BRONTE CREEK WATERSHED STUDY

Natural Heritage

Appendix 4

Progreston Dam, Bronte Creek

Conservation Halton

January 2002

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1.0 INTRODUCTION

The Bronte Creek watershed is located at the western end of Lake Ontario within the Regional Municipality of Halton, City of Hamilton (former Town of Flamborough) and Puslinch Township (Wellington County) (Figure 1.1). The main channel and most of its major tributaries arise from wetlands located on the limestone plain above the Niagara Escarpment which extend in an arc from Strabane to Morriston to Haltonville. The main branch of Bronte Creek plunges over the Escarpment at Progreston then flows through Lowville, Zimmerman and Bronte before entering Lake Ontario at Bronte Harbour. Crawford Lake is the only natural lake within the watershed. Mountsberg Reservoir, constructed by Conservation Halton in 1967, is the only other large impoundment within the watershed.

Bronte Creek is one of three major watersheds within the jurisdiction of Conservation Halton. Watershed studies have recently been completed for the Sixteen Mile Creek (1996) and Grindstone Creek (1998) watersheds. Bronte Creek is the only large watershed without a watershed plan and, to address this shortcoming, the Bronte Creek Watershed Study was initiated in 1999. The watershed study summarizes the abiotic and biotic resources and cultural uses and their interrelationships within the watershed. The Bronte Creek Watershed Study describes a "watershed vision" which will ultimately allow the watershed community to care for its natural heritage and cultural resources within the context of existing and future municipal planning structures.

The Natural Heritage Report forms part of a series of technical appendices compiled in support of the Bronte Creek Watershed Study. Through a compilation and analysis of existing information, the report identifies and describes the natural heritage features within the watershed in a manner which complements the general information provided in the main document.

The report commences with a review of the natural history of the Bronte Creek watershed followed by a description of the underlying physiography which has largely determined land use patterns within the watershed. Forest cover, wetlands, non-forested cover, aquatic habitat, special habitats, corridors/linkages The natural areas section includes an assessment of ecosystem trends and opportunities for restoration and enhancement within the watershed. The last section discusses potential habitat protection and enhancement guidelines and recommendations for improving terrestrial, wetland and aquatic habitats and linkages within the Bronte Creek watershed.

1.1 Previous Studies

The Natural Heritage Report draws heavily on a number of studies that have previously been conducted within the Bronte Creek watershed. These studies include Areas of Natural and Scientific Interest (ANSI) reports, Environmentally Sensitive/Significant Area (ESA) reports, biological inventories of Halton Region Conservation Authority properties and consultant studies.

Three keystone studies form the framework for the Natural Heritage Report. The first study, entitled *Twelve Mile Creek Conservation Report,* was completed in 1960 by the Department of Commerce and Development. Most recently, the Hamilton Naturalists' Club produced the *Hamilton-Wentworth Natural Areas Inventory* (Heagy, 1995). The *Ecological Survey of the Niagara Escarpment Biosphere Reserve* (Riley et al., 1996) was completed in 1996. A brief summary of these keystone studies is provided below.

The *Twelve Mile Creek Conservation Report* (TMCCR; Dept. Commerce and

Development, 1960) was prepared to appraise the conservation needs of the watershed and to outline the conservation measures that should be implemented. Survey work in support of the studies was grouped under five headings: land, forestry, water, wildlife and recreation. A history of the area provided a contextual perspective to conservation needs.

The *Hamilton-Wentworth Natural Areas Inventory* (Heagy, 1995) involved the inventory and evaluation of the biophysical attributes of 92 natural areas within the former Regional Municipality of Hamilton-Wentworth (now the City of Hamilton). Volume 1 of the study provided an overview of the physical, hydrological and biological features of Hamilton-Wentworth. Watershed summaries, including detailed water quality and fisheries information, were compiled for each watershed lying wholly or partly within the Region. Volume 2 provides a description of key natural areas within the Hamilton-Wentworth portion of the Bronte Creek watershed.

The *Ecological Survey of the Niagara Escarpment Biosphere Reserve* (Riley et al., 1996) provides a comprehensive summary of the many biological inventories and research studies that have been conducted along the Niagara Escarpment, including several features within the Bronte Creek watershed. This report reflects the best availabe scientific information on natural areas within the biosphere reserve and the current principles of conservation biology as they relate to natural areas.

1.2 Watercourse Nomenclature

Most of the natural features within the watershed are associated with Bronte Creek and its tributaries, either as large expanses of headwater wetlands and adjacent upland areas or as deep valley/spillway systems. Aside from the interactions between the watercourses and adjacent natural features, the watercourses provide useful location references which are used throughout this report (Figure 1.2). However, there is considerable confusion pertaining to watercourse nomenclature within the Bronte Creek watershed. Some tributaries have two or three names while others have none. This subsection attempts to standardize watercourse nomenclature which will be used throughout the remainder of the report.

Bronte Creek was officially referred to as Twelve Mile Creek (based on distance from the Burlington Beach lakehead) from 1796 until 1954 when the name was changed to avoid confusion with the Twelve Mile Creek in Port Dalhousie, Ontario (ref; asscciated with Niagara-on-the-Lake lakehead).

With the exception of Limestone Creek and Mountsberg Creek which have official name status on 1:50,000 topographic mapping, the names of the Bronte Creek tributaries are largely local in origin with some tributaries known by two or three names while two tributary systems are unnamed to our knowledge. For the purposes of this study, the tributaries are identified by the following names with rationale and other common names in parentheses.

Mount Nemo Creek	(new name; tributaries descend from Mount Nemo)
Indian Creek	(common name)
Lowville Creek	(new name; flows along south side of Lowville)
Limestone Creek	(official name)
Willoughby Creek	(historical name; also known as Cedar Springs Creek, Kelly's Creek, Willow Brook)
Flamboro Creek	(common name)
Mountsberg Creek	(official name; also known as Badenoch Creek)
Strabane Creek	(common name)

2.0 ECOLOGICAL AND CULTURAL HISTORY

About 14,000 BP (before present), the Wisconsinan ice sheet began its final retreat from southern Ontario, leaving behind a legacy of till plains, moraines, drumlins, eskers, glacial spillway valleys and kettle lakes. Soil formation began on denuded landscapes through the sorting of parent materials through wind and water erosion and through biological colonization (Larson et al., 1999).

Vegetation developed in response to the prevailing climate and developing soils. The first postglacial vegetation communities were dominated by tundra species such as willow, alders, grasses and sedges, buffalo berry, silver berry and mountain avens. The herb-dominated tundra was succeeded by shrub communities which, in turn, gave way to a boreal spruce woodland which was well-established by 12,500 BP (Larson et al., 1999). With continued warming, spruce declined and was replaced by jack and red pine forests. White pine forests were prevalent by 9,000 BP. Upland forests were gradually colonized by present-day dominants such as eastern hemlock, sugar maple, ironwood, elms, oaks, American beech, basswood and hickories. Lowland sites were dominated by white cedar, elms, ashes, tamarack, balsam fir and black spruce. Over the past 8,000 years, changes in the relative abundance of these species have occurred as a response to environmental changes and competitive interactions (Larson et al., 1999).

As vegetation returned to the postglacial landscape, it attracted herbivores such as mastodon, mammoth, muskox and giant beaver. Predators and scavengers followed in their wake. Small bands of Paleolithic hunters followed the retreating glacier into southern Ontario, migrating hundreds of kilometres in their quest for subsistence. Changing environmental conditions associated with the emergence of spruce woodlands and the disappearance of mega-fauna from the landscape resulted in the assimilation of Paleolithic tribes with peoples from the south. The Archaic Indians retained a nomadic lifestyle but increasingly became established in specific river basins (Gale, 2000). About 3,000 BP, the introduction of the bow and arrow and ceramic technology ushered in the Woodland period. During this period, trading alliances were extended and new ideas and technologies were introduced from the south. The successful introduction of maize led to an abandonment of nomadic lifestyles (Gale, 2000).

Prior to European settlement, the Bronte Creek watershed was inhabited by Iroquoian peoples of the Wendat and Attiwandaron confederacies. Both confederacies practiced slash and burn horticulture on a limited scale within the watershed (i.e. Crawford Lake), constructing small, palisaded villages which were abandoned when the fertility of the land and other natural resources were exhausted (Gale, 2000). Shortly after European contact, these confederacies were defeated by the Five-Nation Iroquois (1651), also known as the Senecas. The Senecas maintained several hunting camps and temporary villages in the region until they were displaced by the Mississauga, a nomadic Algonquian tribe, in early 1700s (Gale, 2000). The Mississauga constructed two large encampments in the watershed near present-day Rebecca Street and the Queen Elizabeth Way. Until the end of the American War of Independence, European contact was largely limited to fur trapping and missionary work. Larger mammals requiring large tracts of forest cover such as black bear, marten, fisher, wolverine, timber wolf, lynx, elk and eastern cougar were present within the watershed. Atlantic salmon and brook trout were plentiful within Bronte Creek and its tributaries.

Following the end of the war, American colony "Loyalists" were persecuted and

forced to abandon their homes, fleeing north into Canada. The British purchased property from the Mississauga to provide land for the Loyalists. To bolster Upper Canada against the Americans, the army constructed Dundas Street as a main military road which was completed through Burlington by 1800. Initially, settlement was slow; however, there was renewed interest in settlement following the War of 1812.

As the influx of settlers swelled in the early 1800s, forest clearing associated with agriculture grew as did the need for saw mills and grist mills. Nelson Township had three sawmills in 1817 and by 1850 this number had risen to 17. Four sawmills were constructed between Dundas Street and Lake Ontario. These dams prevented fish species, such as Atlantic salmon, from reaching upstream spawning areas.

Forest clearing led to significant changes in the extent of forest cover within the watershed. Early clearing was carried out to create viable agricultural land. Timber that remained after the construction of cabins and barns was burned to produce potash. Commercial logging commenced in the late 1820's. Increasing population and expansion of local industries increased the domestic consumption of lumber. Cordwood was used for heat and cooking purposes while timber was used for house/barn and fence construction. Crown land along Bronte Creek in the vicinity of the present-day provincial park was lumbered for construction of Welland Canal. White oak was utilized in construction of Great Lakes schooners and for barrel staves. White pine was used in general construction and shipmasts (Langlands, 1972). Timber was also utilized to construct transportation routes. Present-day Bronte Road/Regional Road 25 was planked from Bronte Harbour to Acton in 1851.

As a result of clearing activities, forests, which covered 85% of the watershed in 1800, declined to 50% coverage by 1880 and to less than 10% by 1900. This resulted in a significant change in flow regime of Bronte Creek. More intense discharge was experienced during spring freshet and storms while reduced baseflow was evident during summer months. By 1850, the flows necessary for mill operation appeared to have been available only at certain times of the year.

The degradation of aquatic habitat associated with dam construction and deforestation, combined with overharvest, resulted in the decline of fisheries within Bronte Creek. Thousands of Atlantic salmon were caught by spearing and netting during spawning runs following the War of 1812 (Johnson, 1978). As early as 1820, loss of declining stocks of fish and game was noted as one of the factors forcing the Mississaugas to cede their hunting and fishing reserve at the mouth of Bronte Creek. The Atlantic salmon runs in the Credit River (and likely Bronte Creek) were largely depleted by 1855 and the species was extirpated from the Lake Ontario watershed by 1900.

Similarly, loss of forest habitat combined with overharvest led to the extirpation of at least eight species of mammals (black bear, marten, fisher, wolverine, timber wolf, lynx, elk, eastern cougar) which inhabited the watershed prior to European settlement. The presence of some of the larger predators is given credence by the following by-law which was passed by the Nassagaweya Township council in 1870: "Any party claiming bounty for killing a bear, catamount (cougar), lynx or wildcat (bobcat) is required to produce witness that such an animal was killed within the township" (Dept. of Commerce and Development, 1960).

The Bronte Creek watershed lay in the heart of the nesting area of the now-extinct passenger pigeon. Although numbers of passenger pigeon populations fluctuated widely, very large numbers were noted in the adjacent Sixteen Mile Creek watershed

in 1860 (Dept. of Commerce and Development, 1960). The last large flights in Halton County were reported in 1869 and 1870 with numbers declining rapidly thereafter as a result of habitat loss (loss of hardwood forest and associated beech mast) and overharvest (Dept. of Commerce and Development, 1960). The last breeding record was of a few pairs in Nassagaweya Township in 1886. It is unlikely that the passenger pigeon persisted past the turn of the century in the Bronte Creek watershed. The last passenger pigeon died in captivity in 1914.

Massassauga and timber rattlesnakes were common prior to European settlement and likely persisted until 1900 when loss of habitat and persecution resulted in their extirpation from the watershed. Father Galinee described encounters with rattlesnakes on the Escarpment which were "as thick as one's arm, six or seven feet long, entirely black" (Thwaites, 1906) which appears to confirm the presence of timber rattlesnakes in the area.

3.0 PHYSIOGRAPHIC CONTEXT

Local and regional physiography determines the physical extent of the Bronte Creek watershed and is intricately linked to its hydrology and hydrogeology. Physiography (Figure 3.1) is also the driving force which has dictated vegetation and land use patterns throughout the watershed.

The underlying bedrock within the watershed consists of three geological formations which overlie each other. The oldest unit is the Queenston formation, consisting of red shale, which extends from Lake Ontario to the Niagara Escarpment. A thin sequence of sandstone, dolostone and shale units, known as the Cataract Group, is present on the Escarpment slopes between the Queenston Formation and the Amabel Formation. The Amabel formation is an erosion resistant dolostone which extends to the upstream limits of the watershed and forms the Escarpment cliffs (Holysh, 1995). These formations were formed in an ocean environment approximately 400 to 500 million years ago.

The surficial physiography of the watershed has been prominently shaped by the Wisconsinan Glaciation that receded from southern Ontario 10,000 to 12,000 years ago. Repeated advances and retreats of the glaciers resulted in the deposition of sediments over the bedrock. Sediments were plastered over the bedrock as till, deposited as moraines at glacial termini or formed outwash deposits where meltwaters moved along the terminus of the retreating glacier. The physiographic regions within the Bronte Creek watershed are described below.

3.1 Galt and Moffat Moraines

Sand and gravel outwash deposits associated with the Galt and Moffat Moraines overlie the relatively flat dolostone of the Flamborough Plain along the northern boundary of the Bronte Creek watershed. Although small in areal extent within the watershed, the outwash kame deposits form significant groundwater recharge/discharge areas which feed the headwaters of upper Bronte Creek, Mountsberg Creek and Kilbride Creek. The kame deposits north of Calfass Road between Town Line and Watson Road provide particularly strong areas of groundwater discharge which are the source of significant coldwater tributaries of Mountsberg Creek. Significant forest cover is associated with the steeper, more rugged portions of the moraines with some agriculture present in areas of gentler slopes.

3.2 Flamborough Plain

The Flamborough Plain, which tilts southward within the Bronte Creek watershed, consists of an uneven limestone plain above the Niagara Escarpment. This physiographic region is the dominant feature in the upper portion of the watershed and covers almost half of the watershed. The plain is generally overlain by shallow Wentworth Till (bouldery till, sand and gravel). Drumlin fields, outliers of the Guelph Drumlin field physiographic region, are found in the vicinity of Mountsberg, Freelton and Haltonville. Shallow, permeable soils combined with bedrock fractures and the presence of extensive wetland systems provide a significant groundwater recharge/discharge function within the watershed.

In comparison with the remainder of the watershed, the Flamborough Plain is relatively uncultivated due to its predominantly shallow, stony and poorly-drained soils. Extensive forest cover is associated with several wetland complexes and contiguous upland areas. The headwaters of Flamboro Creek, Strabane Creek and Limestone Creek originate within the Flamborough Plain.

3.3 Norfolk Sand Plain

Bronte Creek passes through the Norfolk Sand Plain from Highway 6 downstream through Carlisle. Overlying the Flamborough Plain, the sands and silts of this feature originated as deltaic deposits in glacial Lake Whittlesey and Lake Warren. Light soils and excellent drainage have resulted in extensive cultivation on this feature. Forest cover is generally limited to low lying wetlands. Although a minor feature within the watershed, the well-drained, coarse soils of the Norfolk Sand Plain promote infiltration and groundwater recharge which contributes to coldwater habitat in Bronte Creek and Flamboro Creek.

3.4 Waterdown Moraine

The Waterdown Moraine consists of ridges of stoney till which were deposited at the edge of glacial Lake Warren by the Ontario ice lobe. Overlying the Flamborough Plain to the south of Mount Nemo and west of Medad Valley, the ridges of the moraine lie within the headwaters of the eastern branch of Willoughby Creek and Mount Nemo Creek. Agricultural land use is predominant with some forest cover also associated with this feature.

3.5 Niagara Escarpment and Spillways

The Niagara Escarpment is the most prominent physical feature within the Bronte Creek watershed. Formed by the differential erosion of the softer Queenston shale bedrock and the hard Amabel dolostone formation, the Escarpment bisects the watershed from north to south. The steep, rugged terrain of the Niagara Escarpment and its associated spillways is generally unsuited for agriculture or other development. Large tracts of provincially and regionally significant forest cover and wetlands are the dominant features within this physiographic region. Groundwater discharge emanating from the Escarpment slopes provides the headwater source for Indian Creek, Mount Nemo Creek and Lowville Creek.

Nassagaweya Canyon and the Progreston-Lowville Valley contain deep sand and gravel deposits associated with deposition along glacial spillways. Groundwater discharge from these highly permeable aquifer systems feeds Bronte Creek, the downstream reaches of Willoughby Creek, Flamboro Creek and Kilbride Creek and the mid-reaches of Limestone Creek. The Medad Valley, which drains to both Grindstone Creek and Willoughby Creek, likely was formed as a result of local weathering associated with creek flow through a significant fracture in the Escarpment bedrock (Holysh, 1995).

3.6 Peel Plain

The Peel Plain, formed by a glacial lake that formed between the Trafalgar Moraine and an ice front to the north, consists of a large tract of clayey/silty soils which supports intensive agricultural activity. The characteristic fine-textured soils and extensive clearing of vegetation over this feature limit groundwater recharge and groundwater discharge is generally insignificant. With the exception of isolated woodlots, significant forest cover is restricted to Bronte Creek valley; however, fragmentation is evident even within the valley feature. Much of Indian Creek, Bronte Creek (Lowville downstream to No. 2 Sideroad) and downstream reaches of Lowville Creek and Limestone Creek flow through this feature.

