maintained to downstream habitats which support fish.
- Interim storm flows must be managed to prevent channel adjustment downstream.
- Water temperature should not be increased in waters containing fish which require cool temperatures.
- No barriers to fish passage should be created where fish are present upstream, or immediately downstream.
- Interim storm water quality treatment must meet the requirements for treatment that are specified in this report.
- Additional monitoring requirements may be required.

Natural Heritage System

As Development Plans are prepared, the strategies for the Natural Heritage System will be implemented by: a) addressing conceptual design of corridors and other linkages (including 'natural' stormwater management wetlands), b) implementing agreed buffers and enhancements for natural features to be retained, and c) Subwatershed Impact Studies to identify feature-specific reliances, buffer detailing, and mitigation needs. Strategies will be framed in the context of the overall 'net gain' objective and subwatershed targets. Responsibilities for cost sharing and ongoing management of Natural Heritage features will be subject to detailed negotiations between developers, the Town, agencies, and other stakeholders.

In order to ensure that future NHS objectives are not undermined by development phasing impacts, the Town and Conservation Halton will require landowners to develop and apply a strategy to ensure that key elements of the existing and future system are protected and allowed for in overall phasing of development, and within the specific SIS study areas. This would apply the following techniques to ensure continuity with NHS objectives:

- All key existing features, buffers, and restoration sites to be demarcated and assigned priorities for timing in an NHS phasing plan (at Secondary Plan level and at SIS level).
- SIS to update inventory information for all habitats including open fields, farm ponds and potential hibernacula (e.g. old building foundations) to identify any resources requiring special rescue or phasing approaches.
- Landowners responsible to carry out Species at Risk screening and negotiations with MNRF regarding Endangered Species Act habitat assessments and permitting.
- Where possible, new corridors should be established and functional prior to completing development of adjoining lands with the exception of stripping and grading; existing channel features to be relocated will be left in place until new systems are fully implemented and their functions demonstrated to the satisfaction of Town and Conservation Halton.
- Buffers and restoration to be established and fully landscaped prior to development of adjoining lands, to the satisfaction of Town and Conservation Halton.

(ref. also Section 5.2.3 in NHS Phasing and Construction Practices).

Principles - Subwatershed Wide

General phasing principles applicable to all developing lands within Milton's Urban Expansion Areas have been established as follows:

(i) *Development Phasing by Local Drainage Areas*
There is significant benefit to grouping phases based on/having regard for the ultimate drainage patterns. This may be best identified at the time of Subwatershed Impact Studies, as logical areas have been established for SIS investigations.

(ii) *All Developments, Regardless of Timing, Require Stormwater Management*
Stormwater management facility construction to be completed in conjunction with development to meet quality and quantity control objectives.

(iii) *Downstream to Upstream Staging Philosophy is Preferred*
For stormwater infrastructure, particularly where topography is flat and there is minimal depth for storm servicing, there is a clear advantage to development proceeding from downstream limit to upstream (minimizes temporary/throwaway costs and works – assumes that channels works are constructed to ultimate configuration, as required).

(iv) *Geographic Distance from Communal Facilities can Influence Staging and Need for Interim Works*
Where topography is not a significant constraint, the distance to facilities can become the primary consideration.

(v) *Phasing of Communal Infrastructure is Possible*
Communal stormwater management facilities can be constructed in phases:

- Requires flexibility in outflow control (i.e. can set outflow rates to suit the amount of upstream development).
- Advantage to phasing stormwater management facility construction to ultimate grades (areal expansion):

  - Minimizes need for re-grading of initial phases.
  - Allows control structures to remain and outflow characteristics to be maintained (i.e. permanent pool/extended detention depth).
  - Flood control weirs can be constructed to allow notches to be expanded to suit amount of upstream development etc.

[Note: There would be no concern for migration as the weirs would be within the off-line stormwater management facilities and thus they would not impact the fish habitat].

