NIAGARA PENINSULA CONSERVATION AUTHORITY

SOUTH NIAGARA FALLS WATERSHED REPORT

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INTRODUCTION

The need for a Watershed Plan for the South Niagara Falls watershed has been identified in the Niagara Water Quality Protection Strategy (Regional Municipality of Niagara 2003), now known as the Niagara Water Strategy (NWS)(Regional Municipality of Niagara 2006). The NWS was based on 32 Local Management Areas (LMAs). The South Niagara Falls watershed is located entirely in LMA 2.14 and LMA 2.17, which together form the boundary of this watershed (Figure 1).

The South Niagara Falls watershed is an important watershed on the Niagara Peninsula; it is primarily agricultural, and no part of the South Niagara Falls watershed falls within the Greenbelt Plan area (Ontario Ministry of Municipal Affairs and Housing 2005a). In addition to spanning four municipalities (City of Niagara Falls, City of Welland, City of Port Colborne, and Town of Fort Erie), this watershed is also located in the Niagara River Area of Concern (AOC), which means that it has been determined by the International Joint Commission (IJC) that the aquatic environment has been severely affected. This poses both challenges and opportunities for the restoration strategies in the watershed plan.

The South Niagara Falls watershed is home to three Areas of Natural and Scientific Interest (ANSIs) including the Navy Island ANSI, Lyons Creek Floodplain ANSI, and Willoughby Clay Plain Muck Basin Forest and Marsh ANSI. A portion of the latter ANSI contains the Willoughby Marsh Conservation Area, managed by the Niagara Peninsula Conservation Area. In addition, the South Niagara Falls watershed contains two golf courses, and one of these golf courses preserves the Battle at Chippawa historic site dating back to the War of 1812.

WATERSHED PLANNING AND THE SOUTH NIAGARA FALLS WATERSHED

A watershed, also referred to as a catchment basin, is an area of land from which surface runoff (water, sediments, nutrients and contaminants) drain into a common water body (including for example, Hunters Drain, Lyons Creek and Usshers Creek). Watersheds include all water and water-dependent features such as wetlands, forests, urban areas, and agriculture (Pollution Probe 2004).

A watershed management plan is a proactive document created cooperatively by government agencies and the community to manage the water, land/water interactions, aquatic life and aquatic resources within a particular watershed to protect the health of the ecosystem as land uses change (Ontario Ministry of Environment and Energy and Ontario Ministry of Natural Resources 1993). The South Niagara Falls Watershed Plan provides a systematic strategy to guide development, identify and recommend alternative and preferred restoration programs, and strengthen stewardship and partnerships in the watershed. Completed in 2 phases, the Watershed Plan consists of:

- background data collection in the form of a watershed characterization;
- a summary of the key issues in the watershed;
- completion of any additional studies to fill in data gaps in the study area;
- identification and suitability of restoration sites, landowner incentive programs, and land acquisition based on key issues in the watershed; and
- creation of an implementation plan including a monitoring component.

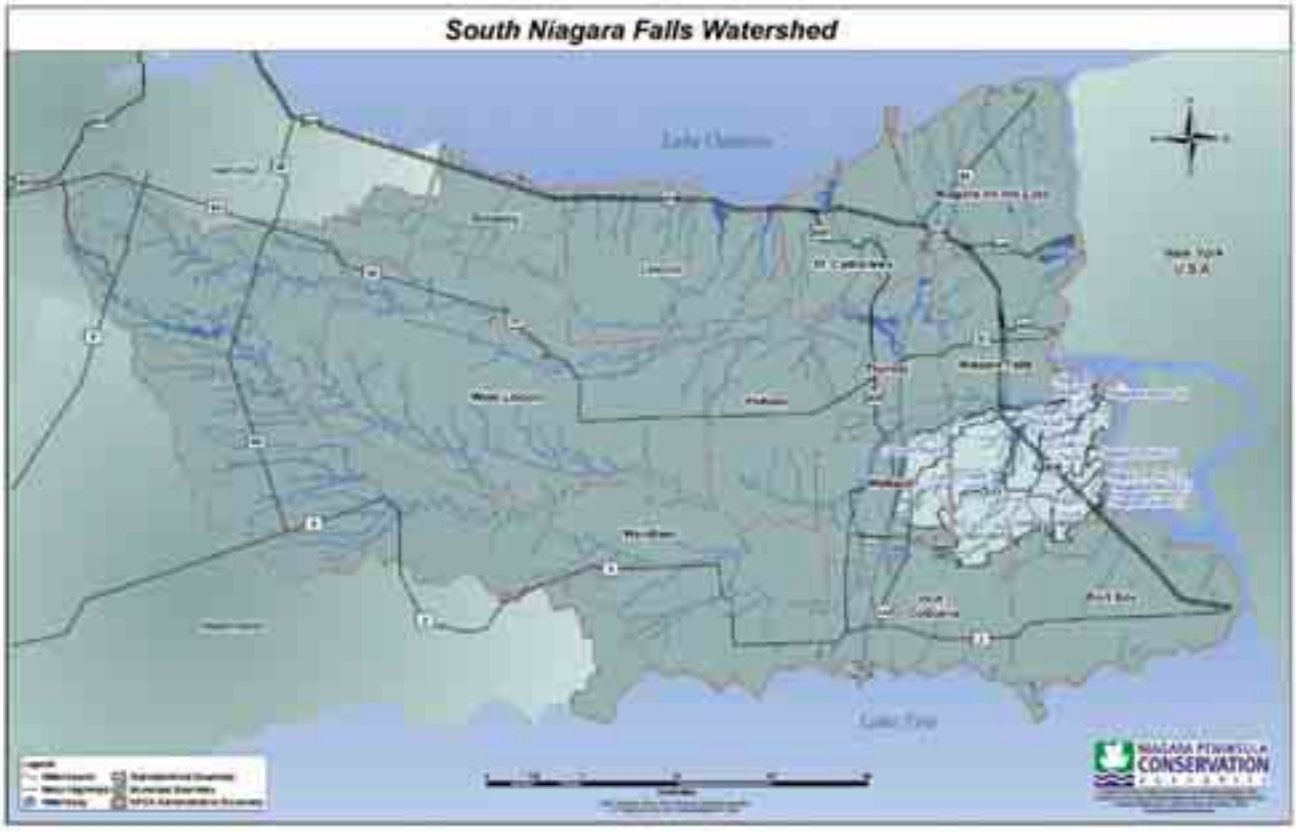

FIGURE 1: GEOGRAPHIC LOCATION

Completed over a 24 month period, the watershed planning process follows several steps including numerous opportunities for public involvement through open houses, workshops, and an agricultural land use survey (Figure 2). The Phase 1 watershed characterization contains a detailed background report including a description of the watershed's physiography, soils, land use, ecological, cultural and natural heritage, as well as a description of surface and groundwater resources. Phase 2 of the watershed planning process provides a set of watershed objectives that are linked to a comprehensive list of watershed issues derived from the NWS (Regional Municipality of Niagara 2006), and public events. Issues specific to agriculture were gathered through the Land Management Issues and Agricultural Best Management Practices survey (Appendix A), which was distributed to Ontario Federation of Agriculture members through a partnership with the Niagara Peninsula Conservation Authority. Any issues derived from these documents and public venues form the foundation of the watershed strategy and subsequent action plan, which are the focus of Phase 2 of the watershed planning process.

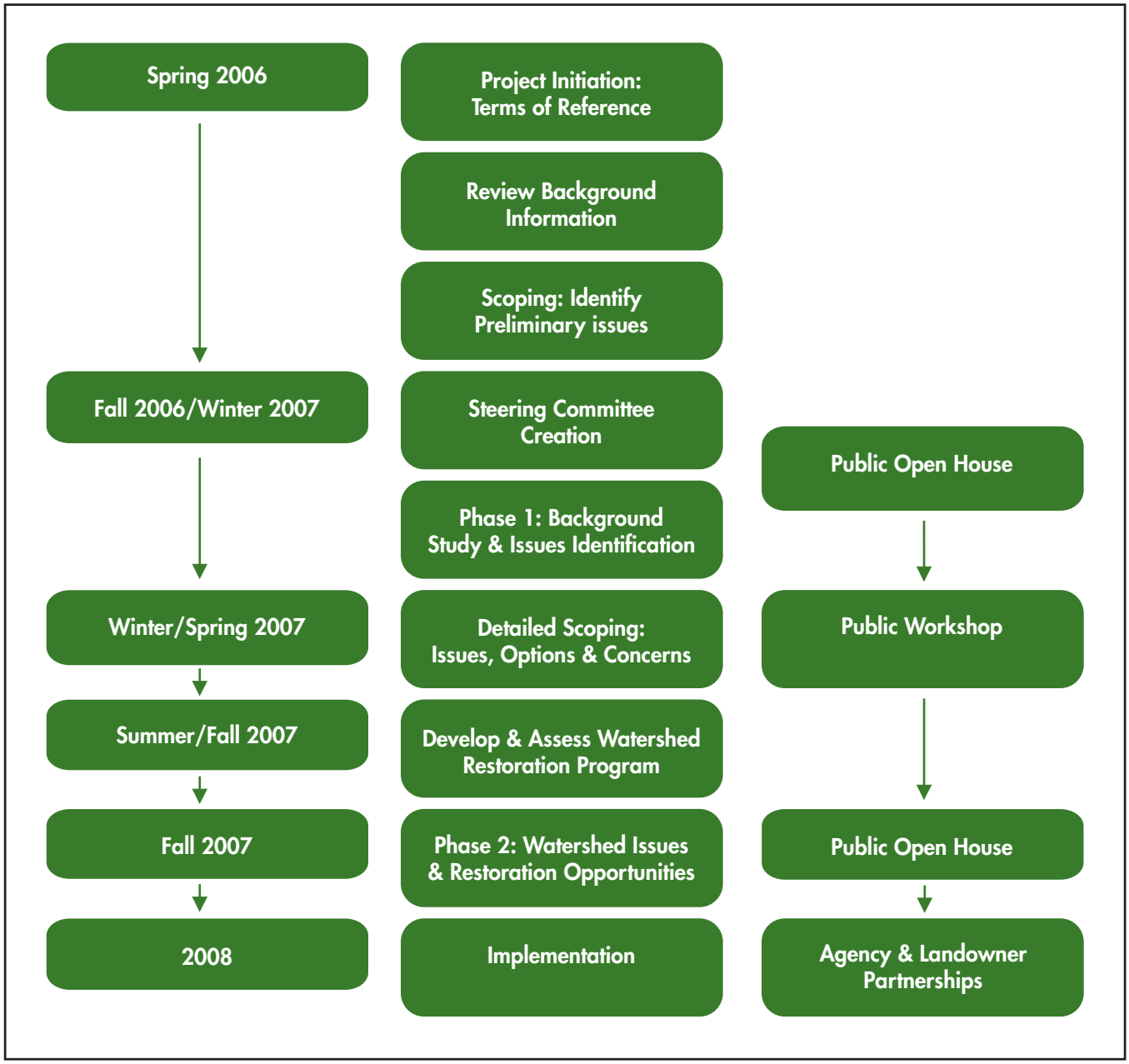

FIGURE 2: WATERSHED PLANNING FRAMEWORK

WATERSHED VISION

Under the Conservation Authorities Act (R.S.O. 1990, c.C27), the mandate of the Niagara Peninsula Conservation Authority is to establish and undertake programs designed to further the conservation, restoration, development and management of natural resources. In keeping with the mandate of the NPCA, NWS (Regional Municipality of Niagara 2006), and the watershed challenges and issues, residents of the South Niagara Falls watershed envision the following:

The South Niagara Falls watershed and its surrounding watersheds will support healthy natural areas, farms, watercourses, and habitat for a diversity of flora and fauna. The preservation, conservation and restoration of the watershed's ecosystem will protect society's resource needs by sustaining the ecological processes that naturally protect air, water, and land resources. Environmental stewardship, achieved through a collaborative approach to conservation, will help create a healthy watershed ecosystem and exciting opportunities for education and recreation for all citizens in the South Niagara Falls watershed.

WATERSHED OBJECTIVES

Each watershed in the Niagara Peninsula Conservation Authority's jurisdiction is unique, having its own set of watershed planning objectives. The watershed objectives for the South Niagara Falls watershed have been categorized based on the watershed's resource components, including the social and built environment. In accordance with the Provincial Policy Statement (Ontario Ministry of Municipal Affairs and Housing 2005b), Growth Plan for the Greater Golden Horseshoe (Ontario Ministry of Public Infrastructure Renewal 2006), Regional Policy Plan (Regional Municipality of Niagara 2007) and public input, natural resources will be managed on a watershed scale in the South Niagara Falls watershed to:

WATER RESOURCES

- maintain, enhance or restore natural stream processes to support human uses, agricultural needs and ecological functions in accordance with Ontario Water Quality Objectives and Remedial Action Plan (RAP) delisting criteria;
- protect, improve or restore all vulnerable areas (surface and groundwater features that can be easily changed or impacted by activities or events);
- ensure the equitable distribution and sustainable use of available surface and groundwater to protect water quality and quantity, aquatic and terrestrial ecosystems, and human health, and to supply existing and planned uses including municipal drains;
- ensure that storm water management practices minimize storm water volumes and contaminant loads, and maintain or increase the extent of vegetative and pervious surfaces;
- manage and mitigate flooding risks to human life and property within acceptable limits;
- minimize erosion caused by human activity through the establishment and implementation of a comprehensive, priority based erosion control program; and
- maintain, improve and provide opportunities for farm-related infrastructures such as drainage and irrigation.

FISH AND AQUATIC HABITAT

- protect, enhance and restore populations of native species and their habitats in the watershed.

NATURAL HERITAGE AND RESOURCES

- protect, enhance and restore the health, diversity and ecological functions of the natural heritage systems in the watershed and their linkages to natural heritage systems in adjoining watersheds;
- protect, enhance, and restore woodlands and other natural heritage features and their ecological functions for the long term;
- maintain, restore and improve the linkages among surface water features, groundwater features, hydrologic functions and natural heritage features and areas, and their ecological functions; and
- preserve all wetlands in the watershed.

COMMUNICATION, EDUCATION AND RECREATION

- foster and develop partnerships between and amongst agencies, interest groups and landowners;
- promote awareness of the linkages between healthy water, healthy lifestyles and economic viability of rural and urban land uses;
- promote the wise use of groundwater and surface water resources in terms of human, agricultural and ecological needs; and
- maintain, create and promote existing and new outdoor recreational areas.

DEVELOPMENT

- promote environmentally-sound land use decision making in the watershed for current and future urban development and rural/agricultural land use

WATERSHED CHARACTERIZATION

LOCATION AND GENERAL DESCRIPTION OF THE SOUTH NIAGARA FALLS WATERSHED

The South Niagara Falls watershed includes all of Local Management Areas 2.14 and 2.17 as identified in the NWS (Regional Municipality of Niagara 2006), including a portion of the City of Niagara Falls, City of Welland, City of Port Colborne and Town of Fort Erie. Several subwatersheds form the South Niagara Falls watershed including Grassy Brook, Hunters Drain, Lyons Creek, and Tee Creek, which all drain into the Welland River. Bayers Creek, Niagara River subwatersheds 9, 10, 11, 12, 13 and 14 as well as Usshers Creek are also included in the watershed. However, these watercourses drain to the Niagara River through multiple outfalls (Figure 1). A brief description of these subwatersheds follows.

GRASSY BROOK

The Grassy Brook subwatershed is primarily agricultural in nature. However, a small portion of Chippawa, located in the City of Niagara Falls, is located in the northern section of this subwatershed. Several woodlands dot the landscape, and two known provincially significant wetland complexes are located in the Grassy Brook subwatershed.

HUNTERS DRAIN

Hunters Drain is currently not designated as a municipal drain, and it is a tributary of Lyons Creek. The Hunters Drain subwatershed includes a small portion of the Chippawa urban area. The remainder of this subwatershed consists of agricultural areas and woodlands.

LYONS CREEK

The operation of the Welland Canal affects both the Welland River and Lyons Creek. For example, siphons and reservoirs have been created to support operations of the canal. The extent of the inflows into the Welland River and Lyons Creek varies with the daily and seasonal operations of the canal (Regional Municipality of Niagara 2006).

TEE CREEK

Tee Creek is designated as a municipal drain, and it is also a tributary of Lyons Creek. Willoughby Marsh is instrumental in regulating Tee Creek's flow and quality by helping to counterbalance any contamination it may receive from Tee Creek's moderately unbuffered extent upstream. This subwatershed contains numerous unevaluated wetlands, several provincially significant wetlands as well as the provincially significant Willoughby Marsh. A portion of the Willoughby Marsh Conservation Area is located in the Tee Creek subwatershed.

BAYERS CREEK

Bayers Creek extends through the municipalities of Niagara Falls and Fort Erie. This subwatershed is primarily agricultural in nature with the exception of the Queen Elizabeth Highway that traverses the subwatershed. Numerous woodlands dot the landscape and the provincially significant Black Creek Wetland Complex extend into the Bayers Creek subwatershed.

USSHERS CREEK

Usshers Creek is a tributary of the Niagara River. The northern section of this subwatershed is currently urbanized. The Legends of Niagara Golf Course, operated by the Niagara Parks Commission, is located in the Usshers Creek subwatershed and the Queen Elizabeth Way also bisects this subwatershed. Agricultural land, numerous woodlands and a portion of the provincially significant Willoughby Marsh characterize the landscape.

NIAGARA RIVER SUBWATERSHEDS 9, 10, 11, 12, 13 AND 14

These small subwatersheds drain to the Niagara River. Niagara River subwatersheds 9 and 10 are located within the urban boundary of Chippawa. The remainder of these small subwatersheds are located in rural/agricultural areas.