3.7 Trafalgar Moraine

The Trafalgar Moraine consists of reddish boulder clay containing large quantities of Queenston shale. The moderately rugged terrain contrasts with relatively flat Peel Plain to the north and the South Slope plain

to the south. This bouldery till serves as a local recharge zone (Holysh, 1995) with groundwater moving downward through the moraine and emerging along its base. The relatively rugged terrain and rocky soils has inhibited agriculture in comparison to the till plains to the north and south. Blocks of forest, albeit fragmented by agricultural land uses, are relatively abundant on the moraine.

The moraine acts as a drainage divide. Tributaries to the north flow to Bronte Creek which bisects the moraine at Zimmerman. To the south, a number of small streams originate along the base of the Trafalgar Moraine, discharging to Lake Ontario through Burlington and Oakville. As a result, the Bronte Creek watershed is constricted through, and downstream of, this feature which marks the downstream extent of major tributaries within the watershed.

3.8 South Slope

Within the Bronte Creek watershed, the South Slope physiographic region lies between the Trafalgar Moraine and the Lake Iroquois Plain. Topographic relief is generally low with soils dominated by clayey/silty Halton Till. Similar to the Peel Plain, the characteristic fine-textured soils and extensive clearing of vegetation over this feature limit groundwater recharge and groundwater discharge is generally insignificant. Significant forest cover is generally restricted to the Bronte Creek valley.

3.9 Iroquois Plain

The Iroquois Plain was formed as a feature of the postglacial shoreline of Lake Ontario when water levels were significantly higher than present. This physiographic region consists of two subcomponents within the Bronte Creek watershed: a shale plain which extends from QEW downstream to Highway 2 and a narrow sand plain (barrier beach) which lies between Highway 2 to Lake Ontario. Forest cover is restricted to the Bronte Creek valley with adjacent tablelands fully urbanized.

4.0 NATURAL FEATURE DESIGNATIONS

A number of natural features within the Bronte Creek watershed have been designated as significant natural areas through international, federal, provincial and regional planning policy. Portions of the Niagara Escarpment Biosphere Reserve, one Carolinian Canada site, Provincially Significant Wetlands (PSW), Areas of Natural and Scientific Interest (ANSI) and Environmentally Sensitive/Significant Areas (ESA) are located within the watershed. There is significant overlap of designations within many of these features (i.e. a PSW can also be part of an ANSI, ESA and Carolinian Canada site). This section provides an overview of these designations including: definition, designation criteria and figures showing the location of these natural features within the watershed. Additional information pertaining to individual ANSIs and ESAs is provided in Appendices 2 and 3, respectively. Section 5 (Natural Heritage Features) provides additional detail with regard to vegetation communities, wildlife and corridors while Appendix 1 provides a listing of rare flora and fauna within the Bronte Creek watershed.

4.1 Niagara Escarpment Biosphere Reserve

In 1990, the Niagara Escarpment Plan Area was designated as a Niagara Escarpment Biosphere Reserve by UNESCO (United Nations Educational, Scientific and Cultural Organization) and is one of six such reserves in Canada (Figure 4.1). World Biosphere Reserves are selected to represent the world's most important ecosystems and are intended to act as demonstration areas for both the conservation of biological diversity and the promotion of environmentally appropriate development (Riley et al., 1996). The Niagara Escarpment has been designated on the basis of its ecological, cultural and scientific importance. A number of ANSIs and ESAs lie within the Biosphere Reserve.

4.2 Carolinian Canada Site

Carolinian Canada is a regional protection program formulated in 1984 by the Nature Conservancy of Canada and the World Wildlife Fund to identify and develop a protection program for the most important natural habitat areas in the Carolinian Zone (Duncan, 1989). Thirty-eight priority protection sites have been identified under this program. Carolinian Canada has recently embarked upon the Big Picture Project whose objective is to develop a network of core natural areas which are linked together and to the surrounding landscape (Carolinian Canada, undated). This vision calls for a near doubling of natural cover within the Carolinian Zone over the course of the next few generations (Carolinian Canada, 2001).

Beverly Swamp is the only Carolinian Canada site designated within the Bronte Creek watershed (Figure 4.2). This natural area is the largest and most pristine lowland swamp remaining in southern Ontario (Eagles and Beachey, 1985) and serves as the headwater source for three river systems (Fairchild Creek, Spencer Creek and Strabane Creek). Although a designated Carolinian Canada site, it is interesting to note that Beverly Swamp is often described as a northern wetland forest that is far south for a biological community of this type (Ecologistics Limited, 1976). Snowshoe hare reaches its southern limit in Ontario within the swamp. Most of the designated site lies within the Fairchild Creek and Spencer Creek watersheds with a small lobe in the southeast portion of swamp extending into the Bronte Creek watershed.

4.3 Provincially Significant Wetlands

Most wetlands within the Bronte Creek watershed have been evaluated using the Ministry of Natural Resources Wetland Evaluation System (OMNR, 1984) which ranks wetlands on an ordinal scale from 1 to 7 based on their biological, hydrologic, social and special features attributes (Figure 4.2). Wetlands which are connected by local surface flows or proximity are grouped together and evaluated as a wetland complex. Wetlands and wetland complexes ranked as Class 1, 2 and 3 are designated as provincially significant wetlands while other wetlands (4-7) are considered locally significant. The Ministry of Natural Resources has recently modified this evaluation system (OMNR, 1993) and portions of the Beverly Swamp and Lower Mountsberg Creek complexes have been re-evaluated by Guelph District MNR staff using this system. Table 1.1 provides a list of the evaluated wetlands within the Bronte Creek including evaluated class, size and status.

Provincially significant wetlands in southern Ontario (south of Canadian Shield) are protected from development by provinicial policy which states "development shall not be permitted within provincially significant wetlands" and may be permitted on adjacent lands (within 120 m) only if it does not result in loss of wetland functions. Although not deemed provincially significant, locally significant wetlands within the Bronte Creek watershed receive protection through the *Conservation Authorities Act* (Regulation 150/90) and may also be regulated through the *Lakes and Rivers Improvement Act* and the *Fisheries Act*.

Table 4.1 Evaluated Wetlands within the Bronte Creek Watershed

WETLAND	Marsh Size (ha)	Swamp Size (ha)	Size (ha)	Class	Status
Badenoch-Moffat Wetland Complex	37.3	428.6	465.9	1	P
Beverly Swamp Wetland Complex	67.1	584.5	651.6	1	P
Crawford Lake and Calcium Pits Wetland Complex	2.9	116.0	118.9	1	P
Guelph Junction Wetland Complex (portion)	25.1	366.6	391.7	1	P
Halton Escarpment Wetland Complex (portion)	0.6	16.7	17.3	1	P
Lake Medad Valley Swamp (portion)		21.9	21.9	1	P
Mill Creek Wetland	10.2	20.7	30.9	1	P
Mountsberg Reservoir Marsh	207.9	1.1	209.0	1	P
Lower Mountsberg Creek Complex	0.5	95.3	95.8	2	P
Flamborough Wetland Complex (portion)	6.0	40.7	46.7	3	P
Nassagaweya Canyon Wetland		31.2	31.2	3	P
North Progreston Swamp	0.5	60.8	61.3	5	L
Bronte Marsh	6.0		6.0	6	L
Carlisle Wetland Complex (portion)	0.3	21.5	21.8	6	L
Cedar Springs Swamp		4.4	4.4	6	L
Kilbride Swamp		17.9	17.9	6	L
Milton Outlier Wetland	2.5	16.5	19.0	6	L
Mount Nemo Wetland Complex (portion)		13.5	13.5	6	L
North Carlisle Swamp		10.7	10.7	6	L
Britannia Road Marsh	4.0		4.0	7	L
Colling Rd. Marsh		8.6	8.6	7	L
East Morriston Swamp	0.7	10.4	11.1	7	L
Morriston Marsh	4.9		4.9	7	L
Total Size (ha)	**376.5**	**1887.6**	**2264.1**		
Percent of Total Wetland Area	**16.6**	**83.4**			
Percent of Watershed Area					

4.4 Areas of Natural and Scientific Interest

Areas of Natural and Scientific Interest are defined as "areas of land and water containing natural landscapes or features that have been identified as having life science or earth science values related to protection, scientific study, or education" (Province of Ontario, 1997). The Ontario Ministry of Natural Resources has identified a number of Life Science and Earth Science ANSIs as part of a program "to identify areas which best illustrate unique and representative biological and physical features" within Ontario (Riley *et al.*, 1997).

Life Science ANSIs are significant representative elements of Ontario's biodiversity and natural landscapes and include specific types of forests, valley, prairies and wetlands, their native plants and animals, and their supporting environments. They contain relatively undisturbed vegetation and landforms, and their associated species and communities (Riley *et al.*, 1997). Earth Science ANSIs consist of some of the most significant representative examples of the bedrock, fossil and landform record of Ontario and include examples of ongoing geological processes.

Provincially significant ANSIs include the most significant and best examples of the natural heritage features in Ontario. Regionally significant sites, which do not meet provincially significant criteria due to lesser importance, greater degree of disturbance and/or duplication of features, are significant at a regional level and often complement the provincially significant sites.

Fourteen provincially significant ANSIs (9 Life Science and 5 Earth Science sites) and 7 regionally significant ANSIs (4 Life Science and 3 Earth Science sites) are located within the Bronte Creek watershed (Figures 4.3 and 4.4). These sites are listed below and are described in Appendix 2

The Provincial Policy Statement states that provincially significant ANSIs are to "be protected from incompatible development"; however, development and site alteration may be permitted in these areas if it can be "demonstrated that there will be no negative impacts on the natural features or on the ecological functions for which the area is identified". Similarly, development and site alteration may be permitted on adjacent lands if it can be demonstrated that no negative impacts will occur (Province of Ontario, 1997).

Provincially significant Life Science ANSIs have been designated as Core Natural Areas and Greenlands B within the Hamilton-Wentworth Natural Heritage System (NHS) and Halton Region Official Plan (1995), respectively. Regionally significant Life Science ANSIs have been designated as Linkages with the Hamilton-Wentworth NHS and as Greenlands B within the Halton Region Official Plan. Provincially and regionally significant Earth Science ANSIs have been designated as Linkages within the Hamilton-Wentworth NHS. Provincially and regionally significant ANSIs have been designated as Greenlands within the County of Wellington Official Plan (1999).

Life Science ANSIs	Earth Science ANSIs
Beverly Swamp (P)	Freelton Esker (P)
Bronte Creek Escarpment Valley (P)	Halton Till (P)
Bronte Creek Provincial Park Nature Reserve Zone (P)	Lowville Re-entrant Valley (P)
Crawford Lake/Milton Outlier Valley (P)	Mount Nemo (P)
Crawford Lake South (P)	Paris, Galt and Moffat Moraines (P)
Halton Forest South (P)	Exhumed Silurian Reef (R)
Lowville-Bronte Creek Valley (P)	Lake Medad and Spillway Channel (R)
Medad Valley (P)	Trafalgar Moraine (R)
Mount Nemo Escarpment (P)	
Mountsberg Wildlife Centre (R)	
Brookville Swamp (R)	
Kilbride Swamp (R)	
Zimmerman Valley (R)	

P: Provincially Significant
R: Regionally Significant

4.5 Environmentally Sensitive/Significant Areas

The Regional Municipality of Halton, City of Hamilton (formerly Hamilton-Wentworth Region) and Wellington County have identified a number of areas which are deemed significant by virtue of their biophysical attributes and which are protected from adverse impacts through their respective Official Plans. These areas are referred to as Environmentally Sensitive Areas (ESAs; Halton Region & Wellington County) and Environmentally Significant Areas (ESAs; City of Hamilton). Twenty-eight ESAs are found within the Bronte Creek watershed (Figure 4.5). Twelve of these are located within Halton Region, twelve within the City of Hamilton and four within Wellington County. The rationale for ESA designation in each jurisdiction and a listing of ESAs are provided below. A description of each ESA is provided in Appendix 3.

4.5.1 Wellington County

ESAs within Wellington County are defined as natural landscapes of inherent biological sensitivity which adhere to one or more of nine designation criteria (Eagles et al, 1976) These criteria are listed below:

1. The area represents a distinctive and unusual landform within the municipality, Ontario or Canada.
2. The area serves a vital ecological function such as maintaining the hydrologic balance over a widespread area (i.e. it serves as a water storage or recharge area).
3. The plant and/or animal communities of the area are identified as unusual or of high quality locally within the municipality, Ontario or Canada.
4. The area is an unusual habitat with limited representation in the municipality, Ontario or Canada, or a small remnant of particular habitats which have virtually disappeared within the municipality.
5. The area has an unusually high diversity of biological communities and associated plants and animals due to a variety of geomorphological features, soils, water, sunlight and associated vegetation and micro-climatic effects.
6. The area provides habitat for rare or endangered species that are endangered Regionally, Provincially or Nationally.
7. The area is large, thereby potentially affording suitable amounts of habitat for

species that require extensive amounts of habitat.
8. The area provides a vital linking system of appropriate habitat between adjacent blocks of natural area for the movement of species between these natural areas.
9. The combination of landforms and habitats is identified as having high aesthetic value in the context of the surrounding landscape and any alteration would significantly lower its amenity value.

Within the County of Wellington Official Plan, ESAs form part of the County's Greenlands System and are "protected from development or site alterations which would negatively impact them or their ecological functions." (County of Wellington, 1999)

The following Wellington County ESAs lie wholly or partly within the Bronte Creek watershed: Aberfoyle Woods (ESA #9), Fish Hatchery Swamp (ESA #8), Moffat Marsh (ESA #7) and Mountsberg Wildlife Area (ESA #6). Descriptions of these features are provided in Appendix 3.

4.5.2 Regional Municipality of Halton

A natural area/feature within Halton Region must fulfill one or more of the eleven primary criteria established by the region to evaluate candidate areas to qualify as an ESA (Geomatics International Inc., 1995). The list of primary criteria, as set out in the Regional Municipality of Halton Official Plan (1995), is provided below.

1. Areas that exhibit relatively high native plant and/or animal species richness in the context of Halton Region.
2. Areas that provide links among two or more adjacent natural systems.
3. Areas that contain a relatively high number of native plant communities in the context of Halton Region.
4. Areas that contain large (in a regional context), relatively undisturbed expanses of natural, native plant communities.
5. Areas that contain remnant native plant communities that are rare within Halton Region or that are not represented in other ESAs.
6. Areas that contain plant and/or animal species that are rare provincially or nationally.
7. Areas that contain earth science features and/or processes typical of those which were instrumental in creating Halton's landscape.
8. Areas that are determined to contribute significantly to local and/or regional groundwater recharge.
9. Areas that are determined to be significant groundwater discharge areas.
10. Areas that contribute significantly to groundwater quality.
11. Areas that contribute significantly to maintaining surface water quality.

ESAs within Halton Region have been designated as Greenlands B within the Regional Official Plan (1995). Where other designations apply to an ESA, such as provincially significant wetlands,and flood plains, the more protective Greenlands A designation applies. The following ESAs lie wholly or partly within the Bronte Creek watershed:

- Lowville-Bronte Creek Escarpment Valley (ESA #9)
- Bronte Creek Valley (ESA #10)
- Brookville Drumlin Field (ESA #43)
- Brookville Swamp (ESA #22)
- Calcium Pits (ESA #19)
- Crawford Lake/Rattlesnake Point Escarpment Woods (ESA #18)
- Guelph Junction Woods (ESA #20)
- Hilton Falls Complex (ESA #25)
- Lake Medad and Medad Valley (ESA #7)
- Milton Heights (ESA #17)
- Moffat Swamp (ESA #21)

- Mount Nemo Escarpment Woods (ESA #8)

Descriptions of these features are provided in Appendix 3.

4.5.3 City of Hamilton (formerly Regional Municipality of Hamilton-Wentworth)

The former Regional Municipality of Hamilton-Wentworth has recently been incorporated within the City of Hamilton; however, the ESA policies and designations have been defined within the Regional Municipality of Hamilton-Wentworth Official Plan (1998). According to the Official Plan, ESAs within Hamilton-Wentworth consist of areas which:

1. serve an important ecological or biological function
2. exhibit rare or varied topography
3. contain rare or varied plant or animal species
4. provide habitat for rare species, including Areas of Natural and Scientific Interest (provincially designated ANSIs)
5. have been designated as Provincially Significant Wetlands on the basis of the Provincial Policy Statement.

The ESAs identified within the Official Plan fulfill one or more of following six standardized criteria developed through the Hamilton-Wentworth Natural Areas Inventory project (Heagy, 1993):

1. The biophysical characteristics of the area serve an important ecological function.
2. The biophysical characteristics of the area serve an important hydrological function.
3. The area exhibits a high diversity of biotic and abiotic features relative to its size, and in the context of Hamilton-Wentworth Region.
4. The area encompasses earth science features which are considered rare or poorly represented.
5. The area contains one or more natural biotic communities which is considered rare or poorly represented.
6. The area provides habitat for species considered significant in the context of Hamilton-Wentworth, the former Ontario Ministry of Natural Resources (OMNR) Central Region, Ontario or Canada.

The Hamilton-Wentworth ESAs have been designated as Core Natural Areas within the Hamilton-Wentworth Natural Heritage System (NHS). As these ESAs encompass the majority of Core Natural Areas within the Region, they are considered to form the "backbone" of the NHS. The following ESAs lie wholly or partly within the Bronte Creek watershed:

- Beverly Swamp (ESA #29)
- Bronte Creek Ravine (ESA #43)
- Carlisle North Forests (ESA #38)
- Flamboro Centre Swamp (ESA #37)
- Freelton Esker-Wetland Complex (ESA #30)
- Lake Medad and Medad Valley (ESA #29)
- Mountsberg East Wetlands (ESA #36)
- Mountsberg Wildlife Area (ESA #35)
- Progreston North Swamp (ESA #40)
- Puslinch Southeast Wetland (ESA #27)
- Strabane North Wetlands (ESA #31)
- Strabane Southwest Drumlin Field (ESA #26)

Descriptions of these features are provided in Appendix 3.

5.0 NATURAL HERITAGE AREAS

Within the context of the Greater Toronto Area, the Bronte Creek watershed is a veritable treasure trove of natural areas. Large expanses of forest cover and headwater wetlands dominate the landscape above the Niagara Escarpment. The Escarpment itself provides a set of specialized habitats that support rare flora and fauna. Located at the ecotone between the Eastern Deciduous Forest (Carolinian) Region and the Great Lakes-St. Lawrence Region, the watershed hosts a number of vegetation communities and taxa which are at the northern and southern limits of their range in Ontario. Corridors link core habitat areas at a local, regional and provincial scale. This section provides a general description of these natural heritage features and their associated functions on the landscape.