- Where downstream outlet elevations are a significant constraint, (i.e. length of watercourse lowering), there may be opportunities to allow phased facility construction on an incremental depth basis, as well as considering “interim” flexibility with respect to allowing storm sewer outfall submergence – where surcharge/maintenance concerns can be addressed.

(vi) *Conveyance Systems Need to be Designed to Ultimate Capacity*
Trunk storm sewers shall be constructed to ultimate capacity (including capture of upstream drainage flows), thus ensuring other lands do not become constrained by capacity.

Boyne Survey Stormwater Management Phasing Plan

The required works for the Boyne Survey Area have been separated into three categories: Stormwater Management Facilities, Culverts, and Watercourses. Detailed cost estimate sheets are located in Appendix ‘G’ of this report.

A summary table has been included in Appendix 'G' to identify the estimated communal infrastructure costs by sub-phase. Additional costs not calculated for this table include recommended erosion control in the form of off-site natural channelization.

6.2 Financing/Cost Sharing

The purpose of the financing/cost-sharing plan is to:

(i) Identify and evaluate alternative models for financing and cost sharing for capital and program works.
(ii) Evaluate and select methods of cost apportionment for capital and program works.
(iii) Identify equitable cost-sharing for the affected landowners.

The preferred solution outlined in this plan essentially consists of the following general types of works:

(i) Flood Control (watercourse and culvert improvements, stormwater management storage facilities)
(ii) Erosion Control (extended detention stormwater management facilities and watercourse improvements on and off-site)
(iii) Water Quality (extended detention stormwater management facilities)
(iv) Servicing (Watercourse lowering)
(v) System/Subwatershed Management Guidelines
(vi) Trunk storm sewers

Of the foregoing, it is inferred that the system/subwatershed management guidelines will apply to all development proponents in a uniform, unbiased manner. The remaining works all relate to specific undertakings which will be required prior to, or in conjunction with, development of the respective development area. As such, the following philosophy has been established as a basis for cost-sharing formulation:

> *Where stormwater works are recommended which can be considered to benefit multiple property owners (i.e. communal), the lands within the benefitting area will be responsible in proportion to total impervious coverage. All other works which would be of benefit to the local landowner, would be wholly attributable to that landowner.*

In terms of a legislative vehicle to implement the works, the Town has several available including:

- *Front-ending Agreements*
- *Development Charges Act*
- *Drainage Act*
- *Municipal Act*

Depending on the will of the potentially affected landowners, as well as Municipal Council, there may be a preference to one of the foregoing, however, selection of the preferred approach is considered beyond the scope of this study. A landowner financial agreement is required by the Town.

6.3 Operations and Maintenance Plan

The purpose of the Operations and Maintenance Plan is to:

> *Develop a plan for effective and efficient operation and maintenance of all infrastructure and environmental systems recommended through the Subwatershed Management Plan.*

The Subwatershed Management Strategy includes recommendations for the construction of various forms of Municipal infrastructure for the purpose of stormwater and environmental management, including:

(i) Stormwater Management Facilities (wet ponds/wetlands/hybrids)
- flood control
- erosion control
- quality management

(ii) Trunk Storm sewers
(iii) Open Watercourse Systems
(iv) Hydraulic Structures (Culverts and Bridges)
(v) Natural Heritage System

Each of these component elements constitutes infrastructure which, once constructed, will need to be operated and maintained by the Municipality in order to preserve its intended function. Without proper maintenance and operations procedures, the infrastructure will degrade and possibly fail, thereby no longer meeting the environmental objectives of the subwatershed plan.

Stormwater Management Facilities

Stormwater management facilities will require periodic maintenance to sustain long term effectiveness for pollutant removal. The type of required maintenance activity would vary for each of the different stormwater management practices. Table 6.3.1 outlines the type, frequency and relative cost of each required maintenance activity for the various stormwater management practices considered for the Boyne Survey Area.