TOPOGRAPHY

The topography of the South Niagara Falls watershed was shaped, in large part, through glacial action. Isostatic rebound, which is the rise of land masses that were depressed by the huge weight of ice sheets during the last ice age, contributed to the rise and fall of Lake Erie water levels and the formation of drainage outlet routes of the post-glacial Great Lakes.

Between 4,000 to 5,000 years ago, the level of Lake Erie rose 3 to 4 metres above its current level. As a result, the land between 177 and 178 metres became discharge routes for Lake Erie waters. The new discharge routes created the temporary Lake Wainfleet (now the Wainfleet Bog). In addition, the existing shoreline of the Niagara River flooded, and a diversion channel of the Niagara River was created in the vicinity of what is now known as Usshers Creek and Willoughby Marsh (Limnoterra Ltd. 1998).

Overall, the glacial events that carved out this portion of the Niagara Peninsula resulted in a gently rolling to flat topography with a dendritic drainage pattern (Figure 3).

PHYSIOGRAPHY AND GEOLOGY

The primary physiographic region above the Niagara Escarpment on the Niagara Peninsula is the Haldimand Clay Plain. The Haldimand Clay Plain was overlain by post-glacial Lake Warren and much of it is covered by lacustrine clay deposits. The Niagara Falls Moraine, located just north of the South Niagara Falls watershed, is visible as a ridge in the clay plain except at Lundy's Lane where it is topped by a gravel bar.
The quaternary geology of the South Niagara Falls watershed is comprised of fine textured glaciolacustrine deposits with some very small areas of coarse textured glaciolacustrine deposits, glaciolacustrine derived silty to clayey till and alluvial deposits. The physiograpy and geology of the South Niagara Falls watershed are illustrated on Figures 4 and 5.

SOILS

The soils in the Niagara Region were resurveyed and documented in a report entitled The Soils of Regional Niagara (Kingston and Present 1989) by the Ontario Ministry of Agriculture and Food and Agriculture Canada. This study included geological and physiological features; soil groups and types; soil moisture characteristics; drainage and variability; common properties of soil groups; as well as information related to agricultural soil use and classification. The following soil descriptions and associated map (Figure 6) are derived from this document.

There are primarily four soil groups that characterize the soil types in the South Niagara Falls watershed including soils from the Niagara, Welland, Malton, and Peel groups. Niagara soils are imperfectly drained and moderately to slowly permeable. Groundwater levels are usually close to the surface until late spring and this soil group has moderate to high water-holding capacities. Niagara soils range from clay loam to clay. The high clay content in these soils means that artificial drainage is usually necessary before Niagara soils can attain their potential capability for field crop production. Niagara soils are commonly found in areas that also contain Welland soils.

Welland soils are poorly drained and slowly permeable except during the summer months when surface cracking increases their permeability. Like the Niagara soils, groundwater levels remain close to the surface most of the year. Moisture availability for plants is affected during dry periods by the high clay content, even though this soil group has a relatively high water holding capacity. Welland soils are representative of clay loam and clay soils. The combined problems associated with high water tables and high clay contents limit the use of Welland soils for most agricultural crops.

Malton soils are commonly found in association with Welland soils. Like the Welland and Niagara soils, Malton soils are poorly drained and slowly permeable, and they are normally saturated by groundwater for long periods of the year. For example, perched water tables are a common occurrence above the compact subsoil till, and they can remain into the growing season. These soils have relatively high water holding capacities, and slow surface runoff. Malton soils range from clay to silty clay or silty clay loam. Although they require drainage, these soils are commonly used for field crops. All Malton soils have inclusions, or associated areas of Peel soils.

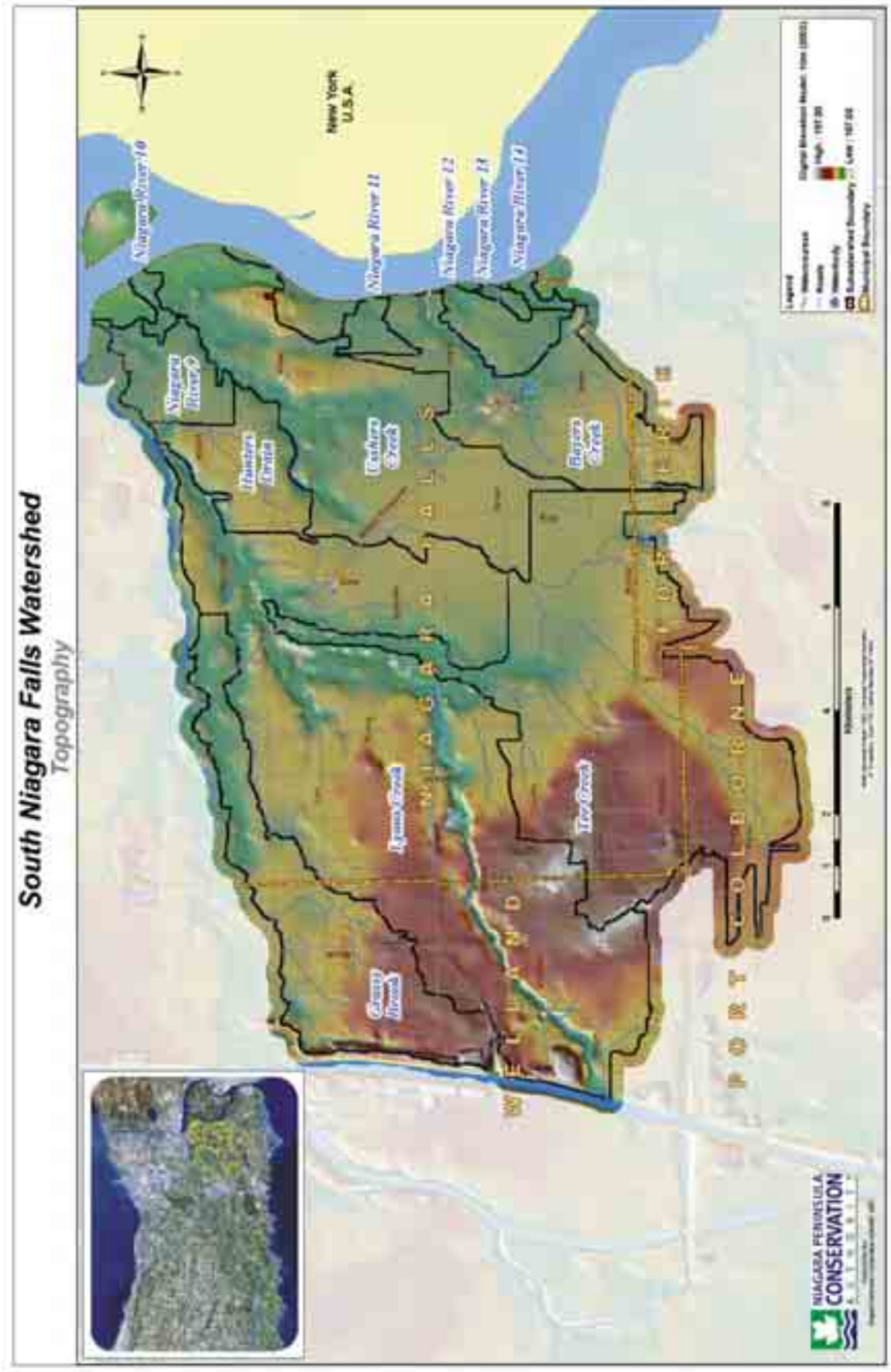

FIGURE 3: TOPOGRAPHY

FIGURE 4: PHYSIOGRAPHY

FIGURE 5: GEOLOGY

FIGURE 6: SOILS

Peel soils are imperfectly drained. Like Malton soils, perched water tables are a common occurrence due to tillage compaction and the dense clay loam till subsoil. Water runoff on these soils is medium to high and increases as slopes become steeper. Peel soils can be used for common field crops. However, with proper drainage they are more commonly used for fruit crops such as grapes, apples, pears, plums, currents and gooseberries. Similar suitability prevails for some vegetable crops such as peppers, cucumbers, tomatoes, sweet corn and squash. This soil group is susceptible to soil compaction and erosion and should be managed accordingly.

HISTORICAL LAND USE

The South Niagara Falls watershed was dominated by lowland forests, which included communities on saturated mineral soils as well as very wet areas on organic soils such as Willoughby Marsh. These wet areas contained species such as black ash, pin oak, swamp white oak and willow with tamarack in the large bog areas (Regional Municipality of Niagara 2006). Land use changed in the watershed with the arrival of early settlers in the late 1700s.

Several historic townships were established in the late 1770s in the South Niagara Falls watershed. The Township of Stamford (now the City of Niagara Falls) was one of the first areas to receive settlers in 1776. Lundy's Lane was the first road used by the early settlers; it was originally an Indian Trail (Berketa No Date).

In 1779, Michael Gonder became the first settler in Willoughby Township. In 1784 an additional 10 United Empire Loyalist families settled in the township. It is reported that undeveloped land was sold for 1 shilling per acre. However, settlement was slow to develop because most of the land was already owned by only a few landowners. By 1850 land was selling for 25 shillings per acre. The main roads in Willoughby Township consisted of a road that ran parallel to the Welland River and one that ran east to west through the swamp (Berketa No Date).

Chippawa, a portion of which is located in the South Niagara Falls watershed, is also rich in history. The Village of Chippawa was officially incorporated in 1850 with the land on the north side of the Welland River falling within Stamford Township and south of the river the Village of Chippawa was located in Willoughby Township. The first settler in Chippawa was United Empire Loyalist Thomas Cummings who settled here in 1783, followed by John Burch. Burch built a saw mill and a grist mill along the banks of the Niagara River where the current Toronto Power Station building now stands. At the time of Burch's death, his property and mills were sold to Samuel Street Jr., and Street continued to operate the mills until they were destroyed by retreating American troops during the War of 1812.

By 1799, tourism flourished in Chippawa and Chippawa's population continued to rise. In 1824 the decision to construct the first Welland Canal was made, and it was decided that the Welland River at Chippawa would be the eastern terminus of the canal. This required dredging a large sand bar at the mouth of the Welland River. The first Welland Canal was opened in 1829. By 1871 the population of Chippawa had drastically decreased for 3 reasons: Chippawa was no longer the terminus of the Welland Canal; in 1846 a suspension bridge was build at Niagara Falls; and the arrival of the Great Western Railroad to Niagara Falls in 1853 diverted traffic away from Chippawa.

The South Niagara Falls watershed is also rich in the history of the War of 1812. Two battles were carried out within the boundaries of the South Niagara Falls watershed: Battle at Chippawa and the Battle at Cooks Mills.

WAR OF 1812: BATTLE OF CHIPPAWA AND BATTLE AT COOKS MILLS

Two battle sites of the War of 1812 are located in this watershed. The Battle at Chippawa took place on the fields of Samuel Street's farm near the banks of the Niagara River. This battle is reported to have begun when a British, Canadian and aboriginal force of about 2,000 attacked an invading American army of about 3,500. The battle began in the morning and lasted until early evening. The Canadian side won this battle. However, a total of 200 men lost their lives and it is believed that they are buried at the battle site.

The Battle at Cooks Mills is reported to be the last engagement between U.S. and British/Canadian armies fought on Canadian soil during the War of 1812. On or about October 20th 1814 at Cooks Mills, a British force of 750 men engaged 1,400 Americans. It is reported that the British lost 19 men and the American losses were acknowledged to be 67 men. In addition, the Americans set 200 bushels of wheat and flour on fire. The Americans eventually retreated and both the British and American generals' reports claimed victory.

NAVY ISLAND

Located opposite Usshers Creek in Chippawa, Navy Island is included in the South Niagara Falls watershed. The first inhabitants of Navy Island were natives who used the Island for fishing and building canoes as far back as 10,000 years ago. However, in the 1700s the French overtook Navy Island and used it for ship building as well as a naval base. The French can also be given credit for giving the Island its present day name. In 1763, Navy Island was occupied by the British. They used this site for the construction of 2 sloops and 3 schooners. The Island was later used by the British for repairing ships used in the War of 1812. The next tenant of Navy Island was William Lyon Mackenzie, who occupied the Island during the civil rebellion (1837-1838) and established the Provincial Government of Upper Canada here.

By the 1850s 4 families had settled on the Island and they started farming and planting orchards. By the late 1880s the families shared the southeast shore of the Island with the Queen's hotel. The hotel remained in business for a few years but then it was abandoned and was eventually reduced to ash in 1910.

Navy Island no longer has any occupants and it is now used for nature appreciation activities and camping.

CURRENT LAND USE

The South Niagara Falls watershed is characterized largely by some urban and mainly agricultural areas. Land use in the South Niagara Falls watershed is illustrated on Figure 7, which has been derived from Official Plan mapping.

The South Niagara Falls watershed spans the City of Niagara Falls, City of Welland, a small parcel of the City of Port Colborne and

Town of Fort Erie. Some sections of land in the South Niagara Falls watershed are urban (residential, commercial, industrial) with some urban development occurring in Chippawa. The majority of the land use in the watershed is rural/agricultural.

Agricultural areas include field crops, grain and oil seed production, poultry and egg production, and miscellaneous speciality production, which includes sheep and lamb, horse and pony, goat, fur, other speciality livestock, mushroom, greenhouse, nursery, and sod, maple and Christmas tree farms. The Regional Agricultural Economic Impact Study (Regional Municipality of Niagara 2003) ranked the top 12 agricultural commodity groups in Niagara (based on 2001 Statistics Canada data). In terms of the watershed municipalities, the three main commodity groups are:

- City of Niagara Falls: miscellaneous speciality, cattle, and field crops;
- City of Welland: miscellaneous speciality, grain and oil seed, and field crops;
- City of Port Colborne: grain and oil seed, miscellaneous speciality, and poultry and egg; and
- Town of Fort Erie: miscellaneous speciality, grain and oil seed, and cattle.

Numerous opportunities for outdoor recreation are found throughout the watershed. For example the Legends on the Niagara Golf Course and Rolling Meadows Golf and Country Club are located in the South Niagara Falls Watershed. The Legends on the Niagara Golf Course consists of two 18 hole championship quality courses, as well as a 9-hole executive length course, practice facility and clubhouse on 700 acres. An additional 300 acres of property was purchased by the Niagara Parks Commission as a park site to protect the site of the War of 1812 Battle at Chippawa. In addition to this historic site, Navy Island is also included in the watershed and it is a National Historic Site, which is currently used for nature appreciation and camping.

The Niagara Peninsula Conservation Authority maintains the Willoughby Marsh Conservation Area. Measuring 232 hectares, Willoughby Marsh is located in the City of Niagara Falls. The marsh is a provincially significant evaluated wetland containing both swamp and marsh communities, and this site helps to protect the water source for Lyons, Usshers and Tee Creeks. The NPCA issues hunting permits at this site during the various hunting seasons. However, no formal trails or facilities exist at this conservation area.

FUTURE LAND USE

The Provincial Greenbelt Plan Area does not extend into the South Niagara Falls watershed. However, agricultural land is protected through the City of Niagara Falls Official Plan (1993, amended 2000) as "Good General Agricultural" and "Rural/ Agricultural" areas.

The majority of the lands within the South Niagara Falls Watershed Plan area are considered to be a prime agricultural area by the Provincial Policy Statement. Lands within the City of Niagara Falls are designated Good General Agriculture west of the QEW and Rural/Agriculture east of the QEW. The area has a wide range of active agricultural uses including vegetable and field crops, hay and pasture, and livestock operations. This area is also characterized by some limited non-agricultural, recreational and agriculturally related uses. Interspersed with the agricultural uses are natural areas including creeks, wetlands and woodlots. It is the intent of the City's Official Plan to protect the continuation of farming operations, restrict the establishment of non-farm uses and minimize land use conflicts in favour of agriculture whenever possible while protecting the natural environment.

Urban development is limited to the Chippawa urban area, located south of the Welland River and bound by Ort Road to the west, the Niagara River Parkway to the east and Willick Road to the south. A 43 hectare parcel located on the west side of Sodom Road, north side of Willick Road and southeast of Lyon's Parkway and Lyon's Creek Road is to be developed as a plan of subdivision with 239 lots for single-detached dwellings, 92 lots (184 units) for semi-detached dwellings, 24 blocks (133 units) for on-street townhouses and a block of land for 70 townhouse condominium units. There are also 26 lots designed with frontage onto Willick Road. Additional blocks of land in the plan are proposed for stormwater management, parkland, valley land/floodplain, walkways, emergency access and future development.

Expansions of the urban boundary are restricted by the policies of the Provincial Policy Statement (Ontario Ministry of Municipal Affairs and Housing 2005b) and the Growth Plan for the Greater Golden Horseshoe (Ontario Ministry of Infrastructure Renewal 2006), which encourage intensification of existing built-up areas and development of greenfields within the urban boundary. In addition to supporting the fore mentioned strategies, Niagara's Growth Management Strategy (Regional Municipality of Niagara 2006) recommends the analysis of all urban areas in Niagara before additional area will be considered for development, including specifically designated intensification areas, corridors and nodes in addition to redevelopment of existing built up areas.

NIAGARA RIVER AREA OF CONCERN (AOC)

The International Joint Commission (IJC) has identified the Niagara River as an Area of Concern (AOC). An area is designated as an AOC when it has been determined that the aquatic environment has been severely affected. The Niagara River (Ontario) AOC includes the 58 kilometre long Niagara River and the Welland River drainage basin, which falls within the boundary of the South Niagara Falls watershed (Figure 8). Water quality issues in this AOC stem from sedimentation and toxic contaminants from industry on the American and Canadian sides of the Niagara River, municipal sources of heavy metals, nutrients and other toxic pollutants, urban and rural runoff, combined sewer overflows and landfills (Environment Canada and Ontario Ministry of the Environment, No Date).