5.1 Wetlands

Wetlands are an integral part of the natural landscape. These features include lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to, or at, the surface. Saturated conditions in these areas result in the formation of hydric soils which favour hydrophytic and/or water tolerant plants.

Traditionally viewed as unattractive and potentially dangerous by early settlers, it is now recognized that wetlands support a myriad of functions within the watershed. Headwater wetlands moderate flow regimes within watersheds. Runoff is stored during periods of high flow and slowly released, thereby reducing flooding and erosion, and extending/enhancing watercourse baseflow during the summer months. Some wetlands act as recharge areas whereby water seeps into the ground, replenishing important groundwater aquifers. Wetlands also have the ability to retain sediments, filter nutrients and heavy metals thus maintaining and improving downstream water quality. The presence of wetlands increases the complexity of the landscape, thereby increasing biodiversity. Extensive riparian cover associated with wetlands along watercourses provides streambank stability, shading, food inputs and instream cover which are essential to healthy fish habitat. Wetlands also provide recreation and tourism opportunities as well as renewable resources which contribute to the economy.

Following European settlement in the 1800s, timber operations and wetland drainage, to facilitate agriculture, significantly reduced wetland coverage in southern Ontario. A historical loss of more than 70% of the wetlands south and east of the Canadian Shield has been documented (Riley and Mohr, 1994).

Although some loss of historical wetlands has occurred at the mouth of Bronte Creek and on the till plains below the Escarpment, much of the wetland area above the Escarpment has remained intact or has regenerated following cessation of agriculture/tree clearing. Headwater swamps continue to provide recharge and storage areas which contribute to flow stability and coldwater fish habitat. Wetlands currently cover approximately 8.8% of the Bronte Creek watershed.

5.1.1 Wetland Communities

There are four different types of wetlands in southern Ontario: swamp, marsh, bog and fen. Swamps and marshes are the only wetlands represented within the Bronte Creek watershed. Swamps are wooded wetlands with at least 25% cover of live trees or tall shrubs. Marshes are wet areas characterized by robust emergent plants, anchored floating plants and submerged plant species.

Within the Bronte Creek watershed, swamps and marshes make up 83.4 % and 16.6 % of

the total wetland area respectively (Axon and Newton-Harrison 1987). Most wetlands within the watershed are located on the Flamborough Plain above the Niagara Escarpment (Figure 4.2).

Swamps

The poorly drained clay soils south of the Escarpment, which are generally small in areal extent, support swamp communities of silver and red maple (*Acer saccharinum*, *A. rubrum*), black ash (*Fraxinus nigra*) and green ash (*Fraxinus pennsylvanica*). Willows (*Salix* spp.), dogwoods (*Cornus* spp.) and winterberry (*Ilex verticillata*) form small thickets with ground cover dominated by sedges (*Carex* spp.), grasses, sensitive fern (*Onoclea sensibilis*) and composites such as beggar-ticks (*Bidens cernua*, *B. frondosa*), spotted joe pye-weed (*Eupatorium maculatum*), boneset (*Eupatorium perfoliatum*) and rough-stemmed goldenrod (*Solidago rugosa*).

Within the seasonally flooded swamp on the bedrock plain above the Niagara Escarpment, silver maple is generally dominant with red maple, white elm (*Ulmus americana*) and yellow birch (*Betula alleghaniensis*) also well-represented. Black ash, balsam poplar (*Populus balsamifera*) and white birch (*Betula papyrifera*) are characteristic of younger swamp communities. Sensitive fern, field horsetail (*Equisetum arvense*), spotted Joe pye-weed, fowl manna grass (*Glyceria striata*) and cut grass (*Leersia orzoides*) are common in the understorey.

Mixed and conifer swamps are common in the northern portion of the watershed. These forests are dominated by white cedar (*Thuja occidentalis*), tamarack (*Larix laricina*), balsam fir (*Abies balsamifera*) and yellow birch with white birch, green ash and balsam poplar also present. Understorey cover is patchy and is often dominated by species with northern affinities such as blue-bead lily (*Clintonia borealis*), twinflower (*Linnaea borealis*), bunchberry (*Cornus canadensis*), Labrador tea (*Ledum groenlandicum*) and small cranberry (*Vaccinium oxycoccos*).

Marshes

Emergent marshes and meadow marshes within the Bronte Creek watershed are generally associated with beaver activity. Cultural marshes, generally less diverse in character, are associated with abandoned agricultural lands. Emergent marshes are dominated by common cattail (*Typha latifolia*) with narrow-leaved cattail (*Typha angustifolia*), cut grass, reed canary grass (*Phalaris arundinacea*) and sedges also abundant (Riley et al., 1996). Duckweeds (*Lemna* spp.), pondweeds (*Potamogeton* spp.) and stoneworts (*Chara* spp.) are found in open water areas while red osier dogwood (*Cornus stolonifera*) and willows (*Salix* spp.) are found along the fringes. Meadow marshes tend to occur upstream of abandoned beaver dams where flooding has receded. Field horsetail, sensitive fern, Canada blue-joint (*Calamogrostis canadensis*), cut grass, purple-stemmed aster (*Aster puniceus*), spotted jewelweed (*Impatiens capensis*), spotted joe pye-weed and a variety of sedges are common elements of these communities.

Bronte Marsh is an estuarine/lacustrine marsh community located near the mouth of Bronte Creek (between Lakeshore Road and Rebecca Street). This marsh community is strongly influenced by fluctuating water levels in Lake Ontario. Cattails (*Typha* spp.) dominate the emergent community. Marsh diversity has been impacted by carp activity, past land use and possibly by water level control in Lake Ontario.

Mountsberg Reservoir is a shallow, artificial reservoir constructed on Mountsberg Creek in 1967. Marsh and macrophyte communities have developed within, and along the fringes of, this reservoir. Cattails, purple loosestrife (*Lythrum salicaria*) and willow thickets dominate emergent communities along the shoreline while the

open marsh component consists of pondweeds, watermilfoil (*Myriophyllum* spp.), Canada waterweed (*Elodea canadensis*) and water smartweed (*Polygonum amphibium*).

5.1.2 Wildlife Function

Wetlands within the Bronte Creek watershed support a variety of vegetation communities which, in turn, provide habitat for a diverse array of wildlife. Conifer swamps (i.e. Beverly Swamp, Badenoch Swamp, Lake Medad Valley) provide important overwintering habitat for white-tailed deer.

Large expanses of swamp forest through the provincially significant wetland complexes provide interior forest habitat for area-sensitive bird species such as veery, brown creeper and wood thrush. Drowned swamps (i.e. Freelton Esker-Wetland Complex) support habitat for colonial nesting bird species such as great blue heron.

The marshes at Mountsberg and the Bronte Creek estuary provide important staging areas for waterfowl and also support warmwater fish habitat. The Mountsberg Marsh provides breeding habitat for uncommon waterfowl and wetland bird species such as gadwall, pied-billed grebe, American coot, sora and least bittern.

Extensive riparian cover associated with wetlands along watercourses provides streambank stability, shading, food inputs and instream cover which are essential to healthy fish habitat. Coldwater habitat within the Bronte Creek watershed is strongly associated with wetland complexes.

5.1.3 Impacts

Although wetlands within the Bronte Creek watershed remain relatively healthy, historical land use activities on the landscape and the introduction of exotic species has resulted in degradation/loss of wetland habitat and, occasionally, significant changes in wetland function.

In 1917, the "Penrice Drain" a channel was dredged on main Bronte Creek and its adjacent wetlands downstream of Highway 6 in an attempt to improve flow conveyance and decrease flood damage in Morriston (Dept. of Commerce and Development, 1960). This attempt did not successfully address flooding concerns and the downstream portion of this area has since regenerated back to swamp habitat.

Construction of the Mountsberg Reservoir in 1967 resulted in the conversion of a soft maple–mixed swamp complex to open marsh habitat. Originally constructed to provide low flow augmentation for downstream communities during the summer months, the shallow reservoir rapidly evolved into an open marsh which has been designated as a provincially significant staging habitat for waterfowl and provides breeding habitat for several sensitive marsh bird species. The marsh has been designated as a provincially significant wetland, ESA and regionally significant Life Science ANSI; however, the benefits of the reservoir are at least somewhat offset by the loss of forest habitat associated with reservoir construction. The discharge of warm water from the reservoir downstream into Mountsberg Creek has adversely affected coldwater fish habitat. The introduction of non-indigenous fish species into the reservoir has led to their colonization throughout Mountsberg Creek and upper Bronte Creek, to the detriment of the indigenous fish communities.

The introduction of carp from Europe into the Lake Ontario watershed in the late 1800s resulted in increased turbidity and reduced aquatic macrophyte diversity and coverage throughout the coastal marshes of Lake Ontario. This pattern of disturbance is evident in Bronte Marsh.

Other wetlands within the watershed have been degraded through human activities.

Encroachment in portions of the Guelph Junction Wetland Complex and Badenoch-Moffat Wetland Complex have reduced the extent of wetland coverage, harmfully altered fish habitat and impacted local drainage.

5.2 Forest Cover

In southern Ontario, it is estimated that forest clearing between 1800 and 1920 left less than 1% of the land base in original older-growth condition and almost none in true old growth condition. More than 90% of the original upland woodlands were converted to non-forest land uses by 1920 (Larson et al., 1999), a rate that exceeds wetland losses. The low point in forest cover appeared to be reached in the period around 1920 when the availability of fossil fuels and electricity began to relieve the pressure for fuel-wood consumption (Larson et al., 1999).

Over the past eighty years, forest cover in southern Ontario has increased significantly as marginal farmland has been removed from production. This increase has been particularly dramatic in counties and regions along the Niagara Escarpment where woodland cover has increased by more than 36% from 1954 to 1978 (Larson et al., 1999).

Forest clearing within the Bronte Creek watershed closely followed the general pattern observed in southern Ontario. The influx of settlers in the early 1800s led to significant changes in the extent of forest cover within the watershed. Forest cover which extended across 85% of the watershed in 1800, declined to 50% coverage by 1880 and to less than 10% by 1910 (Dept. of Commerce and Development, 1960). Over the past ninety years, forest cover has increased within the Bronte Creek watershed and now covers approximately 29% of the watershed (Figure 5.1). Secondary and successional forests are developing in former areas of marginal farmland along the Escarpment and on the Flamborough Plain and in areas adjacent to headwater wetlands. Grazing in woodlots, identified as a significant issue in the 1960 watershed report, has decreased significantly due to education, reductions in livestock farming and changing livestock practices.

Existing forest cover in the Bronte Creek watershed can be broadly divided into two site regions. Hill's site region framework (Hills, 1959) provides a basis for dividing the province into thirteen ecological units. A site region is defined as an area of land that is characterized by a relatively uniform macroclimate. Within a given site region, the response of vegetation to landform features follows a consistent pattern (House and Carleton, 1988).

Two ecological site regions are associated with the Bronte Creek watershed. Site Region 7E is generally associated with lands below the Niagara Escarpment (exceptions: Medad Valley and Mount Nemo) within the Bronte Creek watershed and forms part of the Eastern Deciduous Forest Region, also known as the Carolinian Life Zone. Site Region 6E lies above the Niagara Escarpment and forms the southern portion of the Great Lakes-St. Lawrence Forest Region which is a broad transitional region between deciduous forest to the south and the boreal forest of northern Ontario.

5.2.1 Eastern Deciduous Forest

Fresh upland forests below the Niagara Escarpment consist of diverse associations of species (LGL, 1999) such as sugar maple (*Acer saccharum*), red maple, shagbark hickory (*Carya ovata*), basswood (*Tilia americana*), red oak (*Quercus rubra*), bur oak (*Quercus macrocarpa*), white oak (*Quercus alba*), beech (*Fagus grandifolia),* white pine (*Pinus strobus*), ashes (*Fraxinus americana, F. pennsylvanica*) and ironwood (*Ostrya virginiana*) with species varying in their dominance depending on soil moisture and soil type (Riley et al., 1996). Blue beech (*Carpinus caroliniana*), chokecherry (*Prunus virginiana*), grey dogwood (*Cornus foemina*), alternate-leaved dogwood (*Cornus alternifolia*) and the invasive common buckthorn (*Rhamnus cathartica*) and Tartarian honeysuckle (*Lonicera tatarica*) form important components of the shrub layer. Rich assemblages of spring ephemerals occur, particularly in forests which do not have a past history of grazing. Typical species include Virginia waterleaf (*Hydrophyllum virginianum*), white trillium (*Trillium grandiflora*), yellow trout-lily (*Erythronium americanum*), wild ginger (*Asarum canadense*), blue cohosh (*Caulophyllum thalictroides*) and wild geranium (*Geranium maculatum*) Other typical understorey species include running strawberry-bush (*Euonymus obovata*), zig-zag goldenrod (*Solidago flexicaulis*), blue-stemmed goldenrod (*Solidago caesia*), enchanters' nightshade (*Circaea quadrisculata*) and false Solomon's-seal (*Maianthemum racemosum*). As noted in Section 5.1.1, pockets of poorly drained clay soils support soft maple and ash swamp communities with scattered thickets of willows and dogwood. Sedges, grasses and composities provide ground cover.

Drier habitats along the south and west-facing valley rims and slopes along the Bronte Creek valley support stands of oak-hickory forests; however, in the absence of fire and other canopy disturbances, many of these communities have been colonized by more shade tolerant tree species such as sugar maple, beech and white ash (LGL, 1999). Witch-hazel (*Hamamelis virginiana*) can form a dense mid-canopy shrub layer, reducing light levels required to maintain low shrubs associated with oak woodlands such as New Jersey tea (*Ceanothus americana*), snowberry (*Symphoricarpos albus*), dryland blueberry (*Vaccinium pallidum*) and black huckleberry (*Gaylussacia baccata*). Ground cover associated with oak savannas (see Section 5.5.2) such as big bluestem (*Andropogon gerardii*) and woodland sunflower (*Helianthus divaricatus*) also disappear as light levels in the understorey decrease.

Lowland/floodplain forests within the Bronte Creek valley are generally successional in character and have emerged following intensive clearing and grazing. Tree cover is dominated by species such as Manitoba maple (*Acer negundo*), crack willow (*Salix fragilis*), white elm, green ash, black maple (*Acer nigrum*), black walnut (*Juglans nigra*) and sycamore (*Platanus occidentalis*). Open canopy conditions allow for a profusion of understorey growth. Vines, dominated by wild grape (*Vitis riparia*) and Virginia creeper (*Parthenocissus quinquefolia*) are abundant. Shrub cover is provided by red osier dogwood, willows and brambles (*Rubus strigosus, R. allegheniensis*). Ground cover consists of mix of wet and dry meadow species including pale and spotted jewelweed (*Impatiens pallida, I. capensis*), Jerusalem artichoke (*Helianthus tuberosus*), reed canary grass, goldenrods (*Solidago* spp.) and asters (*Aster* spp.).

5.2.2 Great Lakes-St. Lawrence Forest

Extensive areas of bedrock plain associated with the Flamborough Plain are generally dominated by sugar maple. White ash, beech, ironwood and black maple are occasional co-dominants in mesic forest

stands while red oak is common in drier stands. Conifers such as white cedar (*Thuja occidentalis*), hemlock (*Tsuga canadensis*) and white pine become more prominent in forest stands north of Steeles Avenue (Riley et al., 1996). Other common associates include white oak, black cherry (*Prunus serotina*), bitternut hickory (*Carya cordiformis*) and basswood with successional areas dominated by white birch, trembling aspen (*Populus tremuloides*) and large-toothed aspen (*Populus grandidenta*). Shrub cover is variable consisting of species such as prickly gooseberry (*Ribes cynosbati*), chokecherry, purple-flowering raspberry (*Rubus odoratus*) and alternate-leaved dogwood (*Cornus alternifolia*).

The broadleaf forests of the bedrock plain support lush and diverse understoreys. Spring ephermals include wild leek (*Allium tricoccum*), Virginia waterleaf, sharp-lobed hepatica (*Hepatica acutiloba*), white trillium, yellow trout-lily, large-flowered bellwort (*Uvularia grandiflora*), violets (*Viola* spp.), spring beauties (*Claytonia* spp.) and toothworts (*Dentaria* spp.). Toothworts are the host species for the provinicially and nationally threatened West Virginia White butterfly (S3). Other typical understorey species include: running strawberry-bush (*Euonymus obovatus*), zig-zag goldenrod (*Solidago flexicaulis*), blue-stemmed goldenrod (*Solidago caesia*), false Solomon's-seal (*Maianthemum racemosum*) and early meadow-rue (*Thalictrum dioicum*). Understorey cover tends to decrease in mixed forests with eastern bracken (*Pteridium aquilinum*), marginal fern (*Dryopteris marginalis*), and wild sarsparilla (*Aralia nudicaulis*) becoming more abundant (Riley et al., 1996).

Depressions within the bedrock plain are dominated by wetland communities (see Section 5.1.1). Silver maple swamps are generally dominant within the seasonally flooded swamps while mixed and conifer swamps become more common toward the north end of the watershed. Open marshes, emergent marshes and shrub thickets are associated with beaver activity along the watercourses.

5.2.3 Interior Forest Habitat

Interior forest is generally defined as forest cover which is found a minimum of 100 m from a forest edge; however, some bird species may require additional separation from forest edge habitats to successfully forage and reproduce. Compact forest shapes with low edge:area ratios, such as circular and square woodlots, provide more interior habitat than forests of similar areal extent but with elongate or irregular shapes which have high edge:area ratios.

Large tracts of intact forest cover provide interior forest habitat for a number of sensitive neotropical migrant bird species such as ovenbird, wood thrush, veery, black-throated green warbler and scarlet tanager. Table 5.1 provides a list of forest interior bird species whose breeding range extends through southern Ontario (Larson et al., 1999).

Many neotropical migrants and interior-specialist bird species require interior forest habitat to successfully forage and reproduce. These species are typically insectivorous and are limited in distribution to forests over 10 ha in size (Riley and Mohr, 1994). Neotropical migrants often raise only a single, small clutch of eggs whereas generalist and resident species will raise two, or even three, clutches of eggs during the nesting season. These migrants tend to nest in the open on, or near, the ground. As a result of their reproductive habits, neotropical migrants are highly susceptible to predation from domestic pets, common grackle, raccoon, Virginia opossum and nest parasitism from brown-headed cowbird.

In contrast to forest interior habitat, forest edges and smaller woodlots are subject to edge effects which promote common generalist and opportunistic bird species

while excluding sensitive species which require more extensive, less disturbed habitat areas. The following effects are

- increased solar radiation
- greater extremes in temperature and humidity
- increased wind and desiccation
- increased predation and parasitism
- increased numbers of aggressive, non-native species and pathogens
- increased disturbance from noise, water and air pollution
- improved access for motor vehicles, vegetation clearing and development

Although forest interior species may occasionally breed in smaller woodlots and forest edges, these habitats become population "sinks" as successful nesting and rearing is rare. In contrast, extensive areas of interior forest habitat act as population "sources" where annual production equals or exceeds annual mortality rates.