Table 6.3.1: Summary of Maintenance Activities for Various Stormwater Management Practices Proposed for Boyne Survey Area			
Stormwater Management Practice	**Operations and Maintenance Activity**	**Frequency of Activity (years)**	**Relative Cost**
Constructed Wetland	Inspection	1	LOW
	Debris Removal	1	LOW
	Vegetation Replanting/Maintenance	5-10	MEDIUM
	Grass cutting/weed control	1or none	LOW
	Outlet adjustment	as required	LOW
	Sediment removal from forebay	5-10	MEDIUM
	Sediment removal from wetland area with replanting	25-35	HIGH
Wet Ponds/Hybrid	Inspection	1	LOW
	Debris Removal	1	LOW
	Vegetation Replanting/Maintenance	5-10	LOW- MEDIUM
	Grass cutting/weed control	1 or none	LOW
	Outlet adjustment	as required	LOW
	Sediment removal from forebay	5-10	MEDIUM
	Sediment removal from wet pond area with replanting	25-35	HIGH
Grassed Swales	Inspection	1	LOW
	Debris Removal	1	LOW
	Grass cutting/weed control	1 or none	LOW
	Sediment removal/grading with reseeding/planting	7-10	MEDIUM

In addition to the foregoing, operation and maintenance will be required for all Low Impact Development Best Management Practices. The specific operation and maintenance requirements for these types of facilities depends upon the type and function of the specific facility. For infiltration facilities, maintenance activities would be anticipated to be comparable to those associated with grassed swales, provided that that infiltration medium would not require replacement.

Trunk Storm Sewer Systems

Trunk storm sewer systems provide a critical function in the drainage network, whereby urban runoff is conveyed subsurface to a 'suitable' open system. The component elements associated with the trunk storm sewer system include ditch inlets, catchbasins, stormwater management facility inlets and outlets, outfalls.

Key concerns associated with the system's function include blockage and structural integrity.

Table 6.3.2 provides details of Operations and Maintenance associated with trunk storm sewer systems.

Table 6.3.2: Trunk Storm Sewer System Operations and Maintenance Procedures			
System Element	**OPERATIONS AND MAINTENANCE ACTIVITY**	**Frequency (years)**	**Relative Cost**
Ditch Inlets	Inspection	0.3 – 0.5	LOW
	Debris Removal	0.3 – 0.5	LOW
	Repair	10 - 20	HIGH
Catchbasins	Inspection	1	LOW
	Sediment Removal	1 - 2	MEDIUM
	Repair	20+	HIGH
Outfalls	Inspection	0.3 – 0.5	LOW
	Debris Removal	0.3 – 0.5	LOW
	Erosion Repair	3 – 5	MEDIUM
	Repair	20+	HIGH
Trunk Sewers	Inspection	1	MEDIUM
	Structural Repairs	20+	MEDIUM-HIGH
	Replacement	50	HIGH

Watercourse Systems

Historically, engineered open watercourse systems were constructed in urban environments to convey flood flows efficiently, minimize erosion and maximize development opportunities of adjacent tablelands. This management approach led to the construction of various armoured channels including concrete and gabion baskets. These systems typically require significant maintenance expenditures.

Over the past decade, the trend has been toward a more sustainable approach, whereby open watercourse systems through urban settings are designed to incorporate features of natural systems including low flow channels, flood plains, riparian vegetation, meandering alignments and natural substrate. The premise with these systems, particularly when they are designed as part of a holistic master plan (i.e. Subwatershed Plan), is that they will remain dynamically stable, whereby erosion and sediment movement will be at natural rates in equilibrium over the long term. As a result, long term capital maintenance activities would be expected to be nominal and likely localized, rather than involving major repairs or replacement.

The experience database in Southern Ontario has grown over the 1990's and early 2000's suggesting that repair activities in the first few years of a reconstructed stream may be relatively frequent, particularly for riparian vegetation planting zones. Table 6.3.3 suggests maintenance activities in the first 3 to 5 years, until the system has stabilized; after this point maintenance works should reduce substantially and ultimately be minimal.