The Niagara River Remedial Action Plan (RAP) uses an ecosystem approach to environmental decision-making that involves three stages. The first stage, completed in 1993, included a detailed assessment of environmental problems and their causes in the AOC. In stage two, which was completed in 1995, agencies and citizens collaborated to identify, evaluate, and select preferred actions to address the problems identified in the first stage. The final stage is ongoing and documents the progress of remedial actions until the problems are rectified and the goals of the RAP are achieved (Niagara River RAP 1995; NPCA 2002).

In 2004, a completed project list for the Niagara River RAP was updated. Some of the projects completed in the AOC up until

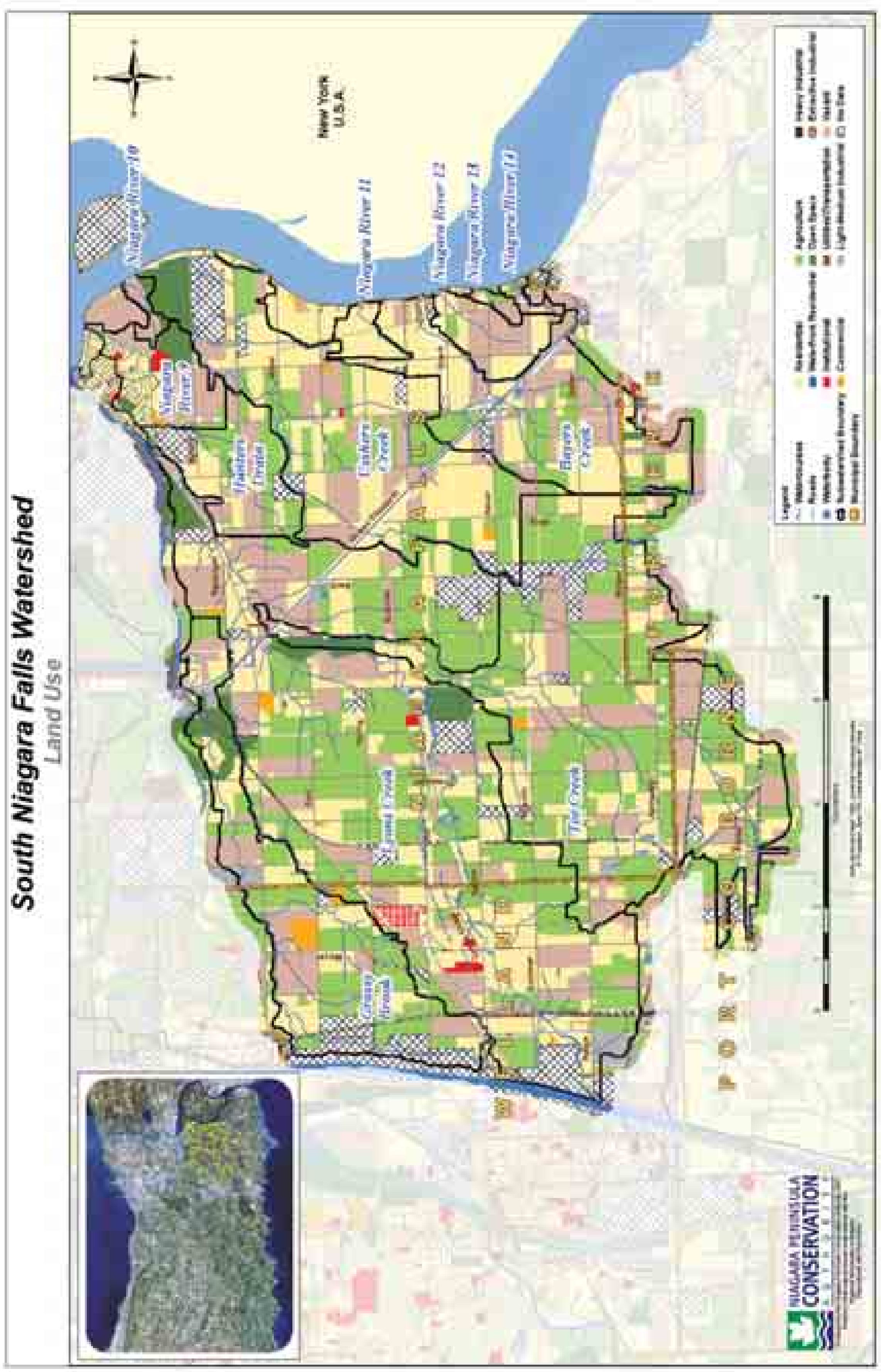

FIGURE 7: LAND USE

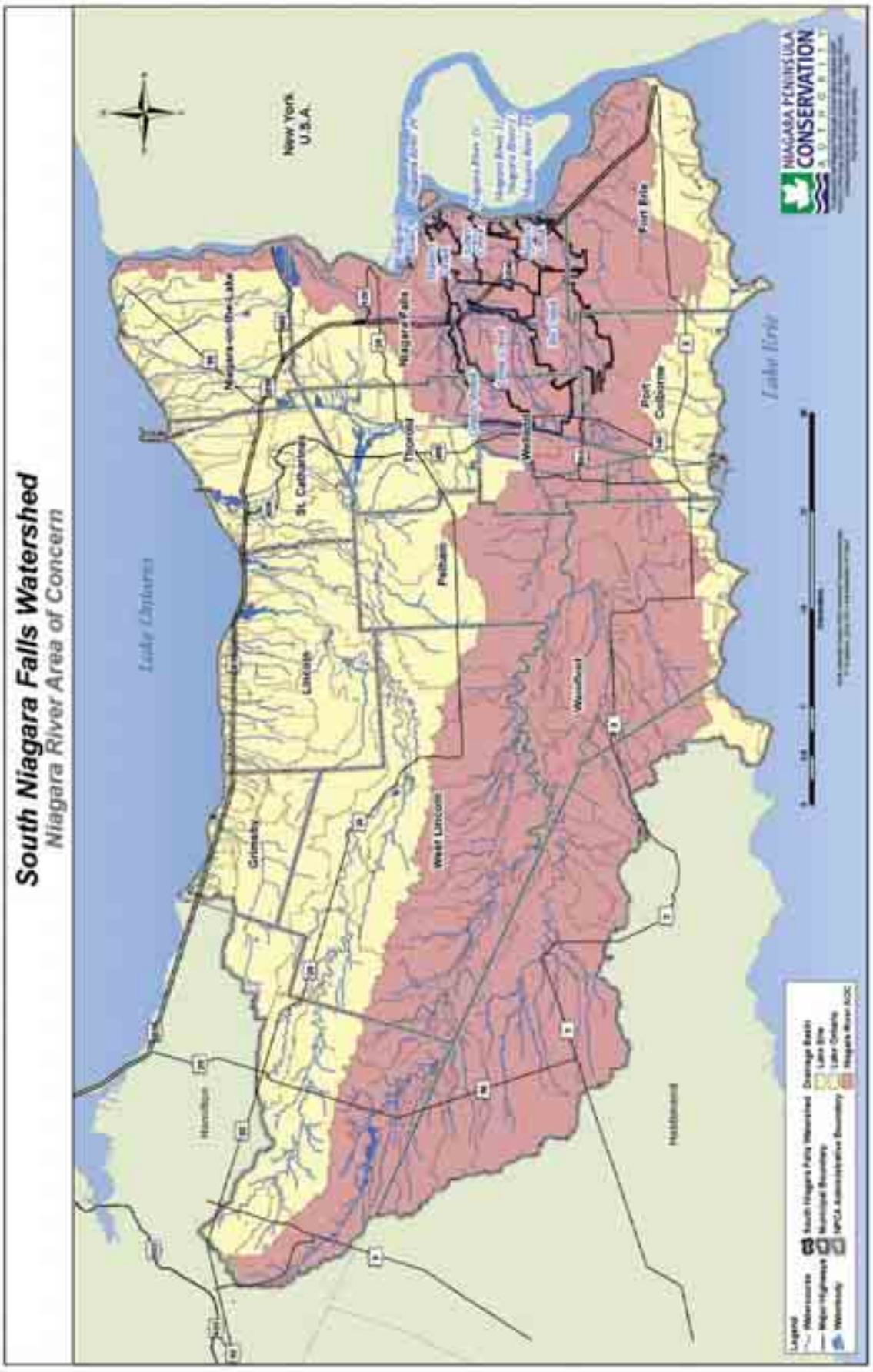

FIGURE 8: NIAGARA RIVER AREA OF CONCERN

2004 include an increase of 278 hectares of forest cover, 22 kilometres of riparian habitat was re-established, and nearly 8 hectares of wetlands were restored. In addition, approximately 70 barriers to fish movement of the 200 identified in the AOC were removed; the cleanup of contaminated sediments ('reefs') in the Lower Welland River at the Atlas Steels site and the review and assessment of contaminated sites in the AOC resulting in the identification of Lyons Creek East and West site for remediation (Cromie Personal Communication NPCA 2007).

Although numerous projects and goals have been achieved, projects under the Niagara River RAP are still being carried out and a ten-year review of the RAP Stage 2 Report (1995) was initiated by the lead RAP agencies in 2004. From this review, the status of the beneficial use impairments for the AOC has been updated; new delisting criteria and RAP Recommendations have been developed; and the implementation frameworks for the new RAP work plan and monitoring and assessment plan are presently being developed. The Stage 2 Update report is currently being drafted and identifies priorities for remediation towards delisting the AOC (Cromie Personal Communication NPCA 2007).

NATURAL HERITAGE RESOURCES

The percentage of upland forest cover, wetlands, and riparian habitat in the South Niagara Falls watershed are recorded in Table 1. These figures will be assessed based on the guidelines set by Environment Canada (2004c) as part of the restoration strategies in the watershed plan.

All of the natural heritage areas including wetlands, woodlots, Areas of Natural and Scientific Interest and Environmentally Sensitive/Significant areas are illustrated on Figure 9 and 10 respectively, and described below. This information was compiled as a joint initiative by the Ministry of Natural Resources, Regional Municipality of Niagara, and the Niagara Peninsula Conservation Authority. Currently the Niagara Peninsula Conservation Authority is undergoing a Natural Heritage Areas Inventory and the following information will be updated to reflect the projects findings.

LIFE SCIENCE AREAS OF NATURAL AND SCIENTIFIC INTEREST

NAVY ISLAND LIFE SCIENCE ANSI

Navy Island is located 5 kilometres upstream from Niagara Falls in the Niagara River. Measuring 171 hectares, this Life Science ANSI has been designated provincially significant because it presents a good example of oak dominated clay plain forests typical of the Niagara Slough Clay Plain, it is the only example of the restricted riparian features of the upper Niagara River Valley in the region, and it is representative of old growth forest. The extensive wet basin located on Navy Island supports intermediate aged deciduous forests of pin oak, shagbark hickory, red ash, and white elm. Local swamp basins of silver maple forests, dogwood, and speckled alder can also be found on the Island. The broad clay plain section consists of wet mesic forests of swamp white oak, red ash, shagbark hickory and spicebush. The riverbank contains zones of red oak, white oak, shagbark hickory and black walnut. Old fields have been planted in the formerly cultivated openings on the island, and the river shore communities consist of narrow zones of scrubland and marsh-meadow (MNR 2002).

LYONS CREEK FLOODPLAIN AND WETLANDS ANSI

The Lyons Creek Floodplain and Wetlands ANSI is a contiguous 79 hectare site along Lyons Creek. This site is provincially significant because it presents the best interior wetland community development recorded for an incised meander stream basin in the area, and the expression of the meander stream landforms is very diverse in the vicinity of the area (Macdonald 1980). This ANSI site is characterized by a relatively large, diverse wetland swamp scrub and marsh complex located in the flooded basin of an incised meander stream basin. Many of the wetland communities developed following the inundation of the basin during road construction. For example, wetland communities of submergent aquatic meadows; wet meadows of sedges; marshes of cattail; scrub swamps of buttonbush, meadowsweet, dogwood and willow; swamp forest groves of green ash, silver maple, white willow, as well as other species; and embankment slope grove fringes of red oak and maple are located at the site (MNR 2002).

WILLOUGHBY CLAY PLAIN MUCK BASIN FOREST AND MARSH ANSI

The Willoughby Clay Plan Muck Basin Forest and Marsh ANSI measures 228 hectares and consists of a small organic basin, which is part of Ussher's Creek. In addition, the area is characterized by a gently rolling, slough patterned heavy clay plain that supports an extensive forest complex in the eastern section of the Niagara Peninsula. The southern half of this ANSI is located primarily in the Willoughby Marsh Conservation Area. This portion of the site is characterized by a series of broad wet basins that support a variety of swamp forest, scrub and marsh communities. The swamp forests are dominated by very wet willow-ash or by wet silver maple-white elm-swamp white oak. The scrublands are primarily comprised of meadowsweet, arrow wood, elderberry and willow. Adjacent to these basins and extending elsewhere through the site are gently rolling heavy clay plains that contain well developed slough pond landforms and associated community patterns, as well as a series of clay plain maple-oak forests dominated by red maple, red oak, pin oak, and shagbark hickory (Johnson 2005; MNR 2002).

TABLE 1: NATURAL HERITAGE RESOURCES

NATURAL HERITAGE RESOURCE	CURRENT %	GUIDELINE (MINIMUM)
UPLAND FORESTS	26	30
WETLANDS	20	10
RIPARIAN HABITAT	51	75

WETLANDS

The Ontario Wetland Evaluation System (OWES) is a science-based ranking system used by the Ministry of Natural Resources to assess wetland functions and societal values. Wetlands are evaluated and assigned a status as "provincially significant" or "locally significant" The Ministry of Natural Resources is currently revising the boundaries of existing wetlands and identifying new wetlands in the Central Welland River watershed. This information will be updated and mapped in the Central Welland River Watershed Plan as it becomes available.

The following wetlands have been designated as Provincially Significant Wetlands in the South Niagara Falls watershed:

THE GRASSY BROOK WETLAND COMPLEX is a provincially significant wetland complex, made up of two individual wetlands consisting of 77.2 percent swamp and 22.8 percent marsh. On this 7.9 hectare complex, numerous wetland plant communities have been identified by Kwicinski et al. (1988a). Some of these communities include submerged plants such as coontail and water milfoil; narrow-leaved emergents such as grasses and sedges; floating plants such as yellow water lily; herbs such as monkey flower and smartweed; ferns; tall shrubs such as blueberry, black elderberry and buttonbush; and deciduous trees such as red ash, pin oak, red oak and black gum are found at this wetland complex.

THE TEE CREEK WETLAND is 15.8 hectares of provincially significant wetland. This single contiguous wetland comprises of 53.5 percent swamp and 46.5 percent marsh. Kwicinski and Littleton (1988b) have noted various vegetation communities. For instance, submerged plants such as milfoil and coontail; free-floating plants such as duckweed; emergents such as pickerel-weed and grasses; shrubs such as buttonbush and dogwood; and deciduous such as American elm, black ash and white ash have been identified at this site.

THE BLACK CREEK WETLAND is a provincially significant coastal wetland composed of 47.5 percent swamp and 52.5 percent marsh (Littleton and Berains 1986). Only a small portion of this fragmented wetland complex occupies Bayers Creek subwatershed, the remainder is in the Black Creek subwatershed. Numerous wetland communities have been identified by Littleton and Berains (1986). Some of these communities include emergents such as blueflag, cattail, grasses and sedges; ground cover consists of mixed herbs; low shrubs such as dogwood and buttonbush are present; tall shrubs such as hawthorn; and deciduous such as Red Ash, Basswood and White Oak.

THE LYONS CREEK FLOODPLAIN WETLANDS is a provincially significant wetland. It extends from the Welland Canal to the mouth of Lyons Creek at Welland River. A portion of this system has also been designated **Lyons Creek Floodplain and Wetlands ANSI** as previously described. Several rare species have been documented in this significant wetland by various organizations. In addition, threatened species and species of special concern as designated under the Committee on the Status of Endangered Species in Canada (COSEWIC) have been documented in the Lyons Creek Floodplain Wetlands. Adjacent landuse consists of agricultural and abandoned fields and several roads crossing the wetland, including the QEW.

THE WILLOUGHBY MARSH WETLAND is a provincially significant wetland that straddles the subwatershed boundaries of Tee, Lyons and Usshers Creeks. Portions of this system have also been designated **Willoughby Marsh Environmentally Sensitive Area** and **Willoughby Clay Plain Muck Basin Forest** as previously described. This 592 hectare wetland is primarily owned by the Niagara Peninsula Conservation Authority. Adjacent landuse consists of agricultural fields and successional meadows. Maple, Beech and Oak are the dominant species; however several other species are present such as Black and Peach-leaf Willow, Speckled Alder and Domestic Apple. The successional areas and ground cover is very dense (Brady 1980).

IDENTIFIED OLD GROWTH

The Ministry of Natural Resources characterizes an old growth ecosystem "by the presence of old trees and their associated plants, animals, and ecological processes. They show little or no evidence of human disturbance (MNR 1994)." During an old growth forest survey conducted by the Bert Miller Nature Club during 2002 and 2003, the definition of an old growth forest used for purposes of their field work was ""a natural community that has been continuously forested since before European Settlement, and that forest's canopy must be dominated by trees with ages of 150 years or older. Most old-growth forests have 8 or more trees per acre that are 150 years old or greater (Bert Miller Nature Club 2003)".

In the South Niagara Falls Watershed, one old growth forest has been identified during field surveys conducted by the Bert Miller Nature Club; the Bowmans Archery Club Black Gum Woods. This forest is unique because is contains ultra-ancient black-gum trees that range in age up to 450 years old, possibly older. This site also has white oaks and swamp oaks ranging from 160 to 210 years old as well as red maples over 130 years old, making this the oldest population of broadleaf trees known on the Niagara Peninsula (Bert Miller Nature Club 2003).