Forest interior habitat supports other taxa that require large tracts of forests for reproduction, foraging and shelter. Weak flying butterflies such as the West Virginia White are dependent on sheltered interior woodland habitats. Herptiles such as Jefferson salamander, wood frog, yellow spotted salamander and wood turtle are strongly associated with interior forest habitat. Similarly, mammals such as flying squirrels and porcupines require large forest tracts to carry out their life cycles. The only associated with forest edges and smaller woodlots (Riley and Mohr, 1994):

modern records of bobcat within the Conservation Halton watershed (winter tracks; Hilton Falls and Badenoch Swamp) are from areas with deep cores of interior forest habitat.

Within the context of southern Ontario, the Bronte Creek watershed has an abundance of forest cover with numerous forest stands providing at least some interior forest habitat (Figure 5.2). Below the Niagara Escarpment, forest cover is limited and interior forest habitat restricted to Bronte Creek valley within Bronte Creek Provincial Park and a handful of isolated woodlots within the Indian Creek subwatershed. However, above the Escarpment, forest cover and interior forest habitat is significantly greater with deep interior forest habitat (forest core areas greater than 300 m from the forest edge) present within the following areas:

- Crawford Lake-Rattlesnake Point
- Calcium Pits
- Hilton Falls
- Guelph Junction Woods
- Freelton Esker-Wetland Complex
- Beverly Swamp
- Shanahan Tract (west of Burns Conservation Area)
- Moffat Swamp

Table 5.1: Forest Interior Bird Species of Southern Ontario. (Larson et al., 1999)

Northern Goshawk	**Blue-headed Vireo**	Red-shouldered Hawk
Yellow-throated Vireo	Broad-winged Hawk	**Black-throated Blue Warbler**
Barred Owl	**Acadian Flycatcher**	**Blackburnian Warbler**
Brown Creeper	**Black-and-white Warbler**	Winter Wren
Cerulean Warbler	**Veery**	**Ovenbird**
Swainson's Thrush	**Louisiana Waterthrush**	**Hermit Thrush**
Hooded Warbler	**Wood Thrush**	**Scarlet Tanager**
Black-throated Green Warbler		

Note: Species referenced in bold are considered neotropical migrants. Other species are resident or undertake relatively short migrations south of their breeding range. It should be noted that there is disagreement within the scientific community as to what species are true interior forest species. This list attempts to find a balance between exclusionary and inclusionary paradigms.

5.3 Wildlife

The natural areas within the Bronte Creek watershed provide habitat for a diverse array of wildlife. This subsection attempts to provide an overview of wildlife and habitat associations within the watershed.

5.3.1 Herpetofauna

Although species such as American toad, leopard frog, green frog, snapping turtle, painted turtle and eastern garter snake are able to persist within, and adjacent to, urban environments, diverse assemblages of amphibians and reptiles are generally restricted to natural areas, particularly at sites with abundant wetland and relatively undisturbed and diverse vegetation communities such as Crawford lake, Medad Valley and Calcium Pits (Riley et al., 1996).

Within intact natural areas, swamps, ponds and stream backwaters provide suitable breeding habitat for more sensitive species such as red-spotted newt, wood frog, gray tree frog and spring peeper. Pickerel frog is associated with cold seepages, springs and streams. The nationally and provincially threatened Jefferson salamander frequents ephemeral woodland pools in the large forest blocks above the Escarpment for breeding as do blue-spotted salamander, yellow spotted salamander. Unlike other salamander species, the redback salamander is wholly terrestrial and is able to persist in fragmented woodlots without temporary/permanent pool features (Lamond, 1994).

Snapping turtle and painted turtle are abundant throughout the watershed. Blanding's turtle, associated with ponds and shallow marshes with organic substrates and aquatic vegetation, has been observed at Crawford Lake (Riley et al, 1996). The nationally/provincially threatened eastern spiny softshell turtle was recorded in 1974 at Lowville (Lamond, 1994). Small populations of the provincially vulnerable wood turtle may persist along the Bronte Creek valley between the Bronte Creek Provincial Park and Progreston.

Intact natural areas with streams and/or wetlands throughout the watershed provide suitable habitat for northern water snake. Eastern ribbon snake is present within large forested swamps above the Escarpment while eastern milk snake, northern redbelly snake, green snake and brown snake are associated with open woodlands, forest edges and clearings. Ringneck snake is uncommon within the watershed with records limited to the Bronte Creek valley upstream of Lowville.

5.3.2 Avifauna

Diverse habitat types within the Bronte Creek watershed such as active/abandoned agricultural fields and pasture, hedgerow, early successional forests, plantations, mature woodlot, extensive wetland complexes, deep ravine valley and Escarpment cliff features support a diverse assemblage of bird species.

The extensive upland and lowland forests above the Niagara Escarpment provide resident, overwintering and breeding habitat for a rich variety of bird species including a number of area-sensitive species (Section 5.2.3). Ninety-four breeding bird species have been recorded within the Crawford Lake-Milton Outlier Valley ANSI (Riley et al., 1996). Intact forests provide suitable breeding habitat for warblers such as scarlet tanager, black-throated green warbler, pine warbler, blackburnian warbler and chestnut-sided warbler and other species such as wood thrush, red-eyed vireo, great crested flycatcher, rose-breasted grosbeak and eastern wood-pewee. Red-shouldered hawk (provincially vulnerable) and Cooper's hawk nest in mixed and deciduous forests adjacent to wetlands (foraging habitat). The provincially vulnerable Louisiana waterthrush is associated with deep forested ravines with running water and often a

waterfall (Gore & Storrie Limited and Ecoplans Limited, 1996)

The marshes associated with beaver activity and reservoir construction (Mountsberg) provide habitat for a variety of wetland species such as great blue heron, green heron, Canada goose, wood duck, mallard, spotted sandpiper, common yellowthroat, swamp sparrow, yellow warbler, Virginia rail and red-winged blackbird. Rarer species such as pied-billed grebe, blue-winged teal and hooded merganser (Riley et al., 1996) also nest in these areas.

Large expanses of grasslands associated with abandoned agricultural fields provide habitat for area-sensitive species such as grasshopper sparrow, savanna sparrow, bobolink and eastern meadowlark. The endangered Henslow's sparrow, a grassland specialist, has been recorded within the watershed. Without human intervention, these habitats are transitional landscape features which quickly evolve to successional shrubland/forest communities.

Agricultural and urban landscapes provide habitat for a number of generalist/opportunistic bird species such as blue jay, robin, crow, starling, grackle, song sparrow, chipping sparrow, house sparrow and cardinal. The parasitic brown-headed cowbird is also associated with these urban, agricultural and edge habitats.

Similar to the vegetation communities within the watershed, the bird community includes species with northern and southern affinities and which are near the edge of their range. Black-throated blue warbler, yellow-bellied sapasucker, hermit thrush and dark-eyed junco are at the southern limit of their breeding range within the Bronte Creek watershed while species such as hooded warbler (provincially vulnerable), Louisiana waterthrush and orchard oriole are near their northern range limits (Riley et al., 1996).

5.3.3 Mammals

The variety of habitat types present within the Bronte Creek watershed support a diverse assemblage of mammals. Some species, such as coyote and white-tailed deer are ubiquitous through a wide range of habitats and may even encroach into urban areas. Striped skunk, Virginia opossum, red fox, eastern cottontail, raccoon and grey squirrel are abundant in old fields, successional shrubland and forest edge habitats. Raccoon and grey squirrel, in particular, have adapted well to urban environments.

Large tracts of mature forests provide habitat for more secretive species such as flying squirrel, American porcupine, white-footed mouse and short-tailed shrew. Red squirrels are abundant in mixed and conifer stands. Small populations of bobcat may inhabit the largest forest tracts in the watershed.

The streams and wetlands within the Bronte Creek watershed support a suite of mammal species including beaver, muskrat, mink, ermine and water shrew. A river otter, a species which has not been recorded from the watershed in recent times, was recently trapped near the watershed boundary in West Flamborough (Hamilton Naturalists' Club,2000).

Seven of Ontario's eight bat species have been recorded within the watershed. Crevice caves at Mount Nemo and Rattlesnake Point may provide important hibernacula for provincially rare species such as eastern pipistrelle and eastern small-footed bat.

5.4 Aquatic Habitat

Bronte Creek and its tributaries provide a variety of habitat types which support a diverse assemblage of fish species. Technical Appendix 3 (Aquatic Habitat Inventory and Assessment), prepared under

separate cover as part of the Bronte Creek Watershed Study, provides a comprehensive description of aquatic habitat within the watershed. This subsection provides a general summary of aquatic habitat conditions.

Streams flowing through the well-vegetated, coarse-grained physiographic features along, and upstream of, the Niagara Escarpment are characterized by cool, constant baseflows associated with groundwater recharge/discharge. These reaches provide suitable habitat conditions for brook trout and a variety of other species. Portions of Bronte Creek (upstream of Lowville), Limestone Creek, Willoughby Creek, Kilbride Creek, Flamborough Creek, Mountsberg Creek and Strabane Creek support coolwater/coldwater habitat within the watershed. Redside dace, a nationally and provincially vulnerable species, occurs in these habitats; however, its range within the watershed has decreased significantly, possibly as a result of introductions of non-indigenous fish species.

Downstream of the Escarpment, the till plain features are more suitable for agriculture and support less forest and riparian vegetation cover. The fine-grained soils do not provide significant opportunities for groundwater recharge or discharge. As a result, stream flows are relatively flashy and instream temperatures are warm during the summer months. Bronte Creek (downstream of Lowville) and Indian Creek provide warmwater habitat within the watershed. Coldwater species such as brook trout are not present in significant numbers in these reaches; however, they support a diverse array of warmwater species such as smallmouth bass and may act as migratory corridors for fish moving upstream from Lake Ontario. A healthy population of silver shiner, a nationally and provincially vulnerable species, is found in Bronte Creek downstream of Zimmerman.

The presence of on-line ponds/reservoirs and lack of riparian vegetation are common concerns throughout the Bronte Creek watershed. The Indian Creek subwatershed provides a large scale example of the impacts associated with these features. Emanating from a number of small springs along the Milton Outlier, the tributaries of Indian Creek soon enter a number of on-line ponds along the slopes of the Escarpment. Entering the Peel Plain, the tributaries are then ditched to facilitate agricultural operations. Riparian cover is negligible along the tributaries and much of the main branch. As a result, water quality is poor, instream temperatures are high and flows may become intermittent during the summer months.

5.5 Special Habitats

The geographical position of the Bronte Creek watershed, combined with its physiography, create conditions suitable for the establishment of special habitats which are rare from a national, provincial and regional perspective. The moderating effects of Lake Ontario, combined with the presence of dry valley rims and south-facing slopes along Bronte Creek valley downstream of Zimmerman provide warm, dry microclimates suitable for a variety of Carolinian and prairie-savanna species which are at the northern limit of their range in Ontario. In contrast, the cool coniferous swamps in the northern portion of the watershed provides habitat for vegetation species which are near the southern end of their distribution. The Niagara Escarpment provides a set of special habitats that are rare at a provincial, national and even global level. This section describes the "special" habitats found within the watershed (Figure 5.3).

5.5.1 Carolinian Forests

The Carolinian Life Zone of Canada (Deciduous Forest Region) is restricted to southern Ontario south of an imaginary line which runs from Grand Bend east to Toronto. The northern boundary

corresponds to the northern limits of Carolinian species which are found only within this region of Canada. This zone boasts the warmest average annual temperatures, the longest frost-free season and the mildest winters in Ontario (Reid, 1985).

The Deciduous Forest Region makes up less than 1% of Canada's total land area but supports a greater number of flora and fauna species than any other ecosystem in Canada. One-third of Canada's rare, threatened and endangered species are found in this region (Reid, 1985). However, the moderate climate and productive soils that support biota in this life zone also attracted European settlers who prospered in this favourable environment. Clearing of hardwoods for timber and draining of wetlands for farming have eliminated over 90% of the natural habitat within this zone. Pressures on the remaining natural habitats within this region from agricultural land use and urban development remain high.

The northern limit of the Deciduous Forest Region bisects the Bronte Creek watershed. Within the watershed, Carolinian species are generally restricted to areas south of the Niagara Escarpment where south-facing slopes and the moderating effects of Lake Ontario on winter temperatures provide warm, dry microclimate conditions which support a number of Carolinian forest and prairie/savanna species. At the edge of this zone, site aspect exerts considerable control over microclimates and associated vegetation. For example, the north-facing slopes of Mount Nemo have a cooler microclimate and support different vegetation communities than the southeast-facing portions due to reduced solar radiation (Riley et al., 1996). Similarly, the southwest-facing slopes of the Bronte Creek valley are relatively warm and dry and support Carolinian vegetation communities while the cooler, more moist east-facing slopes support mixed forest communities that more closely resemble those of the Great-Lakes St. Lawrence Forest Zone.

The following woodlands within the watershed have strong Carolinian affinities and support a number of species which are at the northern limit of their range in Canada.

Bronte Creek Valley

The Bronte Creek Valley ESA downstream of Zimmerman has microclimate features which support a number of Carolinian species. Drier habitats along the south and west-facing valley rims and slopes along the Bronte Creek valley support stands of open oak-hickory forests dominated by white oak, red oak, shagbark hickory, chinquapin oak (*Quercus muehlenbergii*) and black oak (*Quercus velutina*) with scattered tall shrubs such as bladdernut (*Staphylea trifolia*), sassafras (*Sassifras albidum*) and flowering dogwood (*Cornus florida*). A characteristic low shrub understorey consisting of species such as New Jersey tea, snowberry, dryland blueberry and black huckleberry (LGL, 1999) is also present. Large patches of New Jersey tea provide host habitat for the provincially rare mottled duskywing butterfly (Goodban, 1999). Ground cover associated with oak savannas such as big bluestem, bush-clovers (*Lespedeza* spp.) and woodland sunflower may also be present.

In the absence of fire and other canopy disturbances, many of these communities have been colonized by more shade tolerant tree species such as sugar maple, beech and white ash (LGL, 1999). Witch-hazel, chokecherry and common buckthorn can form a dense mid-canopy shrub layer, reducing light levels required to maintain the low shrub communities associated with oak woodlands. Savanna-associated ground cover also tends to disappear as light levels in the understorey decrease.

Three Carolinian species, sycamore, black maple and groundnut (*Apios americana*), are present in floodplain habitat within the valley system. Sycamore, in particular, is representative of Carolinian habitat and is

generally limited in distribution to river valleys downstream of Regional Road 5 within the Conservation Halton watershed.

Mount Nemo

Located at the northern edge of the Eastern Deciduous Forest Zone, Mount Nemo is better known for its old-growth cedar forest along the Escarpment cliff face. However, the southeast-facing talus slopes support one of the largest examples of butternut-basswood talus forest in the province (Riley et al., 1996). Hackberry (*Celtis occidentalis*) is also found on the talus slopes. Yellow mandarin (*Disporum lanuginosum*) and flowering dogwood have been identified in the southern portions of the tableland forests.

Rattlesnake Point

Although Rattlesnake Point lies just north of the Eastern Deciduous Forest Zone, the relatively warm southwest-facing slopes at the talus slope/cliff interface support several mature hackberry trees which provide habitat for the provincially rare hackberry butterfly. Rattlesnake Point is the only site in Halton Region which is known to support this species.

5.5.2 Prairie/Savanna Habitat

Prairie and savanna vegetation formerly occurred discontinuously across much of southern Ontario. This habitat expanded into southern Ontario during a warm, dry climatic phase that peaked approximately 5,000 years ago. Climatic conditions and associated increases in the natural frequency of fires led to the extension of these vegetation communities from the central portion of the continent, particularly in sandy, well-drained areas. As relatively cooler, wetter conditions returned to southern Ontario, many of these prairie/savanna communities were maintained through periodic burning by native peoples, thereby repressing shrub and sapling development and maintaining grassland and open oak woodland habitats to support rich populations of game animals including elk and deer. Later, agricultural settlements were based on these open, well-drained areas where supplementary game animals were readily available.

Lack of extensive tree cover and excellent drainage resulted in extensive clearing of prairie and savanna habitat to accommodate agriculture and urbanization. Far less than one percent of the presettlement prairie and savanna remains in southern Ontario (Goodban et al., 1999). Prairie and savanna communities in Ontario are considered extremely rare and are ranked S1 (extremely rare in Ontario) by the Natural Heritage Information Centre (Bakowsky, 1996). The remnant prairie/savanna features represent the rarest and most threatened community type within the Bronte Creek watershed.

Historical records indicate that prairie and oak savanna vegetation was fairly widespread around the perimeter of the western end of Lake Ontario with a stronghold around Burlington Bay and Cootes Paradise. In the Bronte Creek watershed, these communities were likely limited to the well-drained sandy soils of the Lake Ontario Plain and a shallow band of sandy soils which parallels the east valley rim habitats along Bronte Creek in the vicinity of Bronte Creek Provincial Park. Only a handful of tiny prairie and savanna remnants remain within the watershed. These communities are restricted to the south and west-facing slopes of the Bronte Creek Valley ESA.

Within Bronte Creek Provincial Park, two small prairie remnants support a number of species with prairie and savanna affinities. Similar to other remnants in southern Ontario, they are relatively small and isolated (Goodban, 1998). Both of these features are associated with well-drained sandy loams within hydro corridors along the east rim of the valley. With the exception of High Park (Toronto), the

prairie and related communities within the park are the most significant in Site District 7-4 in terms of size, number of prairie species and number of provincially rare and regionally rare to uncommon species (Goodban, 1998).

Prairie vegetation is dominated by big bluestem with wrinkle-seeded sedge (*Carex rugosperma*), hairy bush-clover (*Lespedeza hirta*) and northern downy violet (*Viola fimbriatula*) also present (Goodban, 1998). A partial burn conducted in 1978 stimulated growth of big bluestem (House and Carleton, 1988). The valley rim and adjacent slopes support a number of species with prairie/savanna affinities such as New Jersey tea, black huckleberry, little bluestem (*Andropogon scoparius*), whorled milkwort (*Polygala verticillata*), intermediate pinweed (*Lechea intermedia*), butterfly-weed (*Asclepias tuberosa*), wandlike bush-clover (*Lespedeza intermedia*), hoary puccoon (*Lithospermum canescens*) and Virginia yellow flax (*Linum virginianum*).