Table 6.3.3: Watercourse System Operations and Maintenance Procedures			
System Element	**Operations and Maintenance Activity**	**Frequency (years)**	**Relative Cost**
Thalweg/Low Flood Channel	Inspection	0.25 [1.]	LOW
	Repair Localized Erosion	1	MEDIUM
Flood Plain	Inspection	1	LOW
	Repair Localized Erosion	3 - 5	MEDIUM
	Reinstate Riparian Plantings	1 - 5	MEDIUM-HIGH

[1.] Following Major Storms

Natural Heritage System

It is anticipated that key operations with respect to the Natural Heritage System will relate to three aspects of subwatershed planning, development and ongoing land use:

1. Implementation of the NHS, as land use plans are advanced in particular development areas, based on guidelines in this study; management responsibilities and associated costs to be financed by the Town of Milton, with review by the Region and Conservation Authority. The cost for implementation of the NHS is to be financed through the Town.

2. Implementation of the NHS through public education, stewardship activities and public programs in areas not subject to active development; planning agencies to work in partnership with local groups to initiate activities, with cost-sharing between public and private sources.

3. Maintenance of NHS features and linkages as stand-alone management exercises (e.g. woodlot, wetland and linkage management), or in association with maintenance of affiliated infrastructure (e.g. natural channels, conveyance features, stormwater management facilities, utility corridors); costs and management responsibilities to be primarily by Municipality or responsible public agency, with support from affected landowners and community participants, and possibly with guidance/support from relevant Provincial and Federal habitat management programs.

6.4 Implementation Principles

During the course of the FSEMS for the Boyne Survey Secondary Plan, agreement has been reached between the Town of Milton, Conservation Halton, Halton Region, and the Milton Phase 3 Landowners Group with respect to the NHS proposed by the Landowner's Group, as well as certain components of the stormwater and watercourse management system as provided in the Conceptual Tertiary Plans developed by the Landowners Group. Implementation Principles for the Boyne Survey Natural Heritage System have been developed based upon this consensus position and are included in Appendix 'I' of this report, along with the corresponding schedules. In the event of any discrepancies between the FSEMS report text and the IP, the Secondary Plan Policies will prevail.

The NHS and watercourse systems provided in the schedules accompanying the Implementation Principles have been tested for conformance with the criteria provided in the SUS and this FSEMS. The Implementation Principles text and schedules provide the following details regarding the NHS, watercourse, and stormwater management systems based upon the current conceptual Tertiary Plans, and are recognized to be in compliance with the Secondary Plan Policies:

- NHS boundaries including limits and configurations of NHS Units A through H (as numbered in this FSEMS);
- NHS buffers and setbacks as outlined in Item 3 of the Implementation Principles.
- Conceptual realignment of watercourse corridors based upon meander belt widths as outlined in Item 2 b) and 2 c) of the Implementation Principles.
- Conceptual locations and number of stormwater management facilities.

The Boyne Survey Secondary Plan and all future applications within the Secondary Plan shall be evaluated on the basis of the agree-upon NHS as outlined in the Implementation Principles, the SUS, the CFCP, the approved SIS reports, and the policies and guidelines in effect as of the date of approval of the Boyne Survey Secondary Plan, and all associated supporting documents. This does not preclude the application of future new legislation and/or regulations. Direction from the SIS Terms of Reference provided in Appendix 'M' of this FSEMS and the Implementation Principles will be used to prepare SIS designs. Nothing in the SIS or its Terms of Reference will change the principles outlined in the Implementation Principles except as noted in the Implementation Principles or as may be required in accordance with new Federal or Provincial Legislation.

6.5 Future Study Requirements

Section 8 of the Sixteen Mile Creek Subwatershed Update Study provides general Terms of Reference for future studies which are to be completed subsequent to the Functional Stormwater and Environmental Management Strategy. Two key components of this future work include the Subwatershed Impact Studies (SIS's) and the Monitoring and Adaptive Management Plan. Detailed Terms of Reference for these studies are included in Appendix 'M' of this FSEMS.