FIGURE 9: SIGNIFICANT NATURAL AREAS

OTHER SIGNIFICANT NATURAL HERITAGE RESOURCE SITES

In the late seventies to early 1980's, the Regional Municipality of Niagara undertook a field study that involved inventorying and evaluating remnant natural areas in the Niagara Region. Remnant natural areas are best defined as "areas which maintain a forest ecosystem that appears unaltered by urban or agricultural activities" at the time of study (Brady 1980). The study was intended to provide a preliminary database to assist the Regional Municipality of Niagara with potential Environmentally Sensitive Areas designations for their Official Plan. Through the study, numerous significant natural areas were documented throughout the Niagara Region. Significance was based on numerous criteria borrowed from previous studies done by Eagles and Adindu (1978). Examples of the criteria used include: the ecological function is vital to the healthy maintenance of a natural system beyond its boundaries (e.g., water storage/recharge area); the area is an unusual habitat with limited representation, or a small remnant of a particular habitat which have virtually disappeared within the Region; area provides habitat for rare or endangered species; and the area has an unusually high diversity of biological communities and associated plants and animals.

In the South Niagara Falls watershed, numerous significant woodlots were documented through this study. The boundaries of these remnant areas fall within the boundaries of, and met criteria as significant woodlands for 'The Core Natural Heritage System' in the mapping for the environmental policies in the Official Plan for Niagara Region by the Regional Municipality of Niagara. Some of the criterion under these policies includes; area contains Species at Risk; core size greater than 100 meters; and the natural area overlaps one or more other significant natural areas such as ANSI's or PSW's.

The following descriptions of the remnant natural areas have been provided by the report; Regional Municipality of Niagara Environmentally Sensitive Areas (Brady 1980). As previously mentioned some of the identified remnant natural areas have also been designated as Areas of Natural and Scientific Interest or Provincially Significant Wetlands and therefore have already been described above.

The MCKENNY ROAD WOODLOT is located within the City of Welland in the South Niagara Falls Watershed. Measuring 31 hectares, this woodlot consists of a slough-ridge terrain comprised of Welland clay soils. The eastern and southern sections of this woodlot are drained by a tributary of Grassy Brook. Tree species found throughout the McKenny Road Woodlot include, for example, hawthorne; red, black, sugar and silver maple; red, pin and swamp white oak; American beech; black and choke cherry; witch-hazel; and serviceberry. Rare species recorded at this site include the nationally and provincially rare swamp white oak and the provincially rare pin oak.

The HORSE TRACK WOODLOT is located in the City of Niagara Falls, and it consists of several segmented woodlots with a total area of 115 hectares. Wetland areas are located within the woodlot consisting mainly of eutrophic ponds, sloughs and bogs. The dominant vegetation throughout these sites include, for example, sugar maple, blue beech, white ash, red ash, slippery elm, rock elm, white elm, white oak, black cherry and willow. Nationally and provincially rare species recorded at this site in 1980 include swamp white oak, eastern flowering dogwood, pignut hickory, chinquapin oak and black oak.

YOUNG WOODLOT measures 64 hectares and is characterized by a flat swampy forest, which is due to the clay soils found throughout the South Niagara Falls watershed. Some species found at this site include, for example, white elm; rock elm; red, white, and swamp white oak; American beech; blue beech; hop-hornbeam; witch hazel; trembling and largetooth aspen; and white pine. Groundcover was also abundant at this site in 1980 and included, for example, mandrake, trillium, birdfoot violet, Jack-in-the-pulpit, purple iris and fern. Nationally and provincially rare species found in the Young woodlot are pignut hickory and swamp white oak.

Located southeast of Cooks Mills, YOKOM WOODLOT is an 82 hectare woodlot dissected by intermittent streams, sloughs and swamps. Yokom Woodlot acts as a water storage area as well as the headwaters for Tee Creek and Lyons Creek. The dominant vegetation in the Yokom Woodlot is sugar maple, red and white oak and American beech. Other vegetation at this site includes, for example, trembling aspen, red maple, choke and black cherry, basswood, alternate leaved dogwood, and eastern white cedar. At the time of the inventory, ground cover was dense and included fern, vines, iris, mandrake, birdfoot violet, cattails, and wild raspberries. Rare species at this site include the nationally and provincially rare swamp white oak and the provincially rare pin oak.

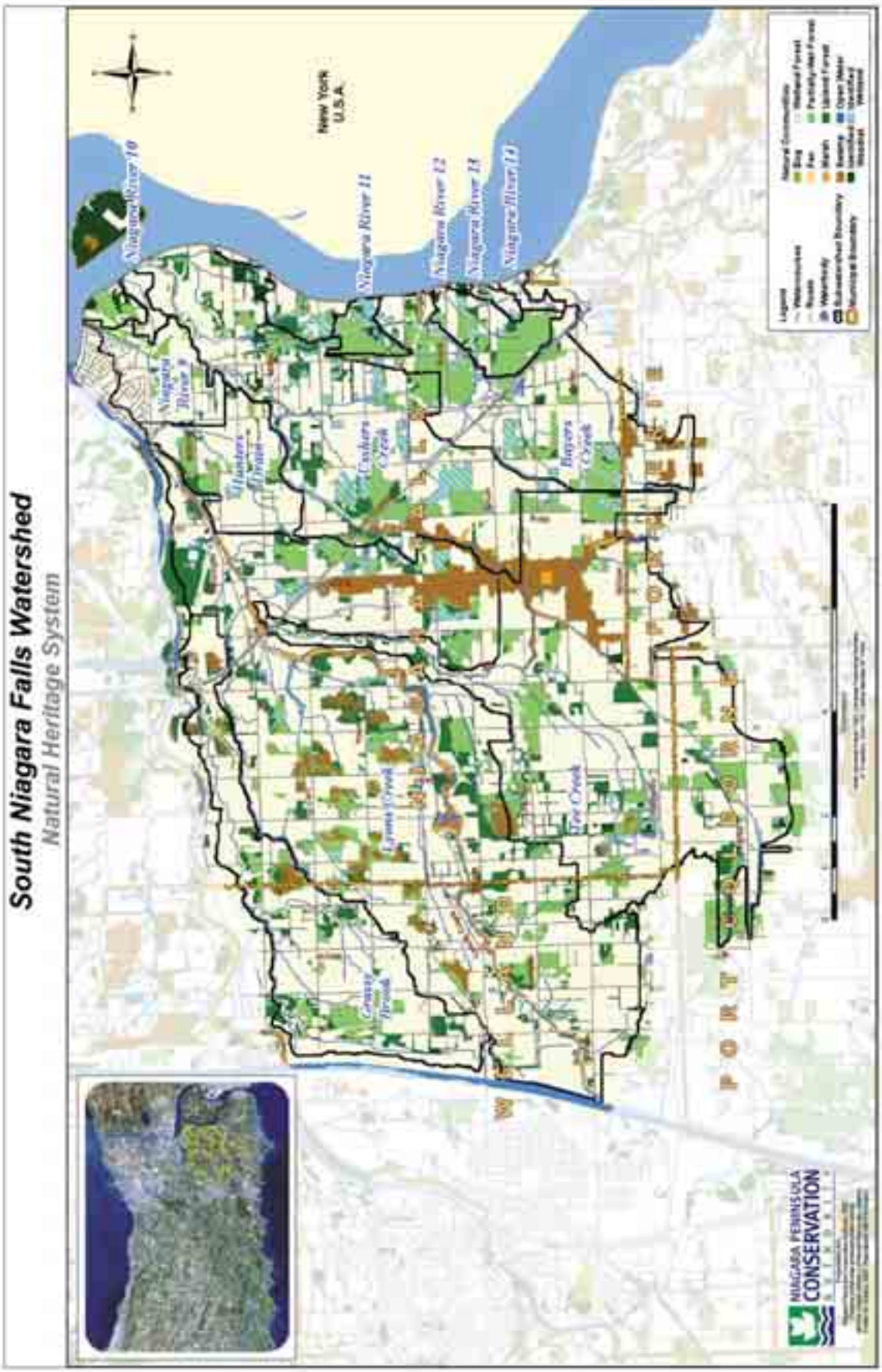

FIGURE 10: NATURAL HERITAGE SYSTEM

The OLD LINCOLN STREET WOODLOT is a 58 hectare site characterized by a slough-ridge terrain over Welland clay soils. This woodlot acts as a water storage and recharge area for tributaries of Tee Creek. The vegetation species found at this site consists mainly of red and black maple; American beech; swamp white, red, pin and white oak; shagbark hickory; and white elm. Other species found in this woodlot include, for example, basswood; blue beech; trembling and largetooth aspen; serviceberry; domestic apple; and alternate-leaved dogwood. Nationally and provincially rare species at this site include black gum, black oak, pin oak and swamp white oak.

Located in Niagara Falls, the WILLOUGHBY DRIVE WOODLOT is a 28 hectare woodlot situated on flat terrain with Welland clay soils. During field work in 1980 there was virtually no understory, which could mean that this site floods in the spring, or there is little revegetation of the canopy. Canopy species present at this site include, for example, swamp white, pin, black, red and white oak; American beech; silver, black, sugar and red maple; basswood; red, black and white ash; shagbark and pignut hickory and willow. Nationally and provincially rare species recorded at this site include pin oak, swamp white oak, pignut hickory and black oak.

BAYERS CREEK BUSH is a 50 hectare woodlot containing a flat wetland with intermittent eutrophic ponds and streams. Bayers Creek borders the southern edge of the woodlot. The dominant vegetation throughout the woodlot includes black and silver maple; swamp white, white and pin oak; slippery, rock and white elm; shagbark and pignut hickory; red and white ash; basswood; black cherry; tupelo; hop-hornbeam; witch hazel as well as others.

The WAVERLY WOODLOT is a 70 hectare woodlot containing a low lying wetland. Several small creeks that drain to the Niagara River are found throughout the woodlot. The dominant vegetation is red maple; slippery and white elm; and red and pin oak. Other species occupying the site include, for example, sugar, black and silver maple; black, red and white ash; swamp white oak; basswood; shagbark hickory, and black cherry. The understory vegetation consists of, for example, serviceberry, common elder and dogwood. Rare species found at this site include the provincially rare pin oak and the nationally and provincially rare swamp white oak.

UPPER'S WOODLOT straddles the border of Tee Creek and Black Creek subwatersheds. The 81 hectare site has been divided into 3 sections by agricultural fields and Troup and Neff Roads. The site has a slough-ridge terrain on poorly drained clay soils. The dominant vegetation throughout the woodlots include american beech, silver, red and black maple, blue-beech and pin oak. Several other species are also present including for example, shagbark hickory, trembling aspen, peach-leaf willow and cottonwood, as well as several others.

BILL'S BUSH sits on the border of Tee Creek and Lyons Creek Drain subwatersheds. This 166 hectare natural area is also divided into 3 sections and consists of open marshes and a slough-ridge terrain. Throughout the 3 sections shagbark hickory, red and pin oak, white elm, as well as several other species can be found. In addition the endangered eastern flowering dogwood and butternut walnut have been noted.

CONSERVATION AREAS

WILLOUGHBY MARSH CONSERVATION AREA

The Willoughby Marsh Conservation Area protects 232 hectares of marsh and forest habitat. The most common plant species at this site include red, white, swamp white, black and pin oak; red, silver and black maple; and white, slippery and rock elm. This site also helps to protect the water source for Black, Usshers and Tee Creeks.

SMITH-NESS CONSERVATION AREA

The Smith-Ness Conservation Area is a 29 hectare wildlife refuge area of wetland and forest habitat. There is no public access for this site.

CAROLINIAN CANADA

The Carolinian Life Zone, also known as the Eastern Deciduous Forest Region, stretches across southwestern Ontario from Toronto to Grand Bend. It is estimated that approximately one third of Canada's rare and endangered species are found in the Carolinian Life Zone. For example, even though the Carolinian Life Zone makes up less than one percent of Canada's total land area, it contains a greater number of species than any other ecosystem in Canada and many of these species are not found anywhere else in the country (Johnson 2005). As part of its Big Picture project, Carolinian Canada identified considerable lands within the South Niagara Falls watershed as a "Carolinian Core Natural Area" (Figure 11).

A core natural area is defined as: an intact natural area with larger habitat blocks; regions with a high overall percentage of natural vegetation cover; viable occurrences of globally rare species and vegetation community types, and concentrations of rare species and vegetation; should exceed 200 hectares where possible with smaller high-quality sites in areas with lower amounts of natural vegetation cover; as well as having minimum corridor widths of 200 metres plus any adjacent areas of natural cover (Riley et al 2003).

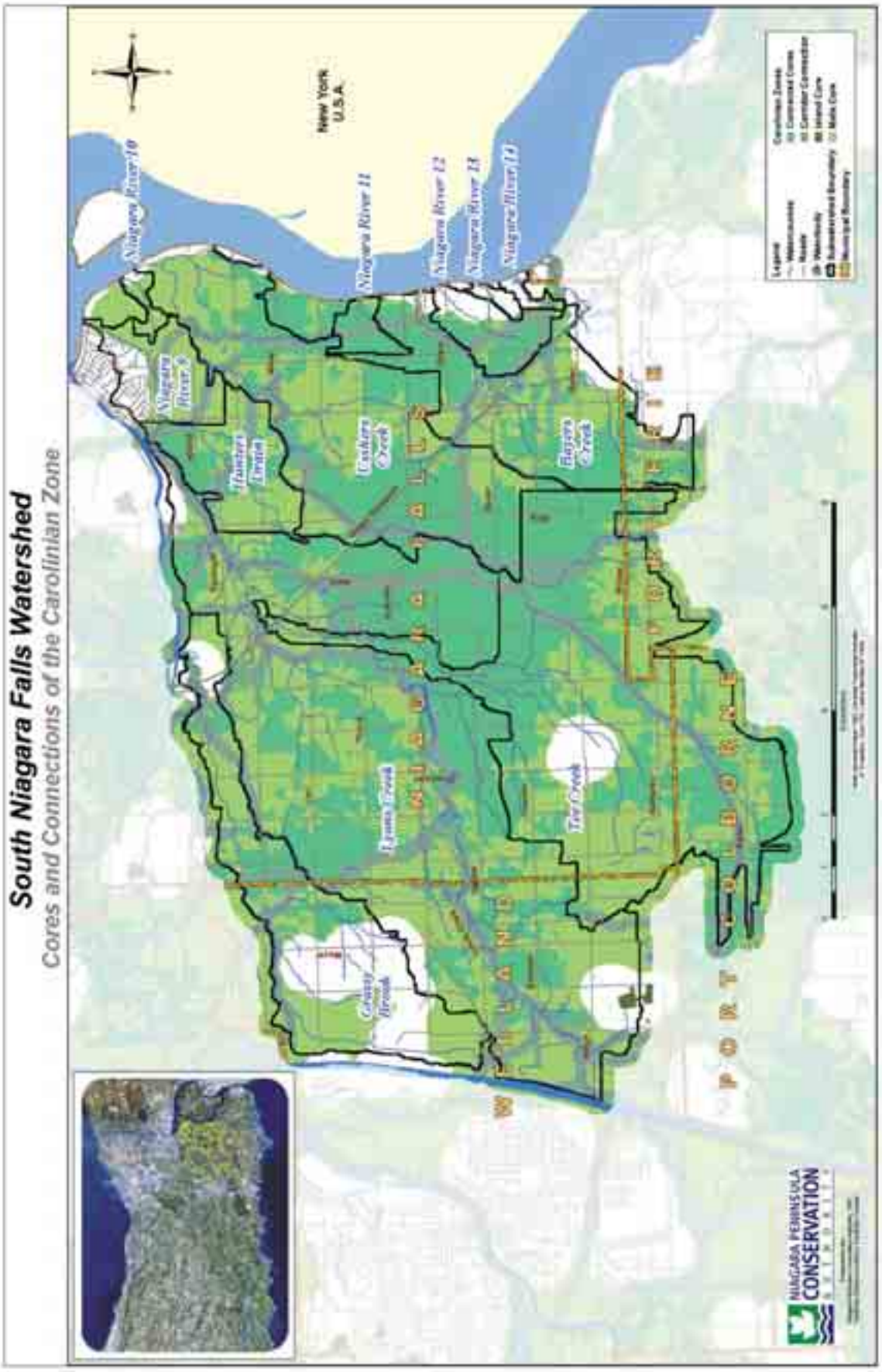

FIGURE 11: CAROLINIAN CANADA

AQUATIC HABITAT

FISH COMMUNITY STUDIES

Fish sampling studies conducted by various agencies reported numerous fish species in the South Niagara Falls watershed. The results of these studies are reported below and in Table 2.

BAYERS CREEK

The Royal Ontario Museum has a record of fish species in Bayers Creek, which it obtained from the Ministry of Natural Resources in 1974. Bayers Creek was also sampled again in 1991 due to a proposed facilities expansion. In addition, the Ministry of Natural Resources conducted fish sampling surveys in Bayers Creek in 1979, 2003, 2004 and 2005. Some of the fish species commonly found in Bayers Creek include, for example, black bullhead, bluntnose minnow, central mudminnow, largemouth bass, pumpkinseed and tadpole madtom. In total, 33 species have been identified in Bayers Creek since 1974 (Table 2).

GRASSY BROOK

Fish sampling surveys were conducted in Grassy Brook by the Ministry of Natural Resources in 2003 and 2005. Some of the fish species commonly found were green sunfish, johnny darter, largemouth bass and trout-perch. A total of 21 different fish species have been recorded in Grassy Brook to date (Table 2).

HUNTERS DRAIN

In 2003, the Ministry of Natural Resources conducted a fish sampling survey in Hunters Drain. Common shriner, largemouth bass and pumpkinseed were some of the common species noted. In total, 8 different fish species were recorded in Grassy Brook during the 2003 survey (Table 2).