5.5.3 Escarpment Habitats

Exposed bedrock and talus slope features associated with the Niagara Escarpment provide a range of specialized habitats that are absent or rare elsewhere in southern Ontario. Brief descriptions of these specialized habitats are provided below.

Escarpment Rim and Cliff Communities

The environmental gradients at the interface between intact Escarpment woodland and exposed cliff communities over a distance of a few metres can be compared with those found when comparing deciduous forest with open tundra thousands of kilometres away (Larson, 1989). With the exception of small pockets and ledges that accumulate litter, soil depths at the cliff edge/face are near zero. The plant community is exposed to intense sunlight and a full range of environmental fluctuations. Snow cover is absent on most cliffs during the winter, exposing plants to temperatures of less than –20°C while full sun exposure during the summer results in heat stress and dessicating conditions. In many respects, the exposed cliff community is subject to environmental extremes similar to those experienced in alvar settings.

Escarpment rim forests consist of open broadleaf stands (sugar maple, ironwood, red oak and white ash) interspersed with mixed stands of white cedar and paper birch (Riley et al, 1996). Understorey, particularly within the more open broadleaf stands, are lush with shrubs such as round-leaved dogwood (*Cornus rugosa*), red-berried elder (*Sambucus pubens*) and chokecherry (*Prunus virginiana*) and ground cover dominated by marginal wood fern (*Dryopteris marginalis*), rock polypody (*Polypodium virginianum*), large-leaved aster (*Aster macrophyllus*) and wild sarsaparilla. Open areas along the rim support uncommon species such as climbing fumitory (*Adlumia fungosa*), sandwort (*Arenia stricta*), golden corydalis (*Corydalis aurea*), buffaloberry (*Shepherdia canadensis*) and purple clematis (*Clematis occidentalis*). Within the Bronte Creek watershed, escarpment rim forest communities are associated with Mount Nemo, Crawford Lake and Rattlesnake Point.

In southern Ontario, few forest ecosystems have escaped human disturbance. On the cliff faces of the Niagara Escarpment a forest of old-growth eastern white cedar has persisted since access is difficult and dangerous and the stunted, twisted nature of the trees has dissuaded harvest. Individual trees can exceed 1,600 years in age and studies indicate that this forest has persisted on the Niagara Escarpment for close to 10,000 years (Kelly, 1996). Smooth cliff-brake (*Pellaea glabella*) is a common associate of the old-growth cedars. The rock itself supports a diverse microflora living within the surface of the dolostone (Riley et al., 1996). A characteristic arthropod fauna

occurs where water seeps down cliff surfaces. Larson (1989) states that, in the absence of human use, the exposed cliff faces of the Niagara Escarpment support the oldest and least disturbed old-growth forest in eastern North America. At Rattlesnake Point, cliff edges and adjacent forest cover are used as summer roosting areas by turkey vultures.

Within the Bronte Creek watershed, old-growth white cedar cliff forests are found at Mount Nemo (north and south sites), Rattlesnake Point/Buffalo Crag and Crawford Lake. Mount Nemo and Rattlesnake Point support extensive sections of cliff forest while Crawford Lake supports a number of shorter sections. The Mount Nemo North site is considered one of the most significant sites identified through the Niagara Escarpment Ancient Tree Atlas Project (Kelly and Larson, 2001). Cedars at all sites routinely reach ages exceeding 400 years.

The introduction of rock-climbing to the Niagara Escarpment in the mid-1950s has transformed the Escarpment cliffs into an important recreational resource. Accelerated popularity of rock-climbing through the 1980s and 1990s has brought increasing pressures of human contact to this old-growth forest (Kelly, 1996). Reduced densities of cedars is observed relative to unclimbed cliff sections. The elimination of younger trees and some older specimens is attributed to active and passive disturbance associated with rock climbing. At Rattlesnake Point, damage is particularly extensive with extremely low density of living trees with all younger age classes having been removed (Kelly, 1996). Disturbed portions of the cliff-edge ecosystem are not self-sustaining (Larson, 1989) and reversing the effects on cliff-edge forest structure, if at all possible, may take decades (Parikesit et al., 1995). Individual old-growth trees are also being removed for the bonsai trade (Riley et al., 1996).

Talus Slopes

Talus slopes are characterized by blocks of limestone and dolostone found at the base of the Escarpment cliffs (OMNR, 2000). This coarse, rocky material cover more than half of the ground surface. Soils are shallow and are primarily composed of organic debris. Semi-open forest stands in these areas consist of basswood, butternut (*Juglans cinerea*) and white ash, interspersed with thickets of mountain maple (*Acer spicatum*). Spotted jewelweed, bulblet fern (*Cystopteris bulbifera*) and herb robert (*Geranium robertianum*) provide ground cover. Accumulations of broken rock, particularly areas with southern exposures, may provide overwintering shelters (hibernacula) for snakes.

Escarpment Rock Surfaces

Calcium-rich carbonate rocks associated with dolostone bedrock outcrops along the Niagara Escarpment provide ideal habitat for calciphilous ferns such as wall-rue (*Asplenium ruta-muraria*), walking fern (*Camptosorus rhizophyllus*), purple-stemmed cliff-brake (*Pellaea atropurpurea*), green spleenwort (*Asplenium viride*), maidenhair spleenwort (*Asplenium trichomanes*), smooth cliff-brake (*Pellaea glabella*) and hart's-tongue fern (*Phyllitis scolopendrium*) which are generally restricted in Ontario to the Niagara Escarpment (Riley et al., 1996).

Caves

Crevice cave systems, running parallel to the Escarpment cliffs, are found at Mount Nemo and Rattlesnake Point. These cave systems may provide significant breeding and overwintering habitat (hibernacula) for several bat species. Small-footed bat (G3 - globally rare, S2S3 - provincially very rare to rare), big brown bat, Keen's bat and eastern pipistrelle (S3S4 - provincially uncommon to common) were collected by Royal Ontario Museum staff from Mount Nemo during the winter months in the 1950s

(Paton and Sharp, 1979) indicating that the Mount Nemo caves may support significant hibernacula for bat species. Eastern pipistrelle was also collected from Rattlesnake Point during this time period. No recent research has been undertaken to determine the extent/significance of these habitats. The growth of spelunking (cave exploration) as a recreational activity may impact the function of these habitats particularly during hibernation when disturbance may force bats to use substantial energy reserves which are required for survival during this period.

5.5.4 Mountsberg Marsh

Constructed in 1967, the Mountsberg Reservoir supports an extensive marsh that is unique within the Bronte Creek watershed. Fringed by cattail marsh and willow thickets, the extensive areas of open marsh support luxuriant macrophyte communities which are poorly represented in this portion of southern Ontario. The marsh provides extensive habitat for waterfowl, wetland bird species, herptiles and warmwater fish, and is considered a regionally significant waterfowl breeding area and a provincially significant waterfowl staging area. It also serves as a significant stopover for migrating shorebirds and passerines (Heagy, 1993).

5.5.5 Grasslands

The development of early successional vegetation (grasses, composites) over abandoned agricultural fields provides suitable habitat for grassland bird species. The principles of interior habitat (see Section 5.2.3) also apply to grasslands within the watershed. Area-sensitive grassland bird species require large grassland areas with little to no successional shrub species which are more likely to be buffered from disturbance (nest predation and parasitism). Species such the Henslow's sparrow prefer grasslands of at least 30 ha in size (OMNR, 2000) while more common grassland species such as grasshopper sparrow, bobolink and savanna sparrow are generally associated with grasslands of at least 10 ha. The grasslands of Bronte Creek Provincial Park support several area-sensitive grassland bird species. Grassland habitats within Courtcliffe Park, though somewhat smaller, support species such as grasshopper sparrow and savanna sparrow. Other grassland habitats are found on abandoned agricultural fields on private lands.

It should be noted that grassland habitats were not a significant component of the pre-settlement landscape within the Bronte Creek watershed. The combinations of physiographic features and climate conditions throughout most of the watershed are conducive to the establishment of mature forest communities. Unless managed (i.e. prescription burns, shrub/sapling removal), grassland habitats are but temporary features on the landscape, soon evolving to successional shrub and sapling cover which no longer supports grassland species.

5.5.6 Rare Species

Rare species of flora and fauna in the Bronte Creek watershed are primarily associated with ESAs (Geomatics, 1995, Heagy, 1993, Eagles et al., 1976) which generally include ANSIs and the larger components of wetland complexes within their boundaries. These species are generally at the limits of their natural range or are associated with unique habitats (i.e. the Niagara Escarpment) which may extend outside of the watershed but are rare within a provincial/national context. Local extirpation of these species may occur through adverse natural or human-induced changes to their environment. Rare species can also recolonize historical and former ranges if positive habitat changes occur (i.e. management of succession in grassland/prairie/savanna communities, increases in interior forest habitat, corridor enhancement).

Appendix 1 contains a listing of the nationally, provincially and regionally rare species within the watershed within each ESA. Hilton Falls ESA was not included in the list since only a small portion of the ESA is within the Bronte Creek watershed. The rare species listed in the ESAs which are found within multiple watersheds may not necessarily be found within the Bronte Creek watershed since there is no separation of species by watershed in the original documents. Some rare species data was also incorporated from Varga et al. 1994 (Mount Nemo Escarpment ANSI) and Riley et al., 1996 (Niagara Escarpment Biosphere Reserve ANSIs).

5.6 Corridors and Linkages

Ecosystems cannot be considered in isolation because life moves and changes across landscapes. The connections between habitat patches and the distances between patches are important because biodiversity can only be maintained if effective dispersal between patches is occurring (Larson et al., 1999). In southern Ontario, the density of forest fragments on the landscape and the overall proportion of habitat may be more critical to long-term sustainability of populations than immediate woodland habitat (Riley and Mohr, 1994). Effective disperal between patches occurs through natural corridors and linkages.

Corridors are generally elongate, naturally-vegetated areas that link or border natural areas within and between watersheds (Riley and Mohr, 1994). Within the Bronte Creek watershed, they tend to follow biophysical breaks in the landscape such as watercourses and associated valleys, wetlands and the Niagara Escarpment (Figure 6.1). Anthropogenic features such as hydro and pipeline right-of-ways and railways also function as corridors within the watershed.

Corridors exist at different scales. Finer scale features include fencerows and hedgerows which may be important at a local level while larger scale features may provide significant ecological functions internally and act as substantive passageways for plant and animal species and communities at a regional and provincial level within the Bronte Creek watershed.

Corridors provide passage for animals which require a variety of habitats to survive. They allow the movement and reproductive interchange between populations of plant and animal species, and buffer natural areas and processes from adjacent land-use activities (Riley and Mohr, 1994). Properly designed corridors may counter the effects of habitat fragmentation since the viability of habitat islands (i.e. woodlots) as suitable wildlife habitat often depends on outside recruitment of animals (Noss, 1987a,b). In southern Ontario, the re-establishment of corridors over time may lead to the re-colonization and range expansion of taxa which were extirpated or suffered significant range contractions since European settlement.

Although a number of benefits may be derived from natural corridors, adverse impacts may also be associated with some corridors. Narrow corridors may provide habitat for edge species such as European starling, common grackle, brown-headed cowbird and red-winged blackbird. These corridors may act as funnels, attracting predators, competitors and brood parasites to a forest (Ambuel and Temple, 1983).

Overall, natural corridors provide important habitat connections within watersheds and provide linkages to adjacent watersheds. In most cases, the ecological benefits of corridors far outweigh any disadvantages, particularly in agricultural and urban settings (Noss, 1987a,b) such as those found within the Bronte Creek watershed. A description of corridors/linkages found within the Bronte Creek watershed, including linkages to adjacent natural areas outside of the watershed, is provided below.

Given the size of the watershed and the significant extent of natural features therein, discussion is limited to larger scale corridors on the landscape. It is noted that smaller scale features (i.e. hedgerows) may be important, particularly from a cumulative and/or local context, however a description of these features is beyond the scope of this report.

5.6.1 Riparian Corridors

Bronte Creek and its tributaries provide important corridor functions which link the provincially significant wetland units/complexes above the Niagara Escarpment. Within the context of the western Lake Ontario basin, the Bronte Creek valley provides a relatively unfragmented conduit from Lake Ontario to the Escarpment corridor which is utilized by migratory birds during seasonal migrations. Migratory fish species from Lake Ontario also utilize this corridor to access upstream spawning habitat.

The functions of riparian corridors have been adversely impacted by human activities within the watershed. Aquatic habitat within Bronte Creek and its tributary corridors has been fragmented by a number of on-line ponds which prevent fish passage and contribute to downstream warming. In some reaches, lowland forest corridors adjacent to the watercourses have been encroached upon or removed entirely to support agricultural operations or residential aesthetics (i.e. lawns). Removal of riparian cover reduces watercourse shading, food sources and habitat for aquatic organisms and can reduce bank stability. Gaps in riparian corridors adversely affect the terrestrial migration and dispersion functions associated with these corridors.

5.6.2 Escarpment Corridor

The Escarpment forest ANISs/ESAs along the slopes and adjacent tablelands of the Niagara Escarpment form part of a large mega-corridor which extends from Niagara Falls to Tobermory (Riley et al., 1996). The significance of this corridor is recognized by UNESCO through its World Biosphere Reserve designation. The Niagara Escarpment itself is linked to the Oak Ridges Moraine near Caledon and through other habitat corridors to the Long Point Biosphere Reserve along the shore of Lake Erie (Hounsell, 1999), forming part of a provincial network of corridors.

5.6.3 Inter-watershed Corridors

The headwater wetlands within the watershed, which feed the main branch of Bronte Creek and several tributaries, are also the headwater source for tributaries of Sixteen Mile Creek, Spencer Creek and Fairchild Creek (Grand River). Important inter-watershed linkages are also associated with forest cover along the Trafalgar Moraine (to the Niagara Escarpment, Fourteen Mile Creek and Sixteen Mile Creek), Bronte Creek Provincial Park (to Fourteen Mile Creek), Hilton Falls (to Sixteen Mile Creek) and the Horseshoe Moraines (to Eramosa River).

6.0 NATURAL AREAS MANAGEMENT GUIDELINES AND STRATEGIES

Natural areas within the Bronte Creek watershed should be protected and enhanced to maintain and increase the extent of remnant natural areas and to enhance intra- and inter-watershed habitat links. Enhancement and restoration of natural areas will ultimately improve the overall health of the watershed and will also benefit adjacent and downstream systems including Lake Ontario.

This section has been divided into two sub-sections. The first sub-section provides general guidelines that should be followed to ensure that natural areas within the Bronte Creek watershed are protected and enhanced. The second sub-section provides site-specific recommendations for several natural areas. Implementation of these guidelines and site-specific recommendations will improve the health of the Bronte Creek watershed.

6.1 General Management Guidelines

The following general guidelines should be implemented to protect, enhance and restore natural areas within the Bronte Creek watershed:

- continue to enforce the Conservation Authority Fill, Construction and Alteration to Watercourse regulations (Ontario Regulation 150/90)
- enact and enforce municipal topsoil preservation bylaws
- enact and enforce tree cutting bylaws based on modern silvicultural practices
- regular updating of municipal ESA studies (ongoing-City of Hamilton, Halton Region)
- ensure that land use planning policies are compatible with regional and provincial policies and objectives for natural area protection
- require preparation of Environmental Impact Assessment studies for proposed developments within and adjacent to significant natural areas identified through the Provincial Policy Statement and regional/municipal Official Plans
- continue to regulate activities affecting natural areas through review of development proposals
- dedicate natural areas for Public Open Space through the development process
- secure voluntary stewardship protection agreements
- provide tax incentives through conservation land tax programs
- develop partnerships with conservation groups (i.e. naturalists groups, angling and hunting groups, Ducks Unlimited) to monitor, protect, enhance and restore natural areas
- continue existing stewardship projects within the watershed (Hamilton Harbour Watershed Stewardship Program)
- implement demonstration projects on public lands
- implement long-term monitoring to assess changes in watershed health

Guidelines specific to the protection and enhancement of wetlands, forest cover, linkages and special habitats are provided below.

6.2 Watershed Strategies

6.2.1 Wetlands

Additional opportunities exist to increase the extent and improve the function of wetlands within the watershed.

Through stewardship programs, there is an opportunity to restore the wetland functions of marginal agricultural areas as they are removed from production. Restoration opportunities should be assessed on a site-by-site basis with consideration given to present and future wetland functions. For example, one site may place an emphasis on restoring lowland forest cover to increase the areal extent of interior forest habitat. However, this may not be a suitable objective at another site where interspersion of vegetation communities is a critical component of wetland function. Landowners should be encouraged to create/restore buffer strips between intensive land uses and wetland areas.

6.2.2 Forest Cover and Riparian Habitat

A number of habitat targets have been established for the Great Lakes Areas of Concern (AOCs; Environment Canada et al., 1998). Although the Bronte Creek watershed does not lie within an AOC, the habitat targets are generally applicable to all watersheds in southern Ontario. Table 6.1 outlines habitat targets which, when achieved, will result in the creation of a natural heritage system that exhibits a high degree of biodiversity and robustness.

Table 6.1. Habitat Targets for Great Lakes Areas of Concern (adapted from Environment Canada et al., 1998).

Parameter	Target	Rationale
Percent Forest Cover in Watershed	> 30%	Will support most bird species expected within range
Size of Largest Forest Patch (minimum 500 m wide)	200 ha	Will support most bird species expected within range
Percent of Watershed that is Forest Cover 100 m or farther from edge	> 10%	Will support most forest-interior and edge bird species
Percent of Watershed that is Forest Cover 200 m or farther from edge	> 5%	Will support most forest-interior bird species expected within range
Percent of Riparian Habitat that is Vegetated along First to Third Order Streams*	> 75%	Should maintain high stream integrity assuming no other major problems; may maintain coldwater habitat
Percent of First to Third Order Streams with at least 30 m wide buffers	> 75%	Should maintain high water quality and stream integrity
Percent of Watershed that is impervious	< 15%	Potential to maintain coldwater streams

* Stream order is a method of ranking stream segments in a drainage basin in which larger segments are given higher order numbers. Headwater tributaries are assigned oreder 1, where two order 1 streams combine, the next (downstream) segment becomes order 2, where two order 2 segments combine, the next (downstream) segment becomes and order 3, etc. (Newbury and Gaboury, 1993).

Watershed and subwatershed analyses have been conducted to assess how Bronte Creek and its subwatersheds meet these habitat targets. The results of these analyses are provided in Table 6.2.