6.5.1 Subwatershed Impact Studies

The January 2000 Subwatershed Planning Study and the subsequent 2013 Subwatershed Update Study identify the need for Subwatershed Impact Studies in areas where multiple land ownership within the subwatershed occurs. The objectives of this level of study are provided in Section 8 of the 2013 Subwatershed Update Study.

With respect to the Natural Heritage System and its implementation, Table F1 in Appendix 'F' details the NHS development process including general implementation requirements, and Section 5.2 in the FSEMS and the Implementation Principles (ref. Appendix 'I') provide detailed guidance on implementation of the NHS as the preferred management strategy within the Secondary Plan area.

The recommended designation and delineation of Subwatershed Impact Study Areas is provided in Drawing 12. Ultimately, the decision as to whether a Subwatershed Impact Study is warranted for a specific development application would be determined through consultation between the various development proponents, the Town of Milton, and would depend on:

- level of planning information completed in the Secondary Plan process such as road layout, facility locations, and municipal servicing concept
- number of development proposals/proponents involved in the study area and opportunity to integrate facilities and phase developments
- the prior completion of an SIS which includes the subject property

6.5.2 Monitoring and Adaptive Management Plan

The Subwatershed Planning Study (2000) and the Subwatershed Update Study (2013) outline various guidelines and protocols for establishing a monitoring plan to assess the impact of proposed development in the natural environment.

The monitoring plan provides mechanisms through which the performance of the Subwatershed Management Plan may be evaluated with respect to the overall goals of the plan. Monitoring should occur on two (2) levels; Holistic monitoring of the important quantities of the Study Area, and local monitoring of particular development areas or specific mitigative works as a refinement to the overall monitoring program.

Terms of Reference for the Holistic Monitoring Program are provided in Section 6 of the Conceptual Fisheries Compensation Plan (CFCP), as the holistic monitoring represents a condition of the Fisheries Act Authorization for the management of cumulative fish habitat impacts and associated mitigation, as outlined in that document for the Boyne Survey Secondary Plan Area.

Terms of Reference for the local monitoring are provided in the SIS Terms of Reference (ref. Appendix 'M'), as the Local Monitoring Program is to be established once the stormwater and environmental management plan, including the watercourse and fish habitat management, have been established for the SIS areas and the corresponding watercourse reaches, and is further discussed below. Monitoring of the success (and failures) will provide input to the design of future mitigative works for future development in other areas. The ability to adjust or modify the impact mitigation program forms the basis of Adaptive Management.

Effective monitoring is essential for an Adaptive Management program, as this involves, by definition, determining the results of previous actions in order to evaluate effectiveness and to incorporate the knowledge gained through evaluation into the decision making process. Monitoring programs should include pre-development characterization, characterization of affected or potentially affected habitats and/or communities, and characterization of reference habitats/communities for comparison.

Natural Heritage System

Local site specific monitoring will be used to provide more detailed monitoring information for specific development areas and/or specific works.

In general, these plans should:

- Effectively and efficiently monitor the terrestrial and aquatic environment components that are most likely to indicate environmental change at that site scale.
- Be initiated once the phasing and pattern of development is determined, and at an appropriate time as to include meaningful pre-development monitoring, where possible.
- Incorporate monitoring of all habitat restoration and buffers, as discussed in the *Town of Milton Restoration Framework*.

- Include monitoring intervals and seasonal timing that are appropriate for the monitoring components being characterized.
- Continue for an appropriate amount of time, until the data acquired is deemed adequate to ensure that impacts have been addressed.(i.e. 3-5 years)
- Identify potential adaptive management responses to rectify potential impact conditions.
- Include reference to the *Fisheries Act* and *Planning Act*, or other relevant legislation, so that the results can be used to address issues that may arise under these.

Monitoring data must be analyzed to yield results that can be formulated into recommendations that can:

- Be used to direct the actions of the Adaptive Management Plan.
- Provide the rationale and terms-of-reference for long-term monitoring plans.
- Provide the rationale and terms-of-reference for site-specific investigations.
- Address concerns related to the application of the *Fisheries Act* and *Planning Act*, or other relevant legislation.