LYONS CREEK

Several sections of Lyons Creek were sampled in 1991 due to a proposed facilities expansion. Lyons Creek was sampled again in 2003 by the Ministry of Natural Resources and again in 2004 by the Department of Fisheries and Oceans. Numerous sites were sampled at this time and numerous fish species were recorded including, for example, bluntnose minnow, brown bullhead, bluegill, central mudminnow, common carp, fathead minnow, green sunfish, northern pike, striped shiner and yellow perch. A total of 25 different fish species have been recorded in Lyons Creek to date (Table 2).

TEE CREEK

Like Lyons Creek, Tee Creek was sampled in 1991 due to a proposed facilities expansion. Four sites along Tee Creek were also sampled in 2004 by the Department of Fisheries and Oceans. In addition, the Ministry of Natural Resources conducted fish sampling surveys in 2003, 2004 and 2005. Numerous fish species are found in Tee Creek including, black and brown bullhead, bowfin, common carp, creek chub, golden shiner, grass pickerel, largemouth bass, pumpkinseed, and yellow perch. A total of 27 fish species have been recorded in Tee Creek (Table 2).

USSHERS CREEK

Usshers Creek has been sampled by the Ministry of Natural Resources in 1974, 1979, 1991, 1998, 1999, 2003, 2004 and again in 2005 for various projects. Fish species found in Usshers Creek include banded killifish, bluntnose minnow, brown bullhead, common shiner, emerald shiner, gold fish, grass pickerel, largemouth bass, pumpkinseed, tadpole madtom and yellow perch. A total of 35 fish species have been recorded in Usshers Creek (Table 2).

SIGNIFICANT FISH SPECIES

Two of the fish species identified in the South Niagara Falls watershed are currently considered “at risk”; grass pickerel and lake chubsucker. This means that grass pickerel has been designated as a species of special concern and lake chubsucker is designated as a threatened species by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (Barrett Personal Communication). The fish species found in this watershed are representative of an intermediately tolerant fish community, and fish habitat must be maintained or restored for the fish present in the system. Fish habitat is classified based on MNR (2000) protocol as identified below.

FISH HABITAT

Fish habitat falls into 1 of 3 categories in Niagara: Type 1, Type 2 or Type 3 (MNR 2000). Habitat type is based on the sensitivity and significance of current or potential habitats in a water body. Type 1 habitat is the most sensitive habitat of the 3 types. As a result, it requires the highest level of protection. Examples of Type 1 habitat include critical spawning and rearing areas, migration routes, over-wintering areas, productive feeding areas and habitats occupied by

TABLE 2: FISH SPECIES IN THE SOUTH NIAGARA FALLS WATERSHED

FISH SPECIES	BAYERS CREEK	GRASSY BROOK	HUNTER DRAIN	LYONS CREEK	TEE CREEK	USSHERS CREEK
Alewife	,					
Banded Killifish						,
Black Bullhead	,				,	,
Black Crappie	,	,		,		,
Bluntnose Minnow	,			,	,	,
Bowfin				,	,	
Brook Stickleback						,
Brown Bullhead	,	,		,	,	,
Bluegill	,	,	,	,	,	,
Central Mudminnow	,	,	,	,	,	,
Common Carp	,	,		,	,	,
Common Shiner	,		,		,	,
Creek Chub	,				,	,
Emerald Shiner	,	,	,	,	,	,
Fathead Minnow		,		,	,	,
Freshwater Drum	,					
Gizzard Shad	,					,
Golden Shiner	,	,		,	,	,
Goldfish	,			,		,
Grass Pickerel	,	,		,	,	,
Greater Redhorse	,					,
Green Sunfish	,	,	,	,	,	,
Hornyhead Chub						,
Johnny Darter	,	,		,	,	,
Lake Chubsucker				,		
Largemouth Bass	,	,	,	,	,	,
Logperch		,				
Longear Sunfish	,					
Longnose Dace						,
Mimic Shiner					,	
Muskellunge						,
Northern Pike	,	,		,	,	,
Pumpkinseed	,	,	,	,	,	,
Rainbow Smelt					,	
Redear Sunfish				,		
Rock Bass	,	,		,	,	,
Round Goby	,					,
Rudd				,		
Shorthead Redhorse	,					,
Smallmouth Bass						,
Spottail Shiner	,					,

TABLE 2: FISH SPECIES IN THE SOUTH NIAGARA FALLS WATERSHED

FISH SPECIES	BAYERS CREEK	GRASSY BROOK	HUNTER DRAIN	LYONS CREEK	TEE CREEK	USSHERS CREEK
Striped Shiner				,		
Tadpole Madtom	,	,		,	,	,
Tessellated Darter	,					
Trout-perch	,					
White Bass					,	
White Crappie	,	,			,	,
White Sucker	,	,	,	,		,
Yellow Bullhead	,				,	
Yellow Perch	,	,		,	,	,

sensitive species. Type 2 habitat is less sensitive and requires a moderate level of protection. These areas are considered "ideal for enhancement or restoration projects" and include feeding areas for adult fish and unspecialized spawning habitat. The third habitat type is considered marginal or highly degraded and does not contribute directly to fish productivity. Examples of Type 3 habitat include channelized streams and artificially created watercourses (MNR 2000).

Fish habitat type in the South Niagara Falls watershed has been delineated according to the Ministry of Natural Resources stream classification data. These areas are depicted on Figure 12 as critical habitat (Type 1), important habitat (Type 2) and marginal habitat (Type 3). As illustrated, the main channel of Bayers Creek, Usshers Creek, Tee Creek, Hunters Drain and Grassy Brook have been classed as Type 1 habitat. The majority of Lyons Creek has been classed as Type 1 habitat with the exception of some of the upper tributaries, which have been classed as Type 2 habitat.

MUNICIPAL DRAINS

Under the Ontario Drainage Act (R.S.O. 1990, Chapter D.17) drainage works "include a drain constructed by any means, including the improving of a natural watercourse, and includes works necessary to regulate the water table or water level within or on any lands or to regulate the level of the waters of a drain, reservoir, lake or pond, and includes a dam, embankment, wall, protective works or any combination thereof."

Four drains currently exist in the South Niagara Falls watershed (Figure13). Even though their purpose is to remove excess water from the land, municipal and agricultural drains do contain fish habitat. To better manage these drains, Fisheries and Oceans Canada has developed a classification system which identifies municipal drains as Types A through F using variables such as flow conditions, temperature, fish species present, and the length of time since the last clean out (Fisheries and Oceans Canada No Date). This classification system has been created for use by municipal drainage superintendents for the purpose of drain maintenance. Therefore, the classification assigned to a drain is subject to change frequently.

A Type A drain has permanent flow with cold or cool water temperature and no presence of trout or salmon present. A Type E drain also has a permanent flow with warm water temperatures and top predators (e.g., largemouth bass, northern pike, muskellunge and crappie) present in the drain. A Type F drain is characterized by intermittent flow (Fisheries and Oceans Canada No Date).

As illustrated on Figure 13 the drains in the South Niagara Falls watershed include Union Marsh Drain (Class E), Young Drain (Class E-F), Boyers Creek Drain (Class E), and Tee Creek Drain (Class E). Please note, drain classification is subject to change (see above).

The City of Niagara Falls has submitted a proposal to the department of Fisheries and Oceans Canada and the Niagara Peninsula Conservation Authority for maintenance and extension of Boyers Creek Drain and Union Marsh Drain, Usshers Creek Branch. In addition, the City of Niagara Falls has proposed to maintain Hunters Drain as a municipal drain (Barrett Personal Communication NPCA 2007).

FIGURE 12: FISH HABITAT

FIGURE 13: MUNICIPAL DRAINS

WATER QUALITY

Surface water quality is monitored by the NPCA staff in the South Niagara Falls watershed through the collection of grab samples on a monthly basis during the ice-free season and analyzed for several parameters including nutrients, metals, bacteria, suspended solids, and general chemistry. The indicator parameters summarized in Table 3 are the most useful in assessing relative stream quality. They include: total phosphorus, nitrate, copper, lead, zinc, *Escherichia coli*, chloride, suspended solids and benthic invertebrates (NPCA 2007a).

At the time the surface water quality monitoring program was initiated, sampling sites were prioritized by catchment size. Therefore, due to the small catchment size of Hunters Drain, it was not identified as a priority. However, due to the identification of algae in the watercourse during the 2007 field season, adding a sampling site in Hunters Drain should be considered for subsequent sampling seasons. Surface water quality is currently monitored in Usshers Creek, Lyons Creek, Grassy Brook, Tee Creek and Bayers Creek through the NPCA Water Quality Monitoring Program (Table 4). The locations of the water quality monitoring sites are illustrated on Figure 14.
Table 3: Water Quality Parameters (as reported in NPCA 2007)

The 2007 water quality data for the Usshers Creek station reported a poor water quality rating with exceedances of phosphorus and suspended solids; benthic species consisting mainly of worms, which is consistent with nutrient enrichment; low base flow; and reports of algae during the summer months. Water quality findings in Bayers Creek report exceedances of chloride, phosphorus and *E. coli*; and nutrient and chloride enrichment from upstream urban and agricultural areas. Grassy Brook is reported to be experiencing exceedances of phosphorus, and algae were observed during the summer months in 2007. Tee Creek water quality results indicated an exceedance of phosphorus in 2007 as did Lyons Creek.

BIOLOGICAL MONITORING AND ASSESSMENT PROGRAM

Benthic macroinvertebrate sampling has been completed at surface water quality monitoring stations using the BioMAP (Biological Monitoring and Assessment Program) protocol. Benthic macroinvertebrates are defined as the larger organisms inhabiting the substrate of waterways for at least part of their life cycle. Benthic macroinvertebrate species that are commonly found in the Niagara Peninsula include clams, snails, leeches, worms, and the larval stages of dragonflies, stoneflies, caddisflies, mayflies and beetles. At sites where water quality is impaired, the organisms found are less sensitive and therefore more tolerant to environmental stresses than organisms that would have historically occurred. The benthic population at an impaired site would typically be dominated by these more tolerant species, and as a result, biodiversity at the site would be quite low.

The BioMAP results for all five water quality monitoring stations in the South Niagara Falls Watershed indicated an impaired water quality rating in 2007 (Table 4).

TABLE 3: WATER QUALITY PARAMETERS (AS REPORTED BY NPCA IN 2007)

CATEGORY	INDICATOR PARAMETER	OBJECTIVE	REFERENCE
Nutrients	Total Phosphorus	0.03 mg/L	PWQO (MOE 1994)
Nutrients	Nitrate	13 mg/L	CWQG (CCME 2007)
Metals	Copper	0.005 mg/L	PWQO (MOE 1994)
Metals	Lead	0.005 mg/L	PWQO (MOE 1994)
Metals	Zinc	0.02 mg/L	PWQO (MOE 1994)
Microbiological	*Escherichia coli*	100 counts/100mL	PWQO (MOE 1994)
Other	Chloride	100 mg/L	CWQG (CCME 2005)
Other	Suspended Solids	25 mg/L	BC MOE (2001)
Biological	Benthic Invertebrates	Unimpaired	BioMAP (Griffiths 1999)

FIGURE 14: WATER QUALITY AND POTENTIAL CONTAMINANTS

TABLE 4: WATER QUALITY DATA MONITORED BY THE NPCA IN 2007

STATION	WATER QUALITY RATING	BIOMAP RATING	FACTORS AFFECTING WATER QUALITY
Usshers Creek US001	Poor	Impaired	• Exceedances of phosphorus and suspended solids • Benthic community consists mainly of worms that are consistent with nutrient enrichment • Site is vulnerable to low baseflow and stagnation • Algae observed during summer months
Bayer Creek BA001	Marginal	Impaired	• Exceedances of chloride, phosphorus and *E. coli* • Nutrient and chloride enrichment from upstream urban and agricultural areas • Lack of riparian buffer
Grassy Brook GR001	Marginal	Impaired	• Exceedances of phosphorus • Algae observed during summer months
Tee Creek TE001	Marginal	Impaired	• Exceedances of phosphorus
Lyons Creek LY003	Marginal	Impaired	• Exceedances of phosphorus

LYONS CREEK CONTAMINATED SEDIMENT STUDY

In addition to the NPCA's Water Quality Monitoring Program, sediment management options for PCB-contaminated sediment in Lyons Creek are being considered under the Niagara River Remedial Action Plan. Completed as a series of documents, a detailed study of the contaminated sediments on Lyons Creek East and Lyons Creek West has determined the extent of contamination and ecological risks at both sites, which were reported in the following documents:

- Golder Associates Ltd. 2004. Niagara River Area of Concern Contaminated Sediment Site Assessment, Phase I and II.
- Golder Associates Ltd. 2005. Niagara River Area of Concern Contaminated Sediment Site Assessment, Phase III.
- Dillon Consulting Ltd. 2005. Human Health Screening Level Risk Assessment: Lyon's Creek East.
- Dillion Consulting Ltd. 2005. Niagara River AOC Phase IV: Sediment Management Options for Lyon's Creek East and West.
- Dougan & Associates. 2007. Lyon's Creek East Wetland Inventory and Monitoring Study.
- Milani, Danielle & R. Fletcher. 2005. PCB contamination and biological impacts in Lyons Creek East: Implementation of a Canada-Ontario Decision-making framework for contaminated sediments. Prepared for the Niagara AOC steering committee.

Results from human health risk assessments for both sites indicate that dermal exposure to Polychlorinated Biphenyls (PCBs) in the sediment would not be expected to result in any adverse human health effects.

INTAKE PROTECTION ZONE STUDY

The Niagara Falls Intake Protection Zone (IPZ) study is being completed by Niagara Region as one of the technical studies that fall under the Clean Water Act (CWA)(Ministry of the Environment 2006). The study report will be used by the Niagara Peninsula Source Protection Committee (NPSPC) to prepare the Assessment Report which is required under the CWA. The IPZ for Niagara Falls is classified as a Great Lakes Connecting Channel and its vulnerability to contamination is being determined in accordance with the Ministry of Environment's Assessment Report Draft Guidance Module number 4: Surface Water Vulnerability Analysis (2006).

The IPZ study is based on the existing Water Treatment Plant intake location. Proposed future locations of the intake were not considered for this IPZ study. Initial results indicate that the IPZ will extend up the Niagara River and the Chippawa Channel approximately 10 kilometres under current operating conditions. A portion of surface water upland area catchments along this reach will be included in the IPZ such as Usshers Creek and Bayers Creek as well as a portion of the urban area of Chippawa.

There is a possibility of the flow in the Welland River being reversed from the existing condition to its more natural state (of flowing down into Niagara River), during a shutdown of the Chippawa Power Canal. These conditions were also modeled and indicate that under such circumstances, the IPZ will likely extend about 4 km southwest from the intake upstream into Lyon's Creek and the Welland River (Campbell 2007).

The Clean Water Act (Ministry of the Environment 2006) requires that decisions made under the Planning Act or the Condominium Act (Ontario Ministry of Municipal Affairs and Housing 1998) shall conform to the significant threat policies and designated Great Lakes policies set out in the source protection plans; the source protection plan 'prevails' in the case of a conflict with official plans and zoning by-laws, although subject to 'the provision that provides the greatest protection to the quality and quantity of any water that is or may be used as a source of drinking water prevails (Ministry of the Environment 2006, CWA Section 39). Therefore, while no policies are in place yet, once the Source Protection Plan is approved, it could restrict future land uses within the areas of the Intake Protection Zones.

GROUNDWATER RESOURCES

A Groundwater Study (Waterloo Hydrogeologic Inc.2005) has been completed for the jurisdiction of the NPCA. The study includes a series of maps illustrating recharge/discharge areas, well locations, overburden thickness, bedrock types, groundwater use, contaminant sources, and groundwater susceptibility to contamination.

Potential groundwater recharge and discharge areas are identified on Figure 14. Discharge areas are locations where groundwater leaves the aquifer and flows to the surface. Groundwater discharge occurs where the water table (or potentiometric surface) intersects the land surface. Potential discharge areas have been identified along Lyons Creek and a portion of Usshers Creek in the South Niagara Falls watershed. The potential height of the water table ranges between 0 and 50 metres above the ground surface at these sites.

Groundwater recharge areas are locations where water is transmitted downward to an aquifer. The amount of water that infiltrates to the water table depends on, for example, vegetation cover, slope, soil composition, surficial geology, and depth to the water table. In the South Niagara Falls watershed potential recharge areas are located in the south-west portion of the watershed. Water that infiltrates to the water table may carry contaminants with it. Therefore, these areas are considered groundwater sensitive.

Figure 15 illustrates areas with high, medium and low shallow intrinsic susceptibility. Two areas have been delineated as having a high shallow intrinsic susceptibility. The stretch along the Niagara River has been delineated as having medium susceptibility. The area in and around Willoughby Marsh has also been delineated as an area with medium shallow intrinsic susceptibility. The areas illustrated on Figure 15 are considered vulnerable to groundwater contamination due to the type of soils and depth of the groundwater table.

Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas, and to ensure that planning authorities are adhering to the Provincial Policy Statement (Ontario Ministry of Municipal Affairs and Housing 2005b) which requires restrictions on development and site alteration in order to protect "all municipal drinking water supplies and designated vulnerable areas; and protect, improve, restore vulnerable surface water and ground water, sensitive surface water features and sensitive ground water features, and their hydrologic functions (Ministry of the Environment 2006, CWA Section 39)".

IDENTIFICATION OF CHALLENGES AND OPPORTUNITIES IN THE SOUTH NIAGARA FALLS WATERSHED

The NWS (Regional Municipality of Niagara 2006) summarized a list of key water protection issues in the South Niagara Falls watershed. Additional issues have been identified by residents living in the watershed via public open houses and workshops during the Fall of 2006 and early in 2007. A Land Management and Agricultural Best Management Practice survey (Appendix A) helped to identify land and water management issues in rural areas of the watershed. Descriptions of the challenges facing the South Niagara Falls watershed are reported here.