Table 6.2 Comparison of Bronte Creek Watershed to AOC Habitat Targets

	Great Lakes AOC Targets						
	Forest Cover >30%	Largest Forest Patch >200 ha	>10% of Watershed as Interior Forest Habitat	>5% of Watershed as Deep Interior Habitat	>75% Riparian Habitat Vegetated	>75% of Riparian Habitat with 30 m Buffers	<15% Impervious Area
BRONTE	**29%**	**3 (total)**	**7%**	**2%**	**52%**	**44%**	**5%**
Lower Bronte	29	0	6	1	73	68	9
Upper Bronte	25	1	5	1	59	48	9
Mt. Nemo Creek	30	0	6	0.6	34	26	3
Indian Creek	8	0	0.6	0	11	8	3
Lowville Creek	26	0	7	3	37	9	7
Limestone Creek	39	1	13	4	54	43	3
Will'by Creek	25	1*	6	1	58	44	3
Kilbride Creek	42	1*	10	3	70	61	3
Flam. Creek	48	0	12	1	71	69	3
Mntsbrg. Creek	33	1	9	3	60	56	3
Strabane Creek	34	1*	12	3	66	60	3

* forest patch is contiguous with >200 ha patch which extends outside of the watershed

Forest Cover

Forest cover within the watershed has increased to 29% as marginal farmland along the Escarpment and headwater wetlands has been removed from agricultural production and approaches the AOC target of 30% coverage. However, there is a significant disparity in forest cover between lands above the Niagara Escarpment (forest cover greater than 30%) and lands below the Escarpment (forest cover approximately 10% to 15% with most cover associated with Bronte Creek valley). Only 8% of the Indian Creek subwatershed supports forest cover.

Although interior forest cover within four subwatersheds equals or exceeds the AOC targets, overall interior forest cover within the Bronte Creek watershed (7%) does not meet the AOC target of 10%. Bronte Creek and its subwatersheds do not meet the AOC target for deep interior forest habitat (>5% of catchment that is forest cover 200 m or farther from forest edge).

The Bronte Creek watershed does meet the AOC target for large forest patches (> 200 ha, >500 m width). These significant forests are associated with the Moffat Marsh, Crawford Lake/Rattlesnake Point Escarpment Woods and Freelton Esker-Wetland Complex ESAs. Forest cover within the watershed is also contiguous with large forest tracts associated with the Hilton Falls Complex ESA, Medad Valley ESA and Beverly Swamp ESA which extend outside of the watershed.

To meet AOC habitat targets, reforestation to promote the establishment of compact forest blocks with significant interior forest

habitat should be a primary focus of stewardship and reforestation initiatives. Abandoned agricultural lands adjacent to wetlands and along the brow and slopes of the Niagara Escarpment provide excellent opportunities for reforestation. Emphasis should be on the creation of compact forest shapes to maximize the areal extent of interior habitat within watershed forests.

A significant opportunity to create a massive block of interior forest lies within a 2 km radius of a point centred on Steeles Avenue midway between Twiss Road and McNiven Road. With a core area centred by the Guelph Junction Woods ESA, this area has extensive forest cover and is similar in size to Hilton Falls; however, fragmentation has restricted the development of a deep core area of interior forest habitat. Although several roads and a rail corridor bisect this area, reforestation of forest gaps could result in the development of extensive interior forest habitat.

Municipalities and landowners should be encouraged to use indigenous plant species for all plantings, particularly regeneration projects, to enhance indigenous plant communities and to minimize the spread of invasive, non-native species into natural habitats within the watershed. If ornamental plantings are deemed necessary, proponents should be encouraged to use aesthetically pleasing native species or non-invasive non-native species as substitutes for invasive species such as Norway maple (*Acer platanoides*).

Riparian Habitat

Bronte Creek and its subwatersheds do not meet the AOC targets for riparian habitat on first to third order streams. Riparian cover is often patchy. Flamboro Creek approaches AOC targets while Indian Creek and its tributaries fall well short. Indian Creek supports riparian cover over only 11% of its stream length with 30 m buffers restricted to 8% of total stream length. Lack of riparian cover within the Bronte Creek watershed is associated with nutrient enrichment, increased instream temperatures, localized bank erosion and impedance of wildlife movement (Environment Canada et al., 1996).

Although the AOC targets pertain to first to third order streams, it should be noted that healthy riparian habitat is also important on the main branch of Bronte Creek in terms of nutrient uptake, bank/valley wall stability, overhanging and instream cover, and terrestrial corridor function.

Restoration/enhancement of riparian habitat along watercourses within the watershed provides an opportunity to create habitat corridors for wildlife while enhancing aquatic habitat and downstream water quality. All tributaries and subreaches within the Bronte Creek watershed could benefit through riparian habitat enhancement as implemented through stewardship programs. Water quality within the watershed and, in an incremental fashion, Lake Ontario will benefit from restoration of riparian corridors.

On-line ponds are ubiquitous within the watershed. Forty-one ponds are found within the Indian Creek subwatershed alone. The impacts of these ponds are numerous. Cumulative evaporation from headwater ponds reduces water available to support summer baseflow, possibly resulting in intermittent flows during the summer months. Solar heating of ponds during the summer months increases instream temperatures downstream of the ponds reducing habitat viability for coldwater fish species such as brook trout. Dams associated with some pond structures restrict fish passage. Dams and ponds act as sediment traps and interfere with the natural sediment and bedload transport within streams. It is recommended that a watershed-wide inventory of ponds be conducted to determine their location and assess their impacts within the watershed.

6.2.3 Linkages and Corridors

Natural corridors and linkages have been fragmented by land use activities within the watershed. These adverse impacts can be addressed through implementation of the strategies outlined for aquatic habitat, wetlands and forest within the watershed.

The restoration of riparian corridors along Bronte Creek and its tributaries will re-connect natural core areas, facilitating the movement and reproductive interchange between populations of plant and animal species. Restored riparian corridors will buffer watercourses from the adverse impacts of adjacent land-use activities and will enhance aquatic habitat within the watershed. Water quality within the watershed and, in an incremental fashion, Lake Ontario will benefit from restoration of riparian corridors.

Within the Bronte Creek watershed, reforestation is encouraged to link natural heritage features and to increase the areal extent of interior forest habitat. Through reforestation efforts, stronger linkages can be restored to, and along, the Niagara Escarpment and to adjacent watersheds. On a larger scale, restoration of linkages and corridors at a local watershed level will enhance the function of the Escarpment mega-corridor system.

It should be noted that references to corridors and linkages within this technical appendix and the Bronte Creek Watershed Study apply to *ecological connectivity only*. These references *do not* imply any access to private or public lands through trail system extension or creation of new access trails.

6.2.4 Monitoring

Long-term monitoring of the natural areas within the Bronte Creek watershed is important to identify and assess ecosystem changes associated with changing land uses and ongoing restoration projects. Information from these monitoring efforts is required to ensure that restoration projects are achieving their objectives and to assist in the development and prioritization of future projects within the watershed. Conservation Halton is currently developing a long-term monitoring program which will meet these objectives.

6.3 Site Strategies

Baseline studies, a review of background literature and an active public stakeholder review process undertaken as part of the Bronte Creek Watershed Study have provided a number of strategies to be employed at the site level to restore and enhance natural heritage features within the watershed. Recommended restoration projects for natural areas within the watershed are summarized below.

6.3.1 Wetlands

- Bronte Marsh - inventory vegetation, fish and wildlife communities to assess enhancement opportunities
- Guelph Junction Woods, Carlisle North Wetlands, Beverly Swamp – reforest gaps to reduce habitat fragmentation, enhance interior habitat and corridors
- Campbellville Industrial Area - removal of fill from encroachment areas and reforest
- Four Seasons Nature Park - enhance and restore wetlands in encroachment areas

6.3.2 Forest Cover

- Indian Creek – reforest areas along Escarpment tributaries (north of Derry Road) to improve linkages and increase interior forest habitat
- Guelph Junction Woods, Carlisle North Wetlands, Beverly Swamp, Mount Nemo, Moffat Swamp, Strabane Southwest Drumlin Field, Rattlesnake Point/Crawford Lake, Milton Heights ESAs – reforest gaps to reduce habitat

fragmentation, enhance interior habitat and corridors
- Rainbow Ranch – reforest gaps to reduce habitat fragmentation, enhance interior habitat and corridors

6.3.3 Special Habitats

- Bronte Creek Provincial Park – develop a management plan to protect and enhance prairie/savanna and grassland habitats (currently in preparation; D.Boddington, pers.comm.)
- Conservation Areas – continue to monitor effects of trails, rock climbing and spelunking on unique features (i.e. old-growth cedar forests, cliff rims, bedrock outcrops, caves) and work with park planners to address any impacts through master planning excercises

6.3.4 Corridors and Linkages

- implement reforestation strategies outlined in Section 6.3.2
- work with municipalities to re-establish creek and valleyland buffers as part of land dedication through development
- work with quarries (i.e. Canada Brick, Nelson Quarry, Sherman Sand and Gravel) to rehabilitate licensed areas following extraction to enhance habitat and improve linkages
- restrict cattle access on upper Bronte Creek, Indian Creek and Limestone Creek
- riparian plantings to improve water quality, aquatic habitat and terrestrial linkages at a number of sites on private and public lands throughout the watershed
- investigate opportunities to retrofit or remove on-line ponds on public and private lands to improve water quality and habitat connectivity

6.4 Summary

The Bronte Creek watershed supports a relatively intact, functional natural heritage system with headwater wetland systems, extensive forest cover, diverse flora and fauna and a set of unique ecological features that is rare, if not unparalleled in the Greater Toronto Area. However, additional work is required to increase interior forest habitat and regenerate riparian habitats within the watershed. Sections 6.2 and 6.3 outline a number of exciting opportunities available to enhance natural heritage areas and to restore areas of degraded function and health. Implementation of the natural areas management guidelines and strategies will increase the extent and function of significant habitats and corridors within the watershed. This will result in the development of a robust natural heritage system, which will support a full complement of flora and fauna adapted to the suite of available physical and climatic conditions endemic to the watershed.

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Appendix 1

Rare Species List

Table 1. Rare Species List for ESA's in Bronte Creek. Data derived from Heagy, 1993, Geomatics 1995, Riley *et al.* 1996, Eagles *et al.*, 1976.

	Vascular Plants																																									
Scientific Name	*Lycopodium clavatum*	*Scheuchzeria palustris*	*Equisetum pratense*	*Equisetum sylvaticum*	*Equisetum variegatum*	*Botrychium matricariifolium*	*Botrychium rugulosum*	*Osmunda claytoniana*	*Dennstaedtia punctilobula*	*Cryptogramma stelleri*	*Woodwardia virginica*	*Asplenium platyneuron*	*Asplenium trichomanes*	*Asplenium viride*	*Dryopteris carth X D. crista*	*Dryopteris gold X D. marg*	*Dryopteris inter X D. marg*	*Phyllitis scolopendrium*	*Phegopteris connectilis*	*Thelypteris noveboracensis*	*Picea mariana*	*Juniperus virginiana*	*Potamogeton amplifolius*	*Potamogeton berchtoldii*	*Potamogeton obtusifolius*	*Potamogeton perfoliatus*	*Potamogeton pusillus*	*Agropyron trachycaulum*	*Andropogon gerardii*	*Andropogon scoparius*	*Brachyelytrum erectum*	*Bromus latiglumis*	*Elymus riparius*	*Muhlenbergia frondosa*	*Muhlenbergia glomerata*	*Muhlenbergia schreberi*	*Muhlenbergia sylvatica*
Common Name	Running Clubmoss	Arrow-grass	Meadow Horsetail	Woodland Horsetail	Variegated Scouring-rush	Daisy-leaved Grape Fern	Grape Fern	Interrupted Fern	Hay-scented Fern	Slender Cliff-brake	Virginia Chain Fern	Ebony Spleenwort	Maidenhair Spleenwort	Green Spleenwort	Hybrid Shield Fern	Hybrid Shield Fern	Hybrid Shield Fern	Hart's-tongue Fern	NorthernBeech Fern	New York Fern	Black Spruce	Red Cedar	Large-leaved Pondweed	Pondweed	Pondweed	Pondweed	Small Pondweed	Slender Wheat Grass	Big Bluestem	Little Bluestem	Bearded Shorthusk	Tall Brome Grass	River Bank Wild Rye	Wire-stemmed Muhly Grass	Muhly Grass	Muhly Grass	Muhly Grass
Status	r	R	r	r	r	r	NPR	r	r	r	r	R	R	R	r	r	r	NRP	r	r	r	r	r	r	R	R	r	r	r	r	r	r	r	R	r	R	NRP
Affinity																													S	S								
ESA																																						
AW		X																X			X																
HFC											X	X																										X
BS									X											X																		
BCR	X		X	X	X							X																										
BCV				X																		X				X			X	X	X	X	X	X			X
BDF																																						
BS	X							X												X																	
CP					X																														X		
CNF												X																										
CLR	X					X	X			X		X			X	X	X								X			X			X	X				X	
FCS																																						
FEW																																						
GJW				X				X											X		X		X				X										
LMM													X																									
MH														X																								
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PNS																																						
PSW																																						
SNW																																						
SSD																																						

	Vascular Plants																																					
Scientific Name	*Muhlenbergia tenuiflora*	*Panicum gattingeri*	*Carex capillaris*	*Carex careyana*	*Carex castanea*	*Carex formosa*	*Carex gracilescens*	*Carex grayi*	*Carex grisea*	*Carex lucorum*	*Carex muhlenbergii*	*Carex prairea*	*Carex prasina*	*Carex scoparia*	*Carex sychnocephala*	*Carex trisperma*	*Carex umbellata*	*Carex vaginata*	*Cyperus erythrorhizos*	*Cyperus rivularis*	*Cyperus strigosus*	*Eleocharis intermedia*	*Scirpus pendulus*	*Lemna trisulca*	*Wolffia punctata*	*Disporum lanuginosum*	*Dioscorea quaternata*	*Dioscorea villosa*	*Calopogon tuberosus*	*Corallorhiza maculata*	*Corallorhiza trifida*	*Cypripedium acaule*	*Galearis spectabilis*	*Goodyera repens*	*Platanthera clavellata*	*Platanthera dilatata*	*Platanthera orbiculata*
Common Name	Muhly Grass	Panic Grass	Sedge	Sedge	Sedge	Sedge	Sedge	Sedge	Sedge	Sedge	Sedge	Sedge	Sedge	Sedge	Sedge	Sedge	Sedge	Sedge	Nut Grass	Nut Grass	Nut Grass	Spike-rush	Bulrush	Star Duckweed	wolffia	Yellow Mandarin	Wild Yam	Wild Yam	Grass-pink	Spotted Coral-root	Pale Coral-root	Stemless Lady-slipper	Showy Orchis	Dwarf Rattlesnake-plantain	Club-spur Orchid	Tall White Northern Orchid	Large Round-leaved Orchid
Status	NRP	NRP	R	NRP	r	P	NRP	R	R*	R	r	r	NPR	r	r	r	R	r	NPR	N or P	r	r	r	r	r	NRP	R*	R	r	r	r	r	r	r	r	r	R
Affinity							C				S															C		C										
ESA																																X						
AW																																						
HFC				X		X	X																						X		X	X		X	X	X	
BS					X																									X							
BCR											X		X																									
BCV	X						X	X	X	X				X					X	X	X	X									X							
BDF																								X	X													
BS												X					X																					X
CP																																						
CNF			X						X							X																						
CLR																																						
FCS																X																						
FEW						X												X																				
GJW																		X								X	X	X										
LMM																																						
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MN		X											X													X												
MEW															X																	X						
MWA															X																							
PNS																							X															
PSW																																						
SNW																																						
SSD																																						

	Vascular Plants																																						
Scientific Name	*Platanthera psycodes*	*Spiranthes cernua*	*Spiranthes lucida*	*Spiranthes romanzoffiana*	*Salix candida*	*Salix nigra*	*Salix pedicellaris*	*Salix serissima*	*Myrica gale*	*Betula pumila*	*Castanea dentata*	*Quercus muehlenbergii*	*Celtis occidentalis*	*Ulmus thomasii*	*Pilea fontana*	*Polygonum achoreum*	*Polygonum cilinode*	*Polygonum virginianum*	*Rumex orbiculatus*	*Trichostema brachiatum*	*Phytolacca americana*	*Arenaria stricta*	*Actaea pachypoda x rubra*	*Clematis occidentalis*	*Ranunculus flabellaris*	*Ranunculus hispidus*	*Sassafras albidum*	*Adlumia fungosa*	*Corydalis aurea*	*Corydalis sempervirens*	*Dicentra cucullaria*	*Arabis divaricarpa*	*Arabis glabra*	*Arabis hirsuta*	*Cardamine pratensis*	*Sarracenia purpurea*	*Drosera rotundifolia*
Common Name	Small Purple Fringed Orchid	Nodding Ladies'-tresses	Shining Ladies'-tresses	Hooded Ladies'-tresses	Sage-leaved Willow	Black Willow	Bog Willow	Autumn Willow	Sweet Gale	Swamp Birch	Wild Chestnut	Chinquapin Oak	Hackberry	Rock Elm	Spring Clearweed	Striate Knotweed	Fringed Buckwheat	Jumpseed	Great Water Dock	False Pennyroyal	Pokeweed	Rock Sandwort	Hybrid Baneberry	Clematis	Yellow Water Buttercup	Swamp Buttercup	Sassafras	Climbing Fumitory	Golden Corydalis	Pink Corydalis	Dutchman's-breeches	Rock-cress	Tower-mustard	Rock-cress	Cuckoo Flower	Pitcher-plant	Round-leaved Sundew
Status	r	r	R	r	r	r	r	r	r	r	NPR	R	r	r	R	r	r	r	r	r	r	R	r*	R	R	r	r	R	r	r	r	r	R	R	r	r
Affinity											C							C		A							C				S						
ESA																																						
AW		X		X																																	
HFC																																						
BS				X	X				X	X							X			X								X				X		X	X	X
BCR																					X																	
BCV						X						X						X								X	X			X							
BDF																																						
BS																																						
CP	X		X				X	X								X									X	X											
CNF																																						
CLR								X					X	X									X	X	X	X					X		X				
FCS																																						
FEW																																						
GJW						X													X						X										X		
LMM									X																													
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MN											X		X		X							X		X				X						X				
MEW																																						
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	Vascular Plants																																						
Scientific Name	*Ribes glandulosum*	*Platanus occidentalis*	*Agrimonia pubescens*	*Amelanchier alnifolia*	*Crataegus aboriginum*	*Crataegus compta*	*Crataegus conspecta*	*Crataegus dodgei*	*Geum rivale*	*Gillenia trifoliata*	*Rosa acicularis*	*Spiraea tomentosa*	*Apios americana*	*Astragalus canadensis*	*Lespedeza capitata*	*Lespedeza hirta*	*Lespedeza intermedia*	*Linum virginianum*	*Polygala verticillata*	*Nemopanthus mucronatus*	*Euonymus atropurpurea*	*Acer rubrum X A. saccharinum*	*Hypericum majus*	*Lechea intermedia*	*Hybanthus concolor*	*Viola affinis*	*Viola fimbriatula*	*Viola macloskeyi*	*Viola septentrionalis*	*Decodon verticillatus*	*Epilobium angustifolium*	*Epilobium strictum*	*Myriophyllum sibiricum*	*Panax quinquefolius*	*Sanicula canadensis*	*Sanicula trifoliata*	*Zizia aurea*
Common Name	Skunk Currant	Sycamore	Hairy Agrimony	Saskatoon-berry	Hawthorn	Hawthorn	Hawthorn	Hawthorn	Purple Avens	Indian Psychic	Wild Rose	Hardhack	Groundnut	Canada Milk-vetch	Round headed Bush Clover	Bush Clover	Bush Clover	Virginia Yellow Fever	Milkwort	Mountain Holly	Burning Bush	Hybrid Maple	Large Canadian St. John's-wort	Pinweed	Green Violet	Marsh Violet	Violet	Violet	Violet	Water Willow	Fireweed	Downy Willowherb	Northern Water-milfoil	Ginseng	Long-styled Canadian Sanicle	Black Snakeroot	Golden Alexanders
Status	r	r	R	r	r	r	NPR	NPR	r	NPR	r	r	r	R	R	R	R	NPR	r	R	NPR	r	r	r	NPR	r	r	r	r	r	r	R	r	NPr	NPR	r	R
Affinity		C		S			C	C							S	C,S	S	C,S	S		C						S							C		
ESA																																						
AW																								X									X				
HFC																				X				X							X			X			X
BS	X		X										X		X																							
BCR		X		X					X		X		X	X		X	X	X	X					X			X		X				X				
BCV																																						
BDF																						X																
BS					X				X															X			X		X		X		X		X		
CP							X								X																							
CNF									X												X			X			X				X		X		X		
CLR																																						
FCS							X																															
FEW									X											X										X								
GJW						X			X	X		X			X													X										
LMM																																						
MH	X																																					
MS														X																								
MN								X																									X					
MEW																																						
MWA															X								X															
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SNW																																						
SSD																																						