The Adaptive Management Plan is only useful if information and recommendations are forthcoming from the monitoring plans, and if these recommendations are acted upon. The Adaptive Management Plan must be able to respond quickly to the recommendations from monitoring studies. Long periods between plans reviews are inappropriate.

Details of recommended terrestrial monitoring (holistic and local SIS scale) are provided in the Conceptual Fisheries Compensation Plan which accompanies this FSEMS.

Hydrogeology (Groundwater)

The groundwater monitoring program should consider the potential impacts from a reduction in groundwater recharge and the potential for degraded stormwater infiltrating into the groundwater system.

As major developments proceed or through the SIS studies, shallow piezometers would normally be installed to confirm the water table. A number of piezometers should remain in each major development area. These piezometers should be cased and locked for security. Water levels and water chemistry should be monitored at least on a five year schedule. The actual schedule is dependent to a large degree on the pace of development. Chemical analysis should include inorganic parameters, nitrogen species, and metals. Water level trends correlated to rainfall are necessary to assess changes on the recharge resulting from development.

Where future SIS studies indicate baseflow within the Boyne reaches the following discussion should be considered. Spot baseflow measurements will give an indication of changes in groundwater discharge to the local watercourses and along with water levels provide data to assess changes in recharge. Groundwater discharge areas within the streams can vary over time due to the stream dynamics. It is important to correlate the spot baseflow measurements with the continuous stream flow measurements. It is recommended that water quality and temperature measurements be taken at a number of spot baseflow locations. The spot

baseflow measurements are to be taken during periods when only groundwater is expected to be providing flow to the stream, such as in between rainfall events, or subsequent to spring runoff.

Stormwater Management

Monitoring and Adaptive Management program for the stormwater management systems would be initiated in order to:

- Verify whether in-stream performance target is being met for:
  - Flood control
  - Erosion/Stream stability
  - Water quality
  - Low flow augmentation

- Verify whether stormwater management facility function is being provided for:
  - Flood control
  - Erosion/Stream stability
  - Water quality

- Evaluate the performance of LID practices in comparison with conventional stormwater management measures for stormwater quality control, erosion control, and water balance; monitoring methods and quality measures/quantity control of results to be established based upon system type and function of LID practices.

- Determine whether the overall ecosystem health is being optimized, whether there are tradeoffs that could/should be considered (i.e. pollutant removal) thermal or particular contaminants, and whether opportunities exist to modify facility performance to address these findings.

- Determine whether other factors are influencing ecosystem health that were not identified at the time of studies.

- Determine the rate and quality of sediment accumulation within stormwater management facilities.

The Monitoring component of the assessment would generally consist of the following components:

- Collection of rainfall data (preferably at a location central to the study area),

- Collection of streamflow data including water temperature and salinity at key locations within and downstream of the study area (preferably including the streamflow monitoring sites applied in the Subwatershed Update Study, where applicable), as well as at the inlet and outlet of select stormwater management facilities within the study area,

- Collection of water quality data at key locations within and downstream of the study area (preferably including the streamflow monitoring sites applied in the Subwatershed Update Study, where applicable), as well as at the inlet and outlet of select stormwater management facilities within the study area, and

- Bathymetric survey of select stormwater management facilities.

- Collection of sediment quality data within select stormwater management facilities.

The details of the monitoring program (i.e. specific monitoring locations, water quality indicators to be measured, etc.) would necessarily require dialogue with Conservation Halton and Town staff as part of the development of the monitoring program.

Ideally, the monitoring program would be initiated at the time the Boyne Survey study area would be urbanizing (i.e. at the onset of development) in order to verify whether or not the targets are being satisfied during and post-construction.