SEPTIC SYSTEMS

A well designed septic system can function properly for years. The basic design of a septic system includes a septic tank and a drainage field. Wastewater from toilets, bathtubs, sinks and other drains flows into the tank where bacteria that is naturally found in the wastewater breaks down any solid material. The liquid effluent travels through the perforated distribution pipes to the leaching bed. The water is then absorbed and filtered by the ground in the drainage field. Problems with septic tanks often stem from improper use and maintenance. Faulty septic systems can create serious local contamination problems with the potential to contaminate groundwater wells (Pollution Probe 2004).

Faulty or improperly maintained septic systems have been reported as a slight to moderate concern in the Land Management Issues and Agricultural Best Management Practices survey. A septic system maintenance and education program could improve local septic system operation and well water quality for groundwater users in the watershed. The watershed strategy will put forth a set of recommendations for this type of water quality initiative.

LANDFILL SITES

There are 2 known closed landfill sites in the South Niagara Falls watershed. Landfill sites labelled as "old dump/fill sites" are areas that were once used as a dump or landfill. Although these sites are known to have existed, they are not monitored for their impact on water quality (Michaud Personal Communication NPCA 2006). One of the closed landfill sites is located in the Lyons Creek subwatershed off of Young Road and the other known closed landfill is located in the Bayers Creek subwatershed on Sherk Road. The locations of these landfill sites are located on Figure 14. No other known dump/fill sites are located in the watershed.

ROAD SALT

Originating from salt storage and snow disposal sites as well as from runoff, road salts are an environmental concern because they are known to have an adverse effect on freshwater ecosystems, soil, vegetation and wildlife (Environment Canada 2004a). In April 2004, Environment Canada produced a Code of Practice for the Environmental Management of Road Salts. The Code of Practice recommends that all road authorities prepare and implement salt management plans that incorporate the implementation of best management practices (BMP) for salt application, salt storage and handling, and snow disposal. The benefits of improved salt management include:

- a reduction in corrosive damage to salt application equipment, vehicles, and infrastructure such as concrete sidewalks and steps;
- a reduction in salt damage to vegetation and surrounding roads and walkways;
- reduced salt releases to surrounding waterways; and
- an overall, more efficient and effective service resulting in safer roads and sidewalks for users (Environment Canada 2004b).

The Regional Municipality of Niagara undertook a Salt Vulnerability Study, which was completed by Ecoplans Ltd (2005). The study identified vulnerable areas for land use, groundwater, surface water, and natural areas. In the South

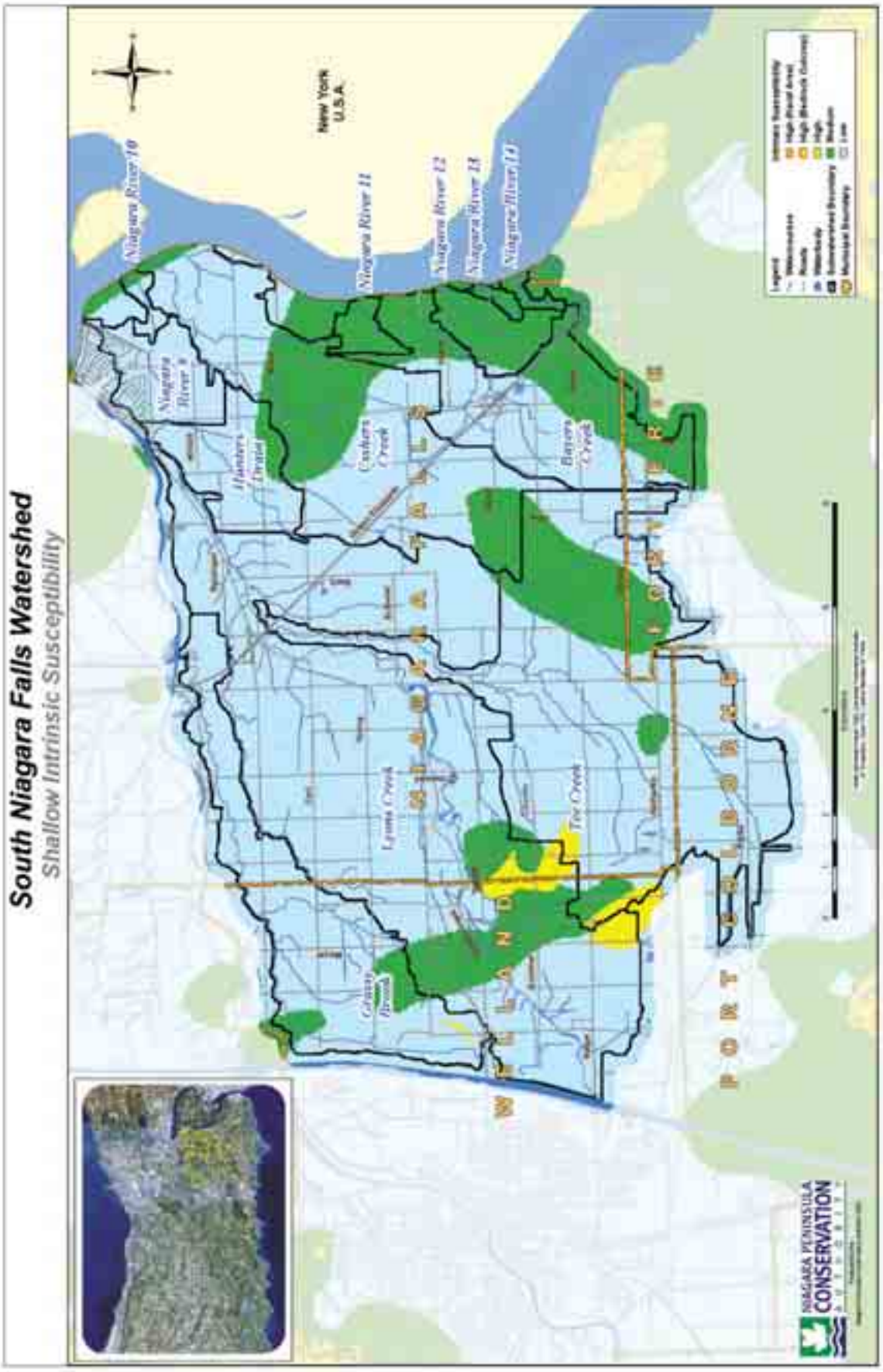

FIGURE 15: SHALLOW INTRINSIC SUSCEPTIBILITY

Niagara Falls watershed, the roads showing susceptibility to salt contamination are in areas of moderately high wetland and fish habitat vulnerability. In terms of salt vulnerability and groundwater resources in the South Niagara Falls watershed, Regional roads are ranked as having a low vulnerability due to the location of groundwater discharge areas. Surface water risk from salt along Regional roads is considered moderately high in the South Niagara Falls watershed (Ecoplans Ltd. 2005).

It is important to note that the Regional Niagara salt vulnerability study only assessed risk for Regional roads. Municipal roads should also be assessed to better identify salt vulnerable areas in the watershed.

NIAGARA TO GTA CORRIDOR

The Ontario Ministry of Transportation (MTO) has initiated Phase I of the Niagara to Greater Toronto Area (GTA) Corridor Planning and Environmental Assessment Study. The need for the Niagara to GTA Corridor was identified in the Growth Plan for the Greater Golden Horseshoe (Ministry of Public Infrastructure and Renewal 2006). The purpose of the Phase I study is to address existing and future anticipated transportation capacity deficiencies, for instance problems and opportunities, within the Niagara to GTA corridor by providing additional capacity for a 30 year planning horizon and beyond.

Although the Niagara to GTA Corridor assessment is still in its infancy, the proposed study area does extend into the South Niagara Falls watershed.

NUTRIENT MANAGEMENT

Ensuring proper nutrient management in the South Niagara Falls watershed was addressed in the NWS (2003) and in the Land Management and Agricultural Best Management Practices survey distributed to agricultural land owners. Nutrients derived from manure and chemical fertilizers are necessary for farm production. However, the improper use of nutrients can result in soil-nutrient imbalances and it can impair water quality locally and downstream of a farm. In order to maintain soil and water quality, the Ontario government introduced the Nutrient Management Act in 2002. Under this Act, farms must develop and implement a nutrient management strategy or a nutrient management plan. A nutrient management strategy is completed by non-agricultural and manure generators to manage the production, storage and use of manure and other nutrients produced and used on a farm. Nutrient management

plans are also completed for agricultural operations that apply nutrients to the land (OMAFRA and OMOE 2003). The purpose of proper nutrient management is to protect surface and ground water from contamination.

DEVELOPMENT

Urban encroachment has been identified as an issue in this watershed in the NWS (Regional Municipality of Niagara 2006). The loss of agricultural land to development was also identified as a serious concern by the members of the agricultural community that participated in the Land Management and Agricultural Best Management Practices survey (NPCA and OFA 2006). Survey participants were very concerned about the loss of agricultural land and the loss of natural areas to urban development. Urban development is permitted in the South Niagara Falls watershed in the Chippawa portion of the watershed. A description of the extent of the urban boundary is provided in the Future Land Use section of this watershed plan. Further, based on the extent of permitted urban development in the South Niagara Falls watershed identified in the City of Niagara Falls Official Plan, urban development is, in fact, not deemed a major concern for this watershed.

URBAN STORM WATER MANAGEMENT

During a rain event, stormwater remains on the surface collecting contaminants instead of seeping into the ground as it would in a natural system. As a result, stormwater accumulates and runs off in great amounts, creating the potential for flooding and erosion (Pollution Probe 2004).

Several strategies can be implemented to achieve stormwater management that aims to reduce stormwater runoff. One method involves storing excess water on or near the site, and releasing it slowly over a long period of time. Detention basins are used to slow the rate of delivery of stormwater by discharging the captured water at a specified rate to receiving water bodies. Another method involves returning the excess water to the ground where it would have gone prior to development. Additional stormwater management methods will be identified as part of the watershed strategy, especially as they relate to areas experiencing urban growth.

NATURAL HERITAGE RESOURCES

Although municipal official plans include the protection of environmentally significant areas, the loss of natural features still occurs with development. Natural features include, for example, wetlands, forests, and riparian stream cover, and they

provide many ecological functions in the South Niagara Falls watershed in terms of protecting water quality, moderating water quantity and providing habitat. In natural areas stormwater is more or less infiltrated where it falls, allowing most of the pollutants to be filtered through soils. When these areas are lost, and their functions not replaced with infiltration, detention or restoration measures, receiving watercourses are negatively affected with increased flows and pollutant loads. The challenge for the South Niagara Falls watershed is the expansion of riparian buffers to help protect and enhance water quality in the watershed.

WETLAND HABITAT

Wetlands provide very important water quality and ecological functions in a watershed. Currently, the percent of wetland cover in the South Niagara Falls watershed is high (Regional Municipality of Niagara 2006). Means to maintain the numbers and/or size of wetlands in the watershed are included in the watershed strategy because wetlands:

- naturally filter water resources thereby improving water quality,
- act like sponges, slowing the flow of water which reduces the impact of flooding and allows for groundwater recharge,
- help to prevent soil erosion, and
- augments low-flows by raising local water tables, which helps to maintain base flows.

RIPARIAN COVER

Riparian cover in the watershed is moderate. Like wetlands, riparian buffers also improve water quality. For example, riparian buffers:

- remove sediment and pollution such as fertilizers, pesticides, bacteria and road salt before they reach surface water,
- reduce the impacts of flooding,
- prevent erosion,
- improve water clarity, and
- provide shade and cooler water temperatures for fish and other aquatic organisms (NPCA 2003).

FOREST HABITAT AND MEADOWS

The amount of forest cover in a watershed determines its ability to support species diversity. The South Niagara Falls watershed is within adequate levels to protect water quality and provide habitat (Regional Municipality of Niagara 2006). However, some of the forest stands may be immature and may be functioning below optimum for habitat diversity (Regional Municipality of Niagara 2006) Forest cover is beneficial because it:

- reduces flooding and low flow events by intercepting runoff thereby encouraging infiltration,
- improves water quality by slowing the rate of runoff to watercourses, and trapping, using or breaking down some of the pollutants and nutrients found in runoff water,
- improves water quality by lowering water temperatures and shading water courses,
- improves groundwater quality by increasing the amount of rainfall that percolates to the groundwater table,
- reduces soil erosion, and
- preserves and increases flora and fauna diversity.

In addition, meadows also play an important role in creating habitat diversity and foraging areas for wildlife. Therefore, they should be given consideration in habitat creation and restoration actions in the South Niagara Falls watershed.

FISH AND AQUATIC HABITAT

The fish community in the South Niagara Falls watershed is representative of a tolerant warm water fishery, which includes different species of fish that have varying tolerances to environmental change. Therefore, they are considered valuable indicators of environmental and ecosystem health (Nottawasaga Valley Conservation Authority 1995). The protection and improvement of critical and important fish habitat has been identified as an issue in this watershed (Regional Municipality of Niagara 2006)

Fish habitat consists of areas that fish need, whether directly or indirectly in order to carry out their life processes including spawning grounds, nursery, rearing, food supply,
and migration areas. Broadly defined, wetlands, groundwater recharge areas, aquifers, and the quantity and quality of groundwater and surface water are all important factors for maintaining the quality and quantity of fish habitat. Development activities, structures, changes in land use, and alteration to hydrology can all impact fish and fish habitat. Fish habitat can be damaged in numerous ways including:

- dredging and filling near spawning and nursery habitat,
- loss of riparian vegetation,
- stream alterations including fish barriers,
- poorly managed stormwater runoff,
- impaired water quality (e.g., sediment and nutrient loadings, increased temperature), and
- loss of groundwater recharge capability (Fisheries and Oceans, Fisheries Act, Section 34).

The watershed strategy will focus on preserving Type 1 fish habitat in the watershed, and it will suggest restoration alternatives to maintain and improve Type 2 fish habitat.

MUNICIPAL DRAIN MAINTENANCE

Several municipal drains are located in the South Niagara Falls watershed including Union Marsh Drain, Bayers Creek Drain, Tee Creek Drain, Young Drain, as well as Howie Drain and Hopf-Wagner Drain both of which are segments of Young Drain. Drain maintenance was raised as an issue by area landowners at the first public meeting held in December 2006. Drain maintenance has been scheduled in the near future for Young Drain (Tee Creek), Boyers Creek Drain (Bayers Creek) and Union Marsh Drain (Ussher's Creek) (Barrett Personal Communication NPCA 2007).

LYONS CREEK CONTAMINATED SEDIMENT STUDY

The Lyons Creek West and Lyons Creek East subwatersheds were created as a result of the Welland Canal By-Pass completed in 1971. The construction resulted in the western portion of Lyons Creek draining to the Welland Canal By-Pass from the original headwaters in the City of Welland. The headwaters for Lyons Creek East subsequently originate in the Welland Canal and a pumping station, installed at the upstream end of the creek, maintains flow in Lyons Creek East through the addition of water from the canal.

In both Lyons Creek East and West, elevated levels of PCBs were found in surface and subsurface soils and/or sediments. Studies show that PCBs in Lyons Creek East could present potential risks to some ecological receptors. Assessments of remedial options are currently underway for both subwatersheds.

In June 2007, public information sessions were held at each site so the public's input on sediment management options for consideration could be obtained by the RAP's Technical Advisory Committee. Four options were brought forward to the public with an explanation of the social and technical aspects of each alternative. The options presented by the RAP Technical Advisory Committee are as follows:

1) Monitored Natural Recovery: The sediment would be left untouched and the area eventually covered by natural generation of new sediment or soil cover.
2) In-filling Without Sediment Removal: A clay cap would be placed over the area to isolate the contamination from the surface.
3) In-filling With Sediment Removal: A clay cap would be placed over less-impacted areas and 'hot spots' would be removed.
4) Removal and Restoration of Wetland: Complete removal of contaminated soil/sediment and restoration of the site into a sculpted wetland.

Since the public information session was held at Lyon's Creek East, a Public Advisory Committee, comprised of a few local volunteers, has been organized to meet over the duration of the remediation planning process for the site. Issues pertaining to the selection of the sediment management option for the site and related concerns raised at the open house are discussed.

The Technical Steering Committee will review a synthesis of the public comments received on the sediment management options and discuss these in context with the selection evaluation criteria. The next phase of the project will involve design and implementation of the preferred sediment management option for each site (Cromie 2007).

CLIMATE CHANGE

Most climatologists agree that climate change and the warming of the Earth's atmosphere is occurring. In addition, there is also broad agreement that human activities are primarily responsible for the changes to global climate that have been observed during the last half of the twentieth century (de Loë and Berg 2006). As reported by de Loë and Berg (2006) some of the predicted impacts to water resources in the Great Lakes Basin include, for example:

- Winter runoff is expected to increase, but total runoff is expected to decrease, thus summer and fall low flows are expected to be lower and longer lasting;
- Groundwater recharge is expected to decrease due to a greater frequency of droughts and extreme precipitation events. As a result, shallow aquifers will be more sensitive to these changes than deeper wells; and
- Water temperature in rivers and streams is expected to rise as air temperatures rise, and as summer baseflow is reduced.

These modeled or predicted impacts to water resources will affect society as well as ecosystems. Societal water use issues may arise because decreased runoff may lead to reduced water quality, resulting in increased water treatment costs and greater competition and conflict for water resources during low water or drought conditions. Ecologically, changes to wetland form and function may also experience change due to the impacts of climate change. For example, a reduction in groundwater discharge and an increase in surface water temperature will stress fish and fish habitat (de Loë and Berg 2006).

ECOLOGICAL RESTORATION AND ENVIRONMENTAL PLANNING TOOLS

COMMUNICATION AND EDUCATION

Watersheds often span numerous political boundaries. Therefore, agency, non-governmental partnerships, and citizen involvement is essential to the successful implementation of the South Niagara Falls watershed strategy. To facilitate communication between citizens and agencies in the watershed, a list of the major water resources legislation and agencies governing water management in Ontario is provided in Box 2. In addition to partnering on public and private lands, policy tools can be employed to foster environmentally responsible land and water management in the watershed.