	Vascular Plants																																						
Scientific Name	*Chimaphila umbellata*	*Orthilia secunda*	*Pyrola asarifolia*	*Pyrola virens*	*Arctostaphylos uva-ursi*	*Chamaedaphne calyculata*	*Gaultheria hispidula*	*Ledum groenlandicum*	*Kalmia polifolia*	*Vaccinium corymbosum*	*Vaccinium myrtilloides*	*Vaccinium oxycoccos*	*Lysimachia terrestris*	*Gentiana crinita*	*Gentianella quinquefolia*	*Halenia deflexa deflexa*	*Asclepias tuberosa*	*Asclepias viridiflora*	*Calystegia spithameus*	*Aureolaria flava*	*Lindernia dubia*	*Veronica catenata*	*Orobanche uniflora*	*Utricularia intermedia*	*Utricularia minor*	*Galium pilosum*	*Galium tinctorium*	*Campanula aparinoides*	*Campanula uliginosa*	*Lobelia spicata*	*Anaphalis margaritacea*	*Aster azureus*	*Aster borealis*	*Aster ericoides*	*Aster sagittifolius*	*Helenium autumnale*	*Helianthus strumosus*
Common Name	Pipsissewa	Wintergreen	Pink Pyrola	Shinleaf	Bearberry	Leather-leaf	Creeping Snowberry	Labrador-tea	Bog Laurel	Highbush Blueberry	Velvet-leaved Blueberry	Small Cranberry	Swamp Candles	Fringed Gentian	Stiff Gentian	Spurred Gentian	Butterfly-weed	Green Milkweed	Low Bindweed	Yellow False Foxglove	False Pimpernel	Speedwell	Cancer-root	Flat-leaved Bladderwort	Small Bladderwort	Bedstraw	Bedstraw	Marsh-bellflower	Marsh Bellflower	Pale-spike Lobelia	Pearly Everlasting	Sky-blue Aster	Bog Aster	Heath Aster	Arrow-leaved Aster	Sneezeweed	Pale Leaved Sunflower
Status	r	r	r	r	r	r	r	r	r	r	r	r	r	R	NPR	r	r	PR	r	r	r	R	r	r	R	NPR	r	r	r	R	r	r	r	r	r	R	R
Affinity															S			S	S		C											S				S	S	S
ESA																																						
AW																																						
HFC																																						
BS		X	X		X	X	X	X			X	X	X	X	X	X								X								X					X
BCR						X																																
BCV					X	X												X		X		X		X			X				X		X	X	X		
BDF																																						
BS																																						
CP														X										X			X	X				X						
CNF																																						
CLR	X				X	X				X										X				X									X				
FCS																																						
FEW																																						
GJW						X																X								X							
LMM				X					X																													X
MH																		X																				
MS																																						
MN																																						
MEW																														X	X							
MWA																								X														
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SSD																																						

	Vascular Plants					Mosses		Fish			Reptiles & Amphibians							Birds																						
Scientific Name	*Hieracium scabrum*	*Lactuca biennis*	*Solidago gigantea*	*Solidago hispida*	*Solidago uliginosa*	*Platydictya convervoides*	*Thamnobryum alleghaniense*	*Ichthyomyzon unicuspis*	*Notropis photogenis*	*Clinostumus elongatus*	*Clemmys insculpta*	*Ambystoma jeffersonianum*	*Rana palustris*	*Thamnophis saurinus*	*Sternotherus odoratus*	*Emydoidea blandingii*	*Diadophis punctatus*	*Botaurus lentiginosus*	*Fulica americana*	*Anas americana*	*Buteo platypterus*	*Sterna caspia*	*Dendroica cerulea*	*Accipiter cooperi*	*Stalia stalis*	*Anas strepera*	*Regulus satrapa*	*Lophodytes cucullatus*	*Icobrachus exilis*	*Asio otus*	*Seiurus motacilla*	*Circus cyaneus*	*Icterus spurius*	*Podilymbus podiceps*	*Carpodacus purpureus*					
Common Name	Rough Hawkweed	Lettuce	Late Goldenrod	Hairy Goldenrod	Bog Goldenrod			Silver Lamprey	Silver Shiner	Redside Dace **	Wood Turtle	Jefferson Salamander	Pickerel Frog	Eastern Ribbon Snake	Stinkpot	Blanding's Turtle	Northern Ringneck Snake	American Bittern	American Coot	American Wigeon	Broad-winged Hawk	Caspian Tern	Cerulean warbler	Cooper's hawk	Eastern Bluebird	Gadwall	Golden-crowned Kinglet	Hooded Merganser **	Least Bittern	Long-eared Owl	Louisiana Waterthrush	Northern Harrier	Orchard Oriole	Pied-billed Grebe	Purple Finch					
Status	r	r	r	r	r		R	N or P	NV	V	N or P	NPrT	NPr	N or P	N or P	r	P	r	r	r	r	NPrS	rS	NPrS	NPr	r	r	r	NPrS	rS	NPrS	r	N	r	r					
Affinity																							C							C		C								
ESA																																								
AW																					X				X															
HFC												X	X	X																X										
BS													X			X		X		X	X		X	X			X			X	X									
BCR									X		X						X													X		X								
BCV	X		X	X				X	X		X													X	X				X											
BDF																																								
BS																																								
CP					X							X	X	X										X				X												
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CLR		X										X			X																									
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MN						X	X					X																				X								
MEW													X																											
MWA										X									X						X		X	X			X	X								
PNS																																								
PSW													X																		X									
SNW																																								
SSD																																								

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	Birds			Mammals													
Scientific Name	*Vireo solitarius*	*Sphyrapicus varius*	*Coccyzus americanus*	*Lynx rufus*	*Pipistrellus subflavus*	*Myotis liebii*	*Sorex palustris*	*Glaucomys sabrinus*	*Napaeozapus insignis*	*Erethizon dorsatum*	*Carterocephalus palaemon*	*Hesperia leonardus*	*Poanes massasoit*	*Pieris virginiensis*	*Fenisseca tarquinius*	*Satyrium caryaevorum*
Common Name	Solitary Vireo	Yellow-bellied Sapsucker **	Yellow-billed Cuckoo	bobcat	Eastern Pipistrelle	Small-footed Bat	Water Shrew	Northern Flying Squirrel	Woodland Jumping Mouse	Porcupine	Arctic Skipper	Leonardus Skipper	Mulberry Wing	West Virginiu White	Harvester	Hickory Hairstreak
Status	r	r	r	N or P	N or P	HS	r	r	r	r	r	r	P	P	r	P
Affinity														C		
ESA																
AW																
HFC				X												
BS	X						X	X	X	X	X	X	X	X	X	X
BCR														X		
BCV																
BDF																
BS																
CP																
CNF														X		X
CLR					X											
FCS																
FEW														X		
GJW																
LMM											X			X		
MH																
MS																
MN					X	X										
MEW			X											X		
MWA		X					X	X						X		
PNS																
PSW											X					
SNW																
SSD															X	

Status
N-Nationally Rare
P-Provincally Rare
r-Rare in Old Central Region
V-Nationally Vulnerable
R-Regionally Rare
T-Threatened
Affinities
C-Carolinian
S-Prarie/Savannah
A-Alvar

ESA Abbreviations	
AW	Aberfoyle Woods
BS	Beverly Swamp
BCR	Bronte Creek Ravine/Lowville-Bronte Creek Escarpment Valley
BCV	Bronte Creek Valley
BDF	Brookville Drumlin Field
BS	Brookville Swamp
CP	Calcium Pits
CNF	Carlisle North Forests
CLR	Crawford Lake/Rattlesnake Point Escarpment Woods
FCS	Flamboro Centre Swamp
FEW	Freelton Esker-Wetland Complex
GJW	Guelph Junction Woods
HFC	Hilton Falls Complex
LMM	Lake Medad & Medad Valley
MH	Milton Heights
MS	Moffat Swamp/Moffat Marsh/Fish Hatchery Swamp
MN	Mount Nemo Escarpment Woods
MEW	Mountsberg East Wetlands
MWA	Mountsberg Wildlife Area
PNS	Progreston North Swamp
PSW	Puslinch Southeast Wetland
SNW	Strabane North Wetlands
SSD	Strabane Southwest Drumlin Field

APPENDIX 2

AREAS OF NATURAL AND SCIENTIFIC INTEREST

Provincially Significant Life Science ANSIs (Gould, 1985 a,b,c,d; Gould, 1989; Riley et al., 1997;Hanna, 1981; Varga et al., 1994)

Beverly Swamp

This feature represents one of the largest relatively undisturbed swamps in Southern Ontario (* ha). The site consists of swamp forest and associated wetlands which are the headwater source of Fairchild Creek (Grand River), Spencer Creek and Strabane Creek (Bronte Creek).

Bronte Creek Escarpment Valley

The Bronte Creek Escarpment Valley is representative of a re-entrant valley of the Niagara Escarpment. The forested valley system is relatively undisturbed and consists of sugar maple forests on the upper and middle ravine slopes, red oak stands on the south facing upper slopes, and conifer forests on the lower slopes. The site contains numerous regionally and locally rare plant, bird, butterfly and fish species (Riley et al., 1996).

Bronte Creek Provincial Park Nature Reserve Zone

The nature reserve zone consists of a tableland forests, dry valley rim communities, mature slope communities and a deep, sheltered valley which conveys the main branch of Bronte Creek. Rare prairie communities are associated with hydro corridors along the east rim of the valley. The cooler, moister north-facing slopes are dominated by eastern hemlock and sugar maple while the warmer, drier south-facing slopes consist of white, red and chinquapin oaks and sugar maple.

Crawford Lake/ Milton Outlier Valley

The southern portion of this ANSI is represented by rich broadleaf escarpment plain forests, mixed and broadleaf talus forest and successional mixed swamps including an unusual wet mesic sugar maple-bitternut hickory-white ash stand. The northern portion of the ESA supports the largest example of mixed and broadleaf talus forests in Halton. The site also supports high quality open cliff and conifer rim forests, some of which may have old-growth attributes. The merimictic Crawford Lake is an unusual and unique feature within the Bronte Creek watershed. This ANSI supports nationally and provincially rare ginseng, green violet as well as other significant flora and fauna.

Halton Forest South

A small portion of the Halton Forest South ANSI is located within the Bronte Creek watershed with the remainder lying within the Sixteen Mile Creek watershed. This ANSI supports the largest expanse of forest south of the Bruce Peninsula as well as extensive escarpment slope features and wetlands.

Lowville-Bronte Creek Valley

The Lowville-Bronte Creek Valley includes relatively undisturbed valley, slope and bottom land forests within a re-entrant valley feature on the Niagara Escarpment. Vegetation communities of note include a mature black maple-sugar maple-white cedar floodplain forest and a mesic mixed hemlock lower slope forest. The ANSI contains excellent habitat for the nationally and provincially vulnerable wood turtle and the locally rare northern ringneck snake. The nationally and provincially threatened eastern spiny softshell turtle has also been identified within this feature.

Medad Valley

This Escarpment valley feature straddles the boundary between the Grindstone Creek and Bronte Creek watersheds and is the headwater source for a tributary of Grindstone Creek as well as Willoughby Creek (Bronte Creek). The valley, slopes and tablelands support a high diversity of vegetation communities including broadleaf swamps, thicket swamps, a conifer swamp, a shallow emergent marsh and a mesic broadleaf forest. Organic peat deposits and a shallow lake are found within the valley. The site contains numerous rare and significant species of flora and fauna.

Mount Nemo Escarpment

Mount Nemo supports representative Niagara Escarpment features such as plain, rim, cliff, talus slope and shale slope forests. This ANSI supports the largest example of Butternut-Basswood talus forest in the area. Old-growth white cedar forests are found along the cliff face. The diverse habitats found within the ANSI support a variety of rare species including species endemic to dolostone habitats and species with Carolinian affinities.

Regionally Significant Life Science ANSIs

Brookville Swamp

The Brookville Swamp ANSI consists of wooded areas dominated by silver maple-balsam poplar-cedar wetlands and rich upland sugar maple-mixed hardwood forest (Geomatics 1995).

Kilbride Swamp

Kilbride Swamp is represented by outwash deposits in a re-entrant valley. The vegetation communities are represented by dry-mesic red oak-white pine forests, successional mixed and conifer forests, mixed swamps, thicket swamps and a natural pond. The ANSI is represented by 36 vegetation community types and supports the nationally and provincially rare green violet and the provincially rare round-leaved orchid (***). Kilbride Swamp also supports several rare bird species and a high diversity of herpetofauna.

Mountsberg Wildlife Centre

This ANSI includes the Mountsberg Reservoir and adjacent natural communities associated with the Mountsberg Conservation Area. The site includes drumlins, deciduous and coniferous swamps, and mature upland forests. The reservoir represents a significant waterfowl breeding area, staging area and stopover for migrating passerines, shorebirds and waterfowl. Mature upland forests and a mix of deciduous and coniferous swamps are found adjacent to the reservoir.

Zimmerman Valley

Zimmerman Valley represents the north end of a deep, well-vegetated valley system which extends downstream to Lake Ontario, conveying Bronte Creek to Bronte Harbour. This portion of the valley is characterized by oak? (check Armour 1979) forests on the warmer, drier east slopes with mixed forests of eastern hemlock, white cedar and sugar maple along the relatively cool and wet western slopes. The eastern slopes support several Carolinian species.

Provincially Significant Earth Science ANSIs

Freelton Esker

The Freelton Esker is the largest complex of eskers in the area, representing late stages of the recession of Lake Ontario ice lobe towards the Lake Ontario basin during the late stages of the Port Bruce Stadial. The esker consists of low uneven gravel deposits, and is considered the best example of an esker landform within the City of Hamilton. Lowlands between the gravel

ridges are associated with the Beverly Swamp.

Halton Till

This ANSI consists of a small exposure of Halton Till along an eroding portion of Bronte Creek. Halton Till is a widespread feature within the watershed between the Escarpment and the Trafalgar Moraine and is associated with a Wisconsonian glacial deposit laid down by the retreating Ontario ice lobe during the Port Huron Stadial.

Lowville Re-entrant Valley

The Lowville Re-entrant Valley is a significant set of spillway features extending from Mount Nemo to Rattlesnake Point. Extensive sand and gravel deposits are associated with Calcium Pits and Nassagaweya Canyon.

Mount Nemo

The Mount Nemo ANSI provides an excellent representation of a major promontory and bedrock components of the Niagara Escarpment. The area also contains exposures of the Amabel Formation and representation of the southern rim of the Lowville re-entrant valley which channeled glacial ice and meltwater through the escarpment. The site also has well developed open joints and crevices along the edge of the escarpment.

Paris, Galt and Moffat Moraine

The Paris and Galt Moraines (also known as the horseshoe moraines) represent coarse sand and gravel deposits associated with the recession of the Ontario ice lobe during the Port Bruce Stadial. The Moffat Moraine consist of a series of hummocky ridges, deposited after the Port Bruce Stadial.

Regionally Significant Earth Science ANSIs (OMNR, 1983a,b,c; Kor, 1991; Kor, 1991a)

Exhumed Silurian Reef

The Exhumed Silurian Reef is a regionally significant ANSI represented by a roche moutonnee created by glacial erosion of the Silurian Amabel Formation bedrock. Glacial striae are evident on top of the reef.

Lake Medad and Spillway Channel

The Lake Medad and Spillway Channel is an example of a partially filled abandoned glacial meltwater channel that drained into the Milton Outlier. Marl (calcium carbonate) and black organic ooze deposition is occurring within Lake Medad. The location of Lake Medad within a bedrock channel indicates deep erosion by glacial meltwater during the Pleistocene period.

Trafalgar Moraine

The Trafalgar Moraine extends from * to *. The exposure at Tremaine Road and No. 2 Sideroad is indicative of this relatively young moraine feature which is characterized by prominent flutings in the Halton till and ablation patterns. The reddish boulder till contatins a significant portion of Queenston shale.