The information collected as part of the Monitoring Program would be integrated into the Adaptive Management Plan in order to provide feedback into the on-going development process. This would require a periodic Review of Subwatershed Plan findings in order to identify mechanism to trigger subsequent Subwatershed Impact Studies, and would afford an ability to alter or refine targets, as well as to incorporate new science and policy. This review and update process would necessarily require a Steering Committee comprised of Conservation Halton and Town staff, in order to provide a formal Management Structure for this update process.

Stream Morphology

The collection of field data from similar sites over an extended period of time can provide great insight on channel processes and function. This monitoring can also yield information regarding the response of channel to changes in upstream land use. Typically, a land use change will result in some alteration in the hydrologic regime (increased flow volumes) and sediment regime (initially more sediment being supplied to the channel followed by an overall decrease in loadings). These alterations can result in changes in the channel planform, bank erosion, cross-sectional area and substrate composition which, in turn, may locally affect aquatic habitat and water quality.

From a geomorphic perspective, while the Subwatershed Update Study did establish key geomorphic monitoring stations, any additional monitoring control points and baseline surveys should be established within the relevant reaches prior to stormwater being released within the system. Monitoring would subsequently take place annually to fulfill performance evaluation requirements. Specifically, the following steps should be taken to monitor for development impacts:

Control Cross-sections – Are to be monitored annually during periods of low flow. An additional site visit will be conducted at each site following a peak storm in excess of the 5 year

storm event for the system. Changes in cross-sectional area in excess of 20% will trigger a review of the need for mitigation in the form of restoration (based on professional review).

Substrate Composition – A modified Wolman pebble count should be conducted at each control cross-section on an annual basis, the results of which will be tabulated in a particle size distribution chart. An additional site visit will be conducted at each site following a peak storm in excess of the 5 year storm event for the system. Grain size adjustments in excess of an order of magnitude will act as a trigger for mitigation. Due to the dynamic nature of substrate composition, no action will be taken until Year 5 unless the adjustment is identified as a potential risk to the function of the channel by a qualified geomorphologist.

Lateral Migration – A series of erosion pins (minimum of 5) installed in areas of active bank migration as well as areas of anticipated migration should be measured on an annual basis during low flow conditions to determine rates of bank adjustment. An additional site visit will be conducted at each site following a peak storm in excess of the 5 year storm event for the system. Annual migration rates in excess of 15 cm/year will trigger an assessment by a geomorphologist to determine whether the adjustment is localized or representative of broader site conditions. Mitigation measures would be recommended based on the extent and source of the issue.

Photographic Record – Photographs from a known vantage point should be used to document general geomorphic site conditions on an annual basis. An additional site visit will be conducted at each site following a peak storm in excess of the 5 year storm event for the system. These photographs will be used as supplemental information to inform decisions regarding the need for mitigation.

This monitoring could be undertaken by a variety of parties including the Town of Milton, Region of Halton and Conservation Halton. However, a fluvial geomorphologist should be used to interpret the findings and assess whether substantial change has occurred. The geomorphologist should also be able to link any change with the causative factors and processes.

APPENDIX 'A'
CONSULTATION

APPENDIX 'B'
HYDROGEOLOGY

APPENDIX 'C'
HYDROLOGY/WATER QUALITY

APPENDIX 'D'
FISHERIES

APPENDIX 'E'
STREAM MORPHOLOGY

APPENDIX 'F'
TERRESTRIAL

APPENDIX 'G'
COST ESTIMATES FOR STORMWATER MANAGEMENT

APPENDIX 'H'
EXCERPT FROM
SECONDARY PLAN POLICIES

APPENDIX 'I'
IMPLEMENTATION PRINCIPLES

APPENDIX 'J'
DRAINAGE DENSITY CALCULATIONS TERTIARY PLAN

APPENDIX 'K'
TOWN OF MILTON
Restoration Framework: Stream Corridors and Natural Area Buffers for the Boyne and Derry Green SubWatersheds of Sixteen Mile and Indian Creeks

APPENDIX 'L'
16 MILE CREEK ECOLOGICAL RESTORATION PRINCIPLES

APPENDIX 'M'
SIS TERMS OF REFERENCE