POLICY TOOLS AND INCENTIVE PROGRAMS

Policy tools related to water quality and quantity protection can be implemented at the local or regional levels of government in the watershed. Designed to allow for continued development, these tools ensure that water quality and quantity issues are taken into consideration throughout the development process. Water protection policy tools might include municipal policies, incentive-based tools as well as other water conservation related tools. Specific examples of these policy tools are presented here.

- Stormwater Management Policies require the control and treatment of stormwater discharges to prevent flooding, minimize downstream channel erosion, and protect water quality. The NPCA is currently developing a set of Stormwater Policies for its jurisdiction.

LAW	FEDERAL LEGISLATION: DESCRIPTION (RELATED TO WATER PROTECTION)	GOVERNMENT AGENCY
Fisheries Act	Protects fish and fisheries habitat.	Fisheries and Oceans Canada
Environmental Contaminants Act	Prevents dangerous contaminants from entering the environment.	Environment Canada
Canada Shipping Act	Controls water pollution from ships by imposing penalties for dumping pollutants or failing to report a spill.	Transport Canada
Canada Water Act	Authorizes agreements with provinces for the designation of water quality and quantity management.	Environment Canada
Canadian Environmental Protection Act	Controls the manufacture, transportation, use, disposal of chemicals and waste that is not adequately regulated by other legislation.	Environment Canada
Pest Control Products Act	Regulates products used to control pests through a registration process based on prescribed standards.	Agriculture Canada
Navigable Waters Protection Act	Prohibits construction in navigable waters.	Transport Canada
International Rivers Improvement Act	Prohibits damming or changing the flow of a river flowing out of Canada.	Foreign Affairs and Environment Canada
	PROVINCIAL LEGISLATION	
Ontario Water Resources Act	Protects the quality and quantity of Ontario's surface and ground water resources (includes Permits to Take Water).	Ministry of the Environment
Clean Water Act	Protects the natural sources of drinking waters. Sources of drinking water are to be mapped by municipalities and conservation authorities, especially vulnerable areas that require protection.	Ministry of the Environment
Environmental Protection Act	Protects Ontario's land, water, and air resources from pollution (includes Certificates of Approval for landfills, sewage treatment, etc.).	Ministry of the Environment
Environmental Assessment Act	Requires an environmental assessment of any major public or designated private undertaking.	Ministry of the Environment
Pesticides Act	Protects Ontario's land, and surface and ground water resources from damage due to improper use of pesticides.	Ministry of the Environment
Nutrient Management Act	The purpose of the Act is to provide for the management of materials, containing nutrients in ways that will enhance protection of the natural environment and provide a sustainable future for agricultural operations and rural development.	Ministry of the Environment
Conservation Authorities Act	Ensures the conservation, restoration and responsible management of Ontario's water, land and natural habitats through programs that balance human, environmental and economic needs (includes floodplains).	Conservation Authorities
Lakes and Rivers Improvement Act	Ensures flow and water level characteristics of lakes and rivers are not altered to the point of disadvantaging other water users.	Ministry of Natural Resources
Planning Act	Provides for and governs land use planning including the provision of statements of provincial interest to be regarded in the planning process.	Ministry of Municipal Affairs and Housing
Municipal Act	Grants municipalities the power to pass bylaws related to water resources (e.g., bylaws that prohibit negative impacts on drains, dam construction and operation, and straightening of watercourses).	Ministry of Municipal Affairs and Housing
Public Lands Act	Protects and perpetuate public lands and waters for the citizens of Ontario.	Ministry of Natural Resources
Public Utilities Act	Empowers municipalities to acquire and operate water works and divert a lake or river for their purposes.	Ministry of Municipal Affairs and Housing
Drainage Act	Facilitates the construction, operation and maintenance of rural drainage works.	Ministry of Agriculture, Food and Rural Affairs
Tile Drainage Act	Provides for low interest loans to farmers from municipalities for tile drainage on their property.	Ministry of Agriculture, Food and Rural Affairs

BOX 2: MAJOR WATER RESOURCES LEGISLATION GOVERNING WATER MANAGEMENT IN ONTARIO

- Riparian Buffer Policies protect watercourses and maintain aquatic habitat. Riparian buffer guidelines should take into account the amount of natural vegetation adjacent to a stream, the width of the vegetated buffer, total suspended solid concentrations, percent imperviousness in urbanizing watersheds, and fish communities (Environment Canada 2004c). Riparian Buffer Policies are addressed by the NPCA (1993 as amended in 2003 and 2005) and in the Official Plan for Niagara Region (2007) in Environmental Policies 187, Policy 7.A.1.1.
- Alternative Subdivision Design encourages the development of subdivisions whereby houses are clustered and open space is protected. Conventional subdivisions spread development evenly throughout a parcel of land. However, conservation subdivisions are considered "density neutral", which means that the same number of lots can fit on a parcel of land, but the arrangement of the houses are clustered. The clustered arrangement helps to protect water quality.
- Incentive-based Tools such as Water Conservation Programs aid in the protection of water quality, quantity and aquatic habitat by maintaining instream flows. Thus, the natural hydrology of streams is protected during peak water demand.
- Alternate Land Use Services (ALUS) is a program whereby agricultural producers offer Canadians an environmental partnership opportunity by contributing the use of a portion of their land, plus labour, equipment, fuel, and money to produce environmental benefits, while encouraging investments from the rest of society to manage these benefits.
- Land Acquisition Programs can help to protect water quality, especially if large areas of undeveloped land are purchased. Maintaining the natural condition of land around watercourses is an ideal approach to enhance water quality protection. In a situation where the municipality does not have an interest in obtaining valleylands, stream corridors and/or floodplains for public open space purposes the NPCA will consider assuming the dedicated lands when they meet at least one of the following criteria:

(a) the valleylands, stream corridor and/or floodplain are contiguous with lands currently owned by the Conservation Authority or another public body;
(b) the valleylands, stream corridor and/or floodplain are within an area that are eligible for tax incentive programs; and
(c) where the valleylands, stream corridors and/or floodplain are adjacent to another natural area (NPCA 1993 as amended 2003 and 2005).

These tools, in addition to a comprehensive public education program will continue the line of communication with participating stakeholders that is developed through the watershed planning process.

WATERSHED BEST MANAGEMENT PRACTICES

A best management practice (BMP) is a land management practice implemented to control sources or causes of pollution. The 3 types of BMPs that treat, prevent, or reduce water pollution include:

- Structural BMPs are practices that require construction activities such as stormwater basins, grade stabilization structures, and crib walls.
- Vegetative BMPs use plants, including grasses, trees and shrubs to stabilize erosion sites.
- Managerial BMPs involve policy changes or operating procedures at a site (Brown, et. al. 2000).

It is important to note that BMPs are available for both urban and rural areas. A brief description of urban and rural BMPs follow and a more complete list of structural, vegetative and managerial BMPs are provided in Appendix C.

URBAN BEST MANAGEMENT PRACTICES

Urban BMPs are designed to redirect water from impervious surfaces to infiltration areas such as lawns, gardens, or forested areas. Residential landowners can minimize outdoor water consumption; plant drought-tolerant vegetation; capture rainwater for outdoor watering; avoid clearing vegetation around streams, riparian zones or floodplains; avoid channelizing streams or channels that connect to streams; avoid filling in floodplain or riparian zone areas; and discontinue the use of chemical fertilizers on their lawns and gardens. In addition to landowner BMPs in urban areas, BMPs can also be employed by local and regional governments to reduce the impacts to water quality and quantity from stormwater.

STORMWATER BEST MANAGEMENT PRACTICES

Stormwater BMPs are techniques, measures, or structural controls that are used to manage the quantity and improve the quality of stormwater runoff in a cost effective manner. Offline infiltration basins are an example of a structural stormwater BMP. Stormwater is diverted into the infiltration basin where it is retained to slowly infiltrate into the soil; it is not part of the main channel. Wet ponds are similar to off-line infiltration ponds. However, stormwater is retained for 2 to 3 weeks to allow for the absorption of pollutants and nutrients and then the water is released to the receiving watercourse. Managerial BMPs can also be achieved through municipalities. Municipalities can encourage and/or regulate land use planning and management by developing ordinances to manage stormwater impacts by limiting pavement, preserving open space, and delineating areas in the watershed for more on-site stormwater management facilities. Additional examples of structural, managerial and vegetative BMPs can be found in Appendix C.

AGRICULTURAL BEST MANAGEMENT PRACTICES

BMPs can improve rural non-point source pollution problems. For example, a lack of tributary buffers, and nutrient management have been identified in the watershed (Regional Municipality of Niagara 2006). Sediment control BMPs, water quality BMPs and nutrient management BMPs can be employed to mitigate the impacts of these activities on watercourses and wetlands. Examples of agricultural BMPs are provided below and a more thorough list of agricultural BMPs can be found in Appendix C.

Sediment Control Best Management Practices

Conservation tillage results in minimum soil disturbance by leaving at least 30 percent of the soil surface covered with crop residue immediately after planting. It is estimated that conservation tillage reduces soil loss by 50-95 percent and is effective in improving water quality. Windbreaks also control sediment and simply consist of rows of trees planted around the edge of fields to reduce soil erosion by wind.

Water Quality Best Management Practices

Tailwater recovery ponds are located at the base of a drainage area. They are designed to intercept runoff before it enters a stream to treat and remove sediment and nutrients from the water. These ponds can also be used as a source of irrigation water. Contour farming involves ploughing furrows perpendicular to the contour of the land, which allows water to be captured between the furrows to prevent the formation of erosion rills down the slope. This method also helps minimize the volume of water that is applied to the field thereby reducing sediment washoff. Buffer strips represent a third example of agricultural BMPs to protect water quality. Vegetation planted along a watercourse ensure bank stability and provide shade to the stream. Buffer strips also act to trap sediment and filter nutrients out of runoff from agricultural fields.

Nutrient Management Practices

The objective of nutrient management in Ontario is to use nutrients wisely for optimum economic benefit, while minimizing the impact on the environment (OMAF 1996). A nutrient management plan provides direction on how nutrients are to be applied to a given land base to optimize the use of nutrients by crops in order to minimize environmental impacts. In addition to nutrient management plans, fertilizer storage BMPs can also be implemented on a farm to ensure storage facilities are placed in appropriate areas (e.g., impermeable areas, away from wells).

FUNDING SOURCES FOR ENVIRONMENTAL PROJECTS

Several funding sources and land management tax incentive programs are available for landowners and non-profit organizations for creating, enhancing and preserving natural heritage. A description of known programs follows.

WATER QUALITY IMPROVEMENT PROGRAM

The Niagara Peninsula Conservation Authority provides landowners with up to 75 percent cost-share funding (depending on the eligible project) through its Water Quality Improvement Program. Participating landowners are responsible for any remaining costs through cash and in-kind contributions. To qualify for funding the following criteria must be met:

- projects must be within the NPCA's jurisdiction;
- projects must demonstrate an improvement to local surface and/or groundwater quality;
- the landowner must demonstrate good land stewardship practices;
- the landowner must contribute financially to the project in some capacity; and
- the landowner must complete a water quality improvement application and sign a project agreement form (NPCA 2003).

Eligible projects are related to woodland, wetland and riparian habitat restoration; manure and nutrient management; milkhouse washwater treatment and disposal; livestock restriction, alternate watering systems and crossings; and conservation farm practices.

CONSERVATION LAND TAX INCENTIVE PROGRAM

The Conservation Land Tax Incentive Program (CLTIP), offered by the Ministry of Natural Resources, was established by the province in 1998 to recognize, encourage and support the long-term private stewardship of Ontario's provincially significant conservation lands. This program provides property tax relief (100 percent for the eligible portion of the property) to landowners and non-profit organizations who agree to protect the natural heritage values of their property. Eligible lands consist of provincially significant areas identified by the Ministry of Natural Resources, and include: provincially significant wetlands; provincially significant Areas of Natural and Scientific Interest; endangered species habitats; lands designated as escarpment natural areas in the Niagara Escarpment Plan; and community conservation lands, which are natural areas of significance owned by non-profit charitable conservation organizations and conservation authorities. Landowners whose land is eligible for this program are automatically notified by the MNR during the summer before each new tax year (MNR 2004).

THE MANAGED FOREST TAX INCENTIVE PROGRAM

The Managed Forest Tax Incentive Program (MFTIP), offered by the Ministry of Natural Resources, was established in 1998 to recognize the social and ecological benefits of forest lands. Privately owned forest land is eligible to be taxed at 25 percent of the municipal tax rate set for residential properties provided the property has at least 4 hectares of forest, is owned by a Canadian citizen, and has a Managed Forest Plan approved by a consultant designated by the MNR (Ontario Woodlot Association 2005).

FARM PROPERTY CLASS TAX RATE

Under the Farm Property Class tax rate, farm properties that satisfy the eligibility requirements will be taxed at 25 percent of the municipal residential rate. However, the farm residence and 1 acre of land surrounding the residence will be taxed as part of the residential class. In order to be eligible for the Farm Property Class tax rate all of the following criteria must be satisfied:

- the property must be assessed as farmland;
- the property must be used as part of a farming operation generating Gross Farm Income of at least $7,000 as reported to the Canada Revenue Agency for income tax purposes;
- a valid Farm Business Registration number is required for the business operating on the land; and
- the property must be owned by a Canadian citizen or a permanent resident of Canada (OMAFRA 2004).

WATER WELL DECOMMISSIONING PROGRAM

The NPCA has launched a water well decommissioning granting program for qualifying landowners with lands located within the NPCA jurisdiction. To qualify for current funding (2007) the following criteria must be met:

- grants are available for the decommissioning of unused water wells only. Oil wells, gas wells and cisterns are not eligible under this program;
- the proposed work must be completed by a water well contractor licensed by the Ministry of the Environment (MOE) as set out in Ontario Regulation 903;
- the proposed work must comply with MOE procedures for plugging or abandoning unused water wells according to Ontario Regulation 903. Details of the procedure must be documented on the water well record and submitted to the MOE by the hired water well contractor upon completion;
- a copy of the water well record must also be submitted to the NPCA by the landowner or the hired water well contractor upon completion;
- priority will be given to:
  - hydrogeologically sensitive areas (based on NPCA Groundwater Study or other studies as endorsed by NPCA),
  - projects located in areas with a high density of domestic water wells, and
  - areas where watershed plans have been completed or are on-going; and
- all proposals are subject to review and approval by NPCA staff.

Under this grant program, applicants must apply and be approved prior to initiating their project. Projects already underway or completed without NPCA approval are not eligible. Eligible costs include those incurred by a licensed contractor and/or licensed technician fees or water well decommissioning (as approved by the NPCA). The Grant will cover 90 percent of well decommissioning costs to a maximum of $2,000 per well (limit of two wells per property). This is a reimbursement program; the landowner will pay the full cost to the contractor, and will be reimbursed for 90 percent of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA.

WATERSHED HABITAT RESTORATION

Environment Canada (2004c) in its How Much Habitat is Enough? document puts forth restoration guidelines for wetland, riparian, and forest habitat. This framework provides "science-based information and general guidelines to assist government and non-government restoration practitioners, planners and others involved in natural heritage conservation and preservation by ensuring there is adequate riparian, wetland and forest habitat to sustain minimum viable wildlife populations and help maintain selected ecosystem functions and attributes". Given the breadth of science used to generate this framework, its guidelines will serve as the basis for the South Niagara Falls watershed strategy. A summary of the riparian, wetland and forest habitat restoration guidelines have been reproduced in Appendix D.

WATERSHED RESTORATION GUIDELINES

Environment Canada (2004c) has created a set of guidelines for wetland, riparian and forest habitat restoration that identify targets for each habitat type in a watershed (Appendix D). These targets are scientifically-based, and therefore have been adopted for this watershed plan. The guidelines recommend the following:

- Wetlands: Greater than 10 percent of each major watershed in wetland habitat; greater than 6 percent of each subwatershed in wetland habitat; or restore to original percentage of wetlands in the watershed.
- Forest: At least 30 percent of the watershed should be in forest cover.
- Riparian: 75 percent of stream length should be naturally vegetated.

The South Niagara Falls watershed currently contains approximately 20 percent wetland cover and approximately 26 percent forest cover (NPCA 2007). Based on the above guidelines, an additional 4 percent of forest cover is required to create minimum desirable habitat proportions in the South Niagara Falls watershed. Therefore, measures to create new upland areas, as well as protect and enhance existing forest cover should be implemented to ensure no net loss of forest cover. Riparian cover in the watershed is approximately 51 percent in the watershed. Based on this percentage approximately

Rob Tervo, photographer

Rob Tervo, photographer

18 percent of the watershed requires a vegetative buffer. The guidelines represent minimum desirable habitat proportions for riparian, wetland and upland forest habitat. Additional restoration above the minimum target is encouraged once these targets have been met. Existing natural heritage features and areas in the watershed should be preserved and enhanced whenever possible to improve water quality, ecological uses and human uses of the natural features. In addition, whenever possible projects should benefit species which are designated federally under the Species At Risk Act or provincially under the Endangered Species Act (Environment Canada 2004c).

SPECIES AT RISK

A Species at Risk is "any plant or animal threatened by, or vulnerable to extinction (MNR No Date). In Ontario, species at risk are governed by two bodies; Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the Committee on the Status of Species at Risk in Ontario (COSSARO).

COSEWIC is an independent body responsible for identifying species that are considered to be at risk in Canada. COSEWIC reports their findings to the federal government. The federal government then determines which at-risk species qualify for protection under the Species At Risk Act (Government of Canada 2003). COSSARO is the provincial review process implemented by the Ontario Ministry of Natural Resources (OMNR), and is also an independent body made up of non-OMNR members. A species status designation may differ from COSEWIC and COSSARO because their vulnerability changes depending on the geographic scale. All species status designations given by COSEWIC will also be given an equal or greater status designation by COSSARO, however, there may be a greater concern for a species province-wide than nation-wide, and therefore it would be given a higher designation by COSSARO than from COSEWIC. In addition, a species may have been given a status designation by COSSARO and not from COSEWIC because there may only be a province-wide vulnerability.

In Ontario, 182 native species have been given official status designations by the OMNR (OMNR 2006). Currently, several legislative and policy tools protect species at risk in Ontario. For instance, under Ontario's Endangered Species Act (1971), species that have been given a status designation and are a regulated species are provided legal protection under the Act. The Provincial Policy Statement (PPS) (2005) under Ontario's Planning Act affords habitat protection by stating "Development and site alteration shall not be permitted in: significant habitat of endangered species and threatened species (PPS 2005)".

In May 2007, Bill 184, Endangered Species Act, 2007 made it to Royal Ascent in Ontario. It will replace Ontario's existing Endangered Species Act (1971) June 2008. Bill 184 states:

"If a species is listed on the Species at Risk in Ontario List as an endangered or threatened species, the Bill prohibits damaging or destroying the habitat of the species. This prohibition also applies to an extirpated species if the species is prescribed by regulations. The regulations may specifically prescribe an area as the habitat of a species but, if no habitat regulation is in force with respect to a species, "habitat" is defined to mean an area on which the species depends, directly or indirectly, to carry on its life processes"

The OMNR status definitions for species designations range from extinct (no longer exists anywhere) to data deficient (insufficient information for status recommendation). In the South Niagara Falls Watershed Plan study area, endangered, threatened and species of special concern have been documented by the OMNR, Dougan & Associates and the NPCA (Table 5). The definitions for these status designations by the OMNR are as follows:

- **Endangered (Regulated):** A species facing imminent extinction or extirpation in Ontario which has been regulated under Ontario's Endangered Species Act
- **Endangered (Not Regulated):** A species facing imminent extinction or extirpation in Ontario which is a candidate for regulation under Ontario's Endangered Species Act
- **Threatened:** A species that is at risk of becoming endangered in Ontario if limiting factors are not reversed
- **Special Concern:** A species with characteristics that make it sensitive to human activities or natural events

In addition to the listed endangered, threatened and species of special concern, numerous provincially rare species have also been noted by these same organizations within the South Niagara Falls Watershed Plan study area (Table 6), including greater redhorse which has been documented in the Niagara River and several subwatersheds within the study area. This species is included in COSEWICs June 2007 candidate species list as being potentially at risk but is waiting a detailed assessment by COSEWIC to determine its status (COSEWIC 2007).

Rob Tervo, photographer

TABLE 5: LISTED SPECIES AT RISK IN ONTARIO

COSEWIC STATUS (FEDERAL)	COSSARO STATUS (PROVINCIAL)	NAME	WATERSHED	PREFERRED HABITAT
Not at Risk	Endangered Species-R	Bald Eagle	Navy Island	Tall trees for roosting associated with large rivers, lakes
Endangered Species	Endangered Species	Butternut	Tee Creek	Upland forests
Endangered Species	No Designation	Flowering Dogwood	Lyons Creek, Tee Creek	Upland forests
Endangered Species	Endangered Species-R	Spoon-leaved Moss	Tee Creek	Wetland
Threatened Species	Threatened Species	American Waterwillow	Lyons Creek	Shallow water along stream banks
Threatened Species	Threatened Species	Blandings Turtle	Lyons Creek	Wetland
Threatened Species	Threatened Species	Lake Chubsucker	Lyons Creek, Tee Creek	Shallow weedy streams and pond areas connected to lakes
Threatened Species	Threatened Species	Round-leaved Greenbrier	Lyons Creek, Bayers Creek	Slough forest
Threatened Species	Threatened Species	White Wood Aster	Tee Creek	Upland forests
Special Concern	Special Concern	Cerulean Warbler	Navy Island	Continuous deciduous or mixed forest.
Special Concern	Special Concern	Grass Pickerel	Bayers Creek, Grassy Brook, Lyons Creek, Usshers Creek	Shallow water with an abundance of vegetation
Special Concern	Special Concern	Shumard Oak	Lyons Creek, Tee Creek, Usshers Creek	Moist soil, close to water or swampy areas
Special Concern	Special Concern	Yellow-breasted Chat	Grassy Brook	Dense riparian thickets in dry, open habitats

TABLE 6: PROVINCIALLY RARE SPECIES IN SOUTH NIAGARA FALLS WATERSHED PLAN AREA

NAME	WATERSHED	PREFERRED HABITAT
Arrow-arum	Hunters Drain, Usshers Creek	Shoreline
Black-crowned Night-heron	Black-crowned Night-heron	Wetlands, freshwater marshes,swamps, streams, lakes, and agricultural fields
Black Gum	Bayers Creek, Lyons Creek, Tee Creek, Usshers Creek	Wetland
Buttonbush Mineral Thicket	Lyons Creek	Lowland shrub, floodplains
Greater Redhorse	Bayers Creek, Niagara River, Usshers Creek	Large streams and mouths of tributaries
Halberd-leaved Tear-thumb	Bayers Creek, Lyons Creek, Tee Creek, Usshers Creek	Wetland
Hirsute Sedge	Lyons Creek, Tee Creek	Meadows, open woodlands, shorelines
Lizards Tail	Usshers Creek	Shoreline
Marsh St. John's wort	Lyons Creek, Tee Creek	Wetland
Mockernut Hickory	Navy Island	Wetland
Pawpaw	Navy Island	Floodplain, well drained soils
Pignut Hickory	Lyons Creek	Upland forests
Pin Oak	Bayers Creek, Grassy Brook, Lyons Creek, Tee Creek, Usshers Creek	Wetland
Sharp-wing Monkeyflower	Tee Creek	Wetland
Shellbark Hickory	Usshers Creek	Swamps and moist woodlands
Small-flowerGroovebur	Bayers Creek	Moist thickets and meadows
Smartweed Dodder	Lyons Creek, Niagara River 12	Lowland habitats
Sweet Joe-pye-weed	Bayers Creek	Woodlands, thickets and partially shaded streambanks
Weak Stellate Sedge	Lyons Creek, Tee Creek	Deciduous dominated forests and swamps
Whitehair Witchgrass	Lyons Creek	Dry soil, open wooded areas

WATERSHED STRATEGY

For convenience, and to make restoration recommendations more manageable and easier to implement, the watershed planning strategy has been divided into separate restoration plans for each of the larger subwatersheds; Grassy Brook, Hunters Drain, Tee Creek, Lyons Creek, Usshers Creek, Bayers Creek and Niagara River 9. Restoration areas have been identified based on riparian, wetland and upland restoration suitability mapping produced by the NPCA; Carolinian Canada's 'Big Picture' corridors; and Regional Niagara's Core Natural Heritage System mapping (Figure 16). Carolinian Canada's 'Big Picture' identifies existing natural cores, corridors and potential linkages in Canada's Carolinian life zone while Regional Niagara's Core Natural Heritage System consists of core natural areas to Niagara Region and potential linkages to areas identified as core areas.

The criteria for each restoration category (riparian, wetland and upland) were derived from several sources including Environment Canada's (2004c) framework for guiding habitat rehabilitation (Appendix D).

Each type of habitat restoration (riparian, wetland, upland) has been prioritized as most suitable, moderately suitable or least suitable. Areas suitable for riparian, wetland and upland habitat restoration may overlap on the following watershed restoration strategy maps due to the methodology from which they were derived. When this occurs, the most suitable restoration project should be implemented based on field verification, available project funding, landowner partnerships as well as the opportunity to enhance ecological linkages.

RESTORATION SUITABILITY MAPPING

The criteria used to create the restoration suitability mapping were derived from several sources (Appendix E). The criteria for each restoration category (riparian, wetland and upland) vary and have been weighted differently based on the suitability of the land for habitat creation. A complete list, including the rationale, methodology and reference for each criterion used in the suitability analysis are presented in Appendix E, and the top three criteria for each restoration category are presented below.

RIPARIAN HABITAT RESTORATION SUITABILITY

The criteria used to identify riparian habitat restoration suitability include, for example, stream bank erosion rates. This criterion is used because riparian areas identified as having high erosion rates resulting from an upslope contributing area and slope gradient analysis are most suitable to restoration with bioengineering. The proximity to a watercourse or waterbody identified riparian suitability because these areas contribute to both riparian buffers and floodplains, and restoration in these areas will improve the hydrological, habitat and water quality functions in the watershed. Land use type is ranked third in terms of identifying suitable areas for riparian restoration. Areas classified as scrub, low intensity agriculture, or natural areas are much more suitable to restoration than areas classified as industrial or urban.

WETLAND HABITAT RESTORATION SUITABILITY

The criteria used to identify wetland habitat restoration suitability include, for example, soil drainage because the drainage class of an underlying soil determines the amount of water the soil can receive and store before runoff. The more poorly drained the underlying soil, the more suitable the area is for wetland restoration. The wetness index predicts zones of water saturation where steady-state conditions and uniform soil properties are assumed. Similar to riparian restoration, land use type plays a role in determining areas suitable for wetland restoration.

UPLAND HABITAT RESTORATION SUITABILITY

Upland habitat restoration suitability is also evaluated based on land use type. Wetland buffer habitat thresholds (0-240m) are also used, which include areas within the 0-240 metre span of a wetland because they contribute to a range of habitat functions when vegetated. Vegetation within the closest proximity to a wetland provides the greatest benefit to that wetland. The third criterion for determining upland suitability is the proximity of an area to a significant patch. Areas within the closest proximity to existing forest patches with the highest Natural Heritage Score, or core size, are considered the most suitable for upland restoration because these sites will increase interior habitat. Additional criteria and the weighting scheme are presented in Appendix E. A series of habitat restoration suitability maps are provided (Figures 17 - 19).

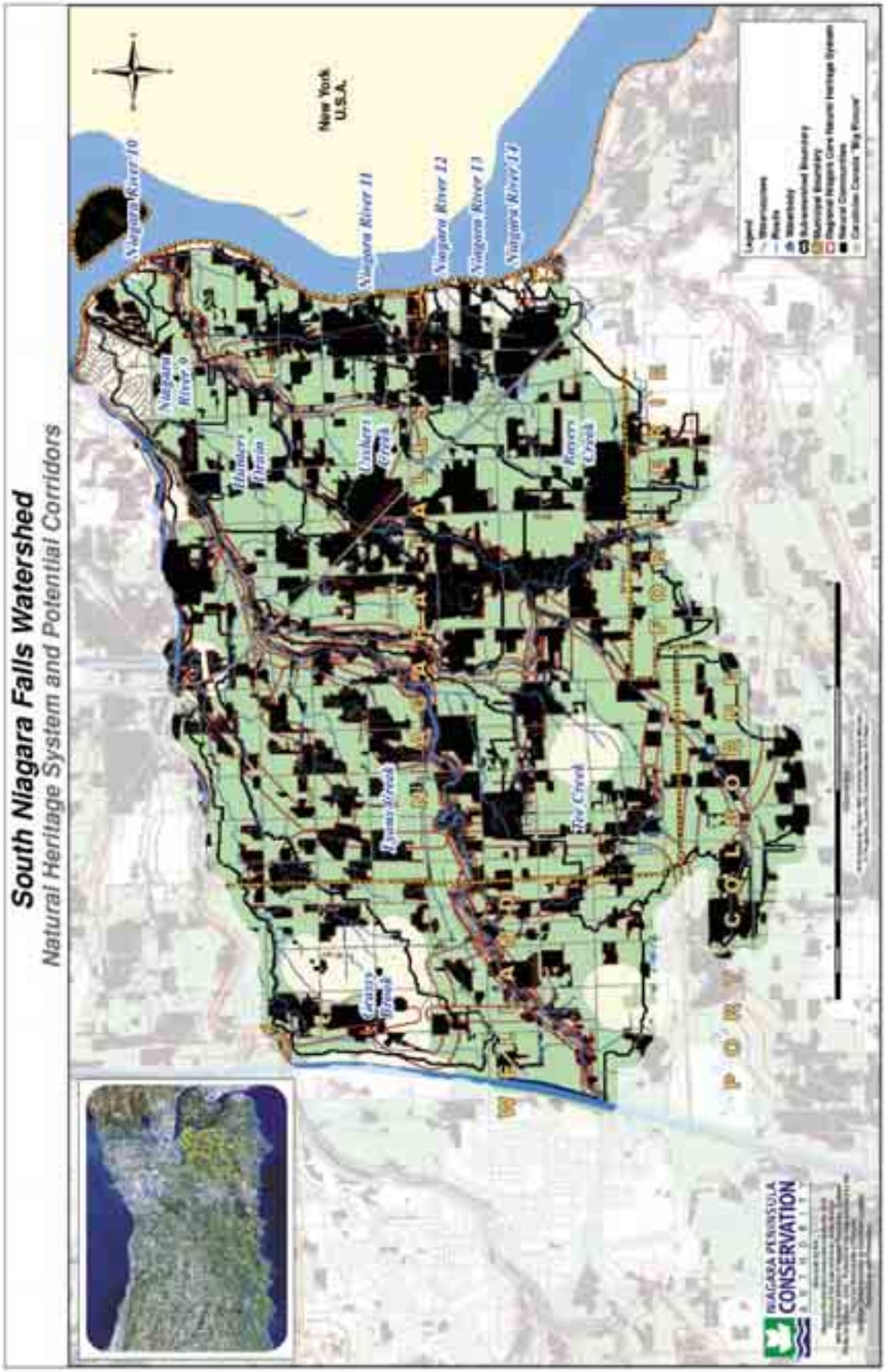

FIGURE 16: NATURAL HERITAGE SYSTEM AND POTENTIAL CORRIDORS

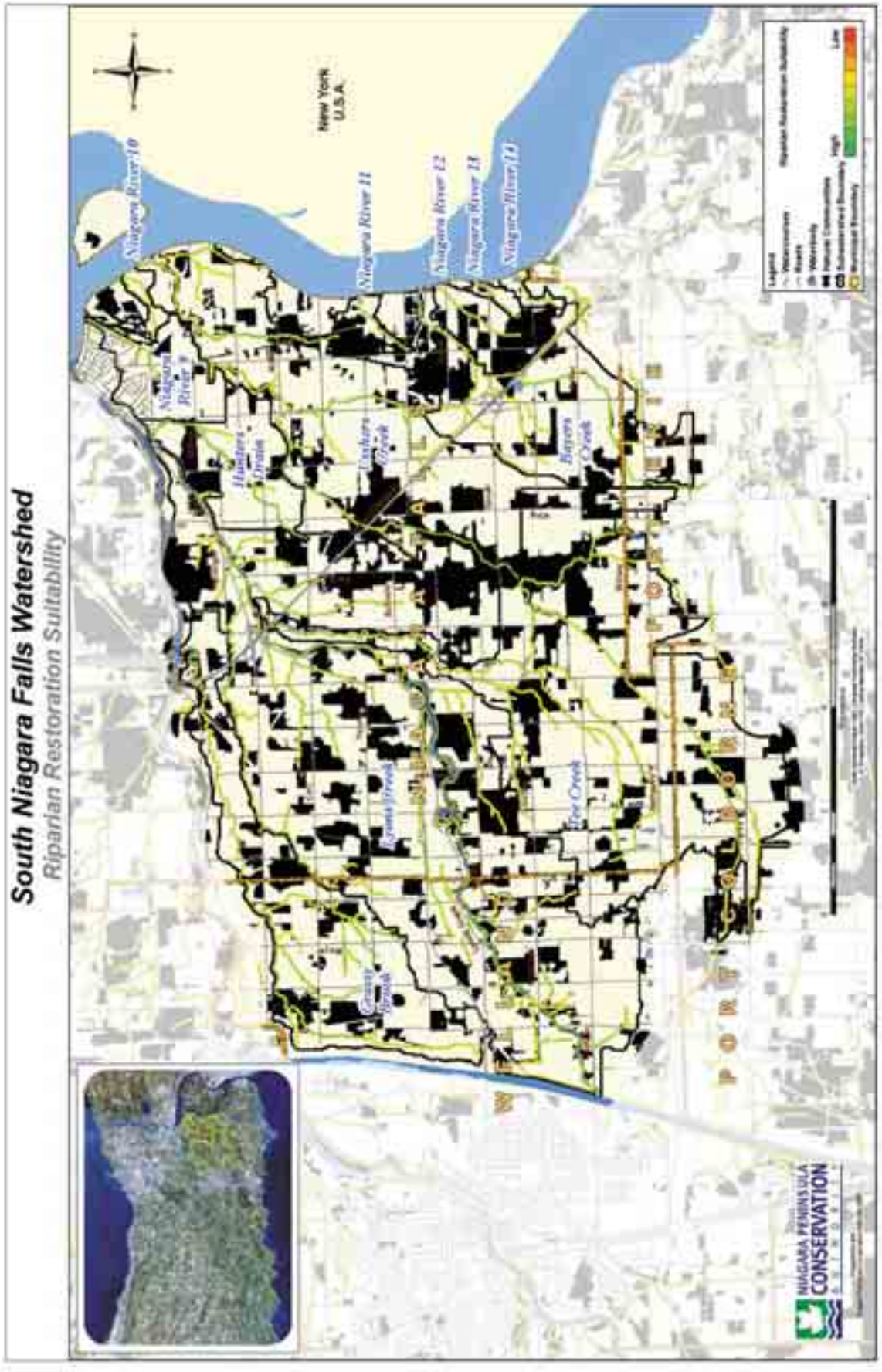

FIGURE 17: RIPARIAN SUITABILITY MAPPING