APPENDIX 3

ENVIRONMENTALLY SENSITIVE/SIGNIFICANT AREAS

A general description of each ESA is provided below. Where ESAs are contiguous between regional jurisdictions (i.e. Lowville-Bronte Creek Valley), they are grouped under one site heading with reference to their designation in each region. (Heagy, 1993; Geomatics, 1995; Eagles *et al.*, 1976)

Aberfoyle Woods (Wellington ESA #9)

Aberfoyle Woods, located primarily within the Grand River watershed, extends into the headwaters of Mountsberg Creek along the Galt moraine. This extensive feature consists of a diverse array of upland and lowland vegetation communities which provide habitat for many uncommon or rare plants and wildlife. The moraine is an important groundwater recharge area and is a headwater source for Mountsberg Creek as well as Aberfoyle Creek and Galt Creek within the Grand River watershed. This feature is linked to the Moffat Marsh, Moffat Swamp and Fish Hatchery Swamp ESAs to the south and east.

Beverly Swamp (Hamilton-Wentworth ESA #29)

The Beverly Swamp ESA lies within the Flamborough Plain physiographic region, extending 15 km east from the edge of Waterloo Region to Highway 6. This extensive feature provides the headwater source for streams in three watersheds including Fairchild Creek (Grand River), Spencer Creek and Strabane Creek (Bronte Creek).

Within the Bronte Creek watershed, the Beverly Swamp ESA encompasses the eastern boundaries of the provincially significant Beverly Swamp Life Science ANSI and the provincially significant Beverly Swamp Wetland Complex. This ESA also represents the only Carolinian Canada site within the Bronte Creek watershed and is regarded as one of the best examples of swamp forest in the Carolinian Zone (Heagy et al. 1993).

Beverly Swamp supports extensive tracts of swamp forest and includes terrestrial, wetland and aquatic communities that are rare or uncommon in southern Ontario. Within the Bronte Creek watershed, the ESA supports broadleaf and mixed swamps and plays an important role in providing water storage, stabilizing stream flows, and maintaining regional hydrology (Heagy et al. 1993).

Beverly Swamp also provides habitat for nationally, provincially and regionally significant vegetation and wildlife. Mixed/coniferous swamps provide yarding areas for white-tailed deer while drowned swamps provide suitable habitat for colonial nesters such as great blue heron. The extensive tracts of unbroken forest support breeding habitat for interior forest bird species.

This ESA forms a highly significant interwatershed linkage draining to three separate watersheds as noted above. Within the Bronte Creek watershed, Beverly Swamp is linked to the Freelton Esker-Wetland Complex and Strabane North Wetlands to the east and to the Strabane Southwest Drumlins to the south.

Lowville-Bronte Creek Escarpment Valley/Bronte Creek Ravine (Halton ESA #9 and Hamilton-Wentworth ESA #36)

The deep glacial spillway valley feature associated with this ESA extends along Bronte Creek from Lowville upstream to Progreston. This feature lies within the UNESCO-designated Niagara Escarpment Biosphere Reserve. Two provincially significant Life Science ANSIs (Lowville-Bronte Creek Valley and Bronte Escarpment Valley) are located within the ESA as is the locally significant Cedar Springs Swamp.

The valley walls are well-vegetated and are dominated by broadleaf and mixed forest cover. A mosaic of broadleaf swamp and

riparian meadow communities are found in the floodplain. The ESA supports a large number of native plant communities, including an uncommon black maple-mixed hardwood community. Large tracts of contiguous forest provide suitable habitat for interior forest bird species. Large amounts of groundwater discharge emanating from the deep glacial spillway deposits in the valley aid in maintaining coldwater habitat within the main branch of Bronte Creek and the downstream portions of Willoughby Creek, Kilbride Creek and Flamborough Creek.

This ESA is linked to the Progreston North Swamp ESA and the Lake Medad/Medad Valley ESAs.

Bronte Creek Valley (Halton ESA #10)

The Bronte Creek Valley ESA extends from No. 2 Sideroad downstream to Bronte Harbour. Two ANSIs (Bronte Creek Provincial Park Nature Reserve Zone and Zimmerman Valley have been designated within the valley. The locally significant Bronte Marsh lies within the Bronte Creek estuary just upstream from Bronte Harbour. The north portion of the ESA lies within the Niagara Escarpment Biosphere Reserve.

Bronte Creek Valley has the highest native vascular plant species richness of Halton's ESAs, containing 14 separate native plant communities including a remnant prairie community. The site lies near the northern limit of the Carolinian zone and includes such species as chinquapin oak (*Quercus muehlenbergii*) and sassafras (*Platanus occidentalis*). The north-facing slope is dominated by sugar maple and eastern hemlock whereas oak-maple forests are found along the warmer, drier south-facing slopes. The valley floor is well vegetated with successional willow or maple-dominated communities. The area also represents one of the best deciduous upland woodlands in the region (Hanna 1984). The creek provides a migratory route for rainbow trout (*Oncorhynchus mykiss*) and chinook salmon (*O. tshawytscha*) and supports spawning habitat for smallmouth bass (*Micropterus dolomieui*). The Bronte Creek Valley provides an important link for migratory bird species providing a connection between the Lake Ontario shoreline and the woodlands of the Niagara Escarpment.

Brookville Drumlin Field (Halton ESA #43)

The Brookville Drumlin Field consists of elongated hills (drumlins) composed of unsorted till separated by flat till plain. This ESA contains portions of the provincially significant Badenoch-Moffat and Halton Escarpment Wetland Complexes. The Brookville Swamp ANSI also lies within the drumlin fields. This ESA extends across both the Bronte Creek and the Sixteen Mile Creek watersheds and is considered the best representation of a drumlin field and drumlin landforms within Halton Region (Geomatics, 1995). The Brookville Drumlin Field is contiguous with the Brookville Swamp ESA.

Brookville Swamp (Halton ESA #22)

Brookville Swamp is located in a low-lying area on the Flamborough Plain and consists of mixed swamp complexes and upland sugar maple-mixed hardwood forests. Portions of the site form part of the Brookville Swamp ANSI and the provincially significant Guelph Junction wetland complex. This relatively undisturbed swamp straddles the boundaries of the Bronte Creek and Sixteen Mile Creek watersheds. Brookville Swamp is contiguous with the Brookville Drumlin Field ESA.

Calcium Pits (Halton ESA #19)

The Calcium Pits ESA encompasses significant portions of the Crawford Lake-Milton Outlier Valley and Kilbride Swamp ANSIs as well as portions of the provincially significant Crawford Lake and

Calcium Pits Wetland Complex. A portion of the ESA has also been designated as part of the Niagara Escarpment Biosphere Reserve.

The valley consists of a spillway and extensive marl deposits, which were mined in the 1920s and 1930s creating open pits which now form a complex of ponds and wetlands west of Twiss Road. These wetlands provide suitable habitat for several rare orchids. Groundwater discharge contributes to the maintenance of resident brook trout populations in Limestone Creek. The slopes and tablelands support a variety of forest types with occasional dolostone bedrock exposures.

Calcium Pits is contiguous with the Guelph Junction Woods ESA to the north and to the Crawford Lake/Rattlesnake Point ESA to the east.

Carlisle North Forests (Hamilton-Wentworth ESA #38)

The Carlisle North Forests ESA encompasses portions of the provincially significant Lower Mountsberg Creek Complex and the locally significant North Carlisle Swamp. The ESA supports broadleaf and mixed upland forests, which include several provincially and regionally significant species. The ESA is also important hydrologically in the maintenance of coldwater conditions in the headwaters of Flamboro Creek. Carlisle North Forests is part of a larger network of natural areas of upland forests, wetlands, and stream corridors and is closely linked to the Mountsberg East Wetlands ESA to the northwest and the Progreston North Swamp ESA to the east.

Crawford Lake/Rattlesnake Point Escarpment Woods (Halton ESA #18)

Portions of the Crawford Lake/Rattlesnake Point Escarpment Woods ESA have been designated as part of the Niagara Escarpment Biosphere Reserve (Crawford Lake South). The ESA also encompasses a significant portion of the Crawford Lake-Milton Outlier Valley ANSI. Portions of two provincially significant wetland complexes (Crawford Lake and Calcium Pits Wetland Complex, Nassagaweya Canyon Wetland) are also located within this ESA.

The vegetation communities consist of variety of mature upland hardwoods forest, mixed forest, slope forests, talus slope forests and mixed swamps. Old growth white cedar cliff forests are associated with exposed cliffs along the Escarpment edge. Crawford Lake is a meromictic lake that is unique within the Bronte Creek watershed. The thick sand and gravel deposits associated with the Nassagaweya Canyon spillway provide significant groundwater recharge which eventually give rise to significant groundwater discharge which supports coldwater salmonid habitat in Limestone Creek.

Crawford Lake/Rattlesnake Point provides a significant linkage along the Milton Outlier, connecting the Calcium Pits ESA to the Milton Heights ESA.

Flamboro Centre Swamp (Hamilton-Wentworth ESA #37)

The Flamboro Centre Swamp ESA encompasses portions of the provincially significant Flamborough wetland complex which extends into the Bronte Creek and Grindstone Creek watersheds. The ESA consists of forested wetlands which function as groundwater recharge zones which are the headwater sources of tributaries within both watersheds. The vegetation largely consists of broadleaf swamps, marsh and tall shrub thickets. The Flamborough Centre Swamp is weakly linked to the Bronte Creek Ravine and Medad Valley ESAs.

Freelton Esker-Wetland Complex (Hamilton-Wentworth ESA #30)

The Freelton Esker-Wetland Complex encompasses portions of the provincially significant Beverly Swamp Wetland Complex (Class 1).

The vegetation communities consist of silver maple swamps, upland hardwoods, old fields and abandoned borrow pits. Drowned swamps provide important nesting habitat for great blue herons. The wetlands feed into a reach of Bronte Creek which supports a coldwater fish community. Groundwater supports the wetlands and contributes to baseflow of the coldwater stream.

The ESA is part of a network of natural areas and is linked to the following ESAs: Puslinch Southeast Wetland, Mountsberg East Wetlands, Strabane North Wetland, Beverly Swamp and Carlisle North Forests.

The ESA contains high significant species such as the West Virginia white butterfly.

Guelph Junction Woods (Halton ESA #20)

The Guelph Junction Woods encompasses portions of two provincially significant wetland complexes (Crawford Lake and Calcium Pits Wetland Complex and the Guelph Junction Wetland Complex). A portion of the ESA has been designated as part of the Niagara Escarpment Biosphere Reserve.

The Guelph Junction Woods ESA is characterized by undisturbed mixed forest and wetland habitats which support many regionally rare plants. The area is a major recharge zone for groundwater and is the headwater source for portions of Limestone and Kilbride Creek. Guelph Junction Woods is closely linked to the following ESAs: Mountsberg East Wetlands, Mountsberg Wildlife Area, and Calcium Pits.

Hilton Falls Complex (Halton ESA #25)

Only a small portion of the Hilton Falls ESA is found within the Bronte Creek watershed. Portions of the ESA have been designated as part of the Niagara Escarpment Biosphere Reserve. This ESA encompasses the Halton Forest South ANSI.

The Hilton Falls Complex is the largest ESA and forest unit in Halton and is considered the largest forest unit along the Niagara Escarpment south of the Bruce Peninsula. A number of nationally and provincially rare flora and fauna as well as an old growth cedar cliff forest are found in the ESA. Hilton Falls represents one of the richest vascular flora and botanical sites in the region. The site provides an excellent linkage for migrating raptors and passerines between Guelph Junction Woods, Milton Heights, and Speyside Escarpment Woods. The ESA is known to contribute to groundwater recharge and contributes significant discharge to the Sixteen Mile Creek watershed.

Lake Medad and Medad Valley (Halton ESA #7 and Hamilton-Wentworth ESA #29)

Lake Medad and Medad Valley has been recognized by UNESCO as part of the Niagara Escarpment Biosphere Reserve. The ESA also encompasses the Medad Valley ANSI and the provincially significant Lake Medad Valley Swamp Wetland Complex. Lake Medad and Medad Valley extend into both the Grindstone Creek and Bronte Creek watersheds.

Lake Medad is a small natural lake found at the bottom of the valley. The forests provide habitat for nationally, provincially and regionally rare plant species and a deer yard is associated with conifer swamps along the valley floor. The ESA provides refuge for wildlife species requiring large tracts of undisturbed forest. Significant groundwater discharge to Willoughby Creek and a tributary of Grindstone Crees aids in maintaining cool, constant baseflows in these systems.

The ESA is closely linked to the Lowville-Bronte Creek Escarpment Valley ESA and to the Waterdown North Wetlands and Wyatt Road Wetland ESAs within the Grindstone Creek watershed.

Milton Heights (Halton ESA #17)

The majority of the Milton Heights ESA lies within the Sixteen Mile Creek watershed. The ESA has been designated as part of the Niagara Escarpment Biosphere Reserve. The Niagara Escarpment and associated tableland and talus slope forests are the prominent features of the Milton Heights ESA. A rare old growth cedar forest is found along its vertical cliffs and the ESA exhibits a high native plant and animal species richness. Headwater swamps on the tablelands form the headwaters of Limestone Creek (east branch). Milton Heights is connected to the Crawford Lake-Rattlesnake Point Escarpment Woods ESA.

Moffat Swamp, Moffat Marsh, Fish Hatchery Swamp (Halton ESA #21, Wellington ESA #7 and ESA #8)

This set of interconnected ESAs incorporates portions of the provincially significant Badenoch-Moffat and Guelph Junction wetland complexes. The area consists of silver maple-black ash swamp, conifer swamp, shrub marshes and open cattail marsh. Large areas of contiguous forest provide habitat for interior forest bird species. High interspersion of habitats within more open portions of the wetland provide suitable breeding habitat for a number of wetland bird species. These wetlands maintain high surface water quality within several tributaries of Mountsberg Creek and may contribute significant groundwater discharge to these systems. These ESAs are linked to the Aberfoyle Woods ESA to the north and the Mountsberg Wildlife Area ESA to the south.

Mount Nemo Escarpment Woods (Halton ESA #8)

A portion of the Mount Nemo Escarpment Woods ESA has been designated as part of the Niagara Escarpment Biosphere Reserve. This ESA also encompasses the Mount Nemo Escarpment ANSI and the locally significant Mount Nemo Wetland Complex.

The most prominent feature within the ESA is the Niagara Escarpment, which consists of high cliffs and deep crevice caves. Red oak-sugar maple forests are the dominant tableland forest community and the extensive cliff system supports a significant old growth cedar community. Southern exposures provide suitable habitat for flora with Carolinian affinities such as yellow mandarin and flowering dogwood. Groundwater discharge along the Escarpment slopes is the headwater source for tributaries of Mount Nemo Creek and Lowville Creek. Mount Nemo Escarpment Woods is closely linked to the Nelson Escarpment Woods ESA to the south and is linked via Mount Nemo Creek and agricultural fields to the Bronte Creek Valley ESA to the east.

Mountsberg East Wetlands (Hamilton-Wentworth ESA #36)

The Mountsberg East Wetlands ESA encompasses portions of the provincially significant Lower Mountsberg Creek, Beverly Swamp and Guelph Junction wetland complexes. This ESA consists of a network of interconnected natural areas within a large drumlin field (Heagy, 1993). The natural areas include tall shrub thicket swamp, a mixed coniferous swamp, broadleaf swamps, and upland forest. Mixed coniferous swamps support in the eastern portion of the ESA are part of the extensive Guelph Junction deer wintering area (Heagy, 1993). The wetlands between the drumlins likely function as important sites of groundwater recharge and assist in maintaining water quality in the upper Bronte Creek and Mountsberg Creek. The

Mountsberg East Wetlands ESA is contiguous with the following ESAs: Mountsberg Wildlife Area, Guelph Junction Woods, Carlisle North Forests and is weakly connected with the Puslinch South Wetlands ESA.

Mountsberg Wildlife Area (Hamilton-Wentworth ESA #35 and Wellington ESA #6)

The Mountsberg Wildlife Area ESA encompasses the Mountsberg Wildlife Centre ANSI and the provincially significant Mountsberg Reservoir Marsh as well as portions of the provincially significant Guelph Junction and Lower Mountsberg Creek wetland complexes.

The site consists of drumlins, deciduous and coniferous swamps, mature upland forests and an extensive marsh formed by the construction of the Mountsberg Reservoir in 1967. The marsh supports a number of aquatic macrophytes which are rare within the watershed. The reservoir is recognized as a provincially significant waterfowl staging area and a significant stopover for migrating shorebirds and passerines. A variety of wetland bird species utilize the marsh and adjacent habitats for breeding. The Mountsberg Wildlife Area is linked to several ESAs including Moffat Swamp to the north, Guelph Junction Woods to the east and Mountsberg East Wetlands to the south.

Progreston North Swamp (Hamilton-Wentworth ESA #40)

The Progreston North Swamp ESA encompasses portions of the locally significant North Progreston Swamp wetland. Vegetation communities are dominated by broadleaf and cedar swamps which provide groundwater discharge and are important in maintaining surface water quality in Flamboro creek. The Progreston North Swamp ESA provides a forested corridor which is linked to the Bronte Creek Ravine ESA to the south, Carlisle North Forests to the northwest and with Calcium Pits to the east.

Puslinch Southeast Wetland (Hamilton-Wentworth ESA #27)

The Puslinch Southeast Wetland encompasses part of the provincially significant Beverly Swamp Wetland Complex. The plant communities within the ESA are predominantly cedar and silver maple swamps with marsh and wet meadow communities also represented. The wetlands support significant coldwater habitat in Bronte Creek. The Puslinch Southeast Wetland is linked with the Mountsberg East Wetland ESA to the east, the Freelton Esker-Wetland Complex ESA to the south and the Fletcher Creek Swamp Forest ESA (Spencer Creek watershed) and Beverly Swamp ESA to the west.

Strabane North Wetlands (Hamilton-Wentworth ESA #31)

The Strabane North Wetlands ESA is part of the provincially significant Beverly Swamp wetland complex. Vegetation communities are dominated by silver maple-black ash-cedar swamps, swamp thickets, and marsh communities. Groundwater discharge through the wetlands to Strabane Creek supports significant coldwater habitat. This ESA is contiguous with the Beverly Swamp ESA and is also linked to the Strabane Southwest Drumlin Field to the southwest.

Strabane Southwest Drumlin Field (Hamilton-Wentworth ESA #26)

The wetlands associated with the Strabane Southwest Drumlin Field are part of the provincially significant Beverly Swamp wetland complex. The ESA consists of narrow strips of wetlands between large drumlins associated with the Strabane Westover drumlin field which drains to Bronte Creek and Spencer Creek. Vegetation associations consist of a diverse array of wetland and upland communities. The ESA provides ecological linkages to the

Beverly Swamp ESA to the north and west, the Strabane North Wetlands ESA to the northeast, and the Westover Lowland Forest ESA to the south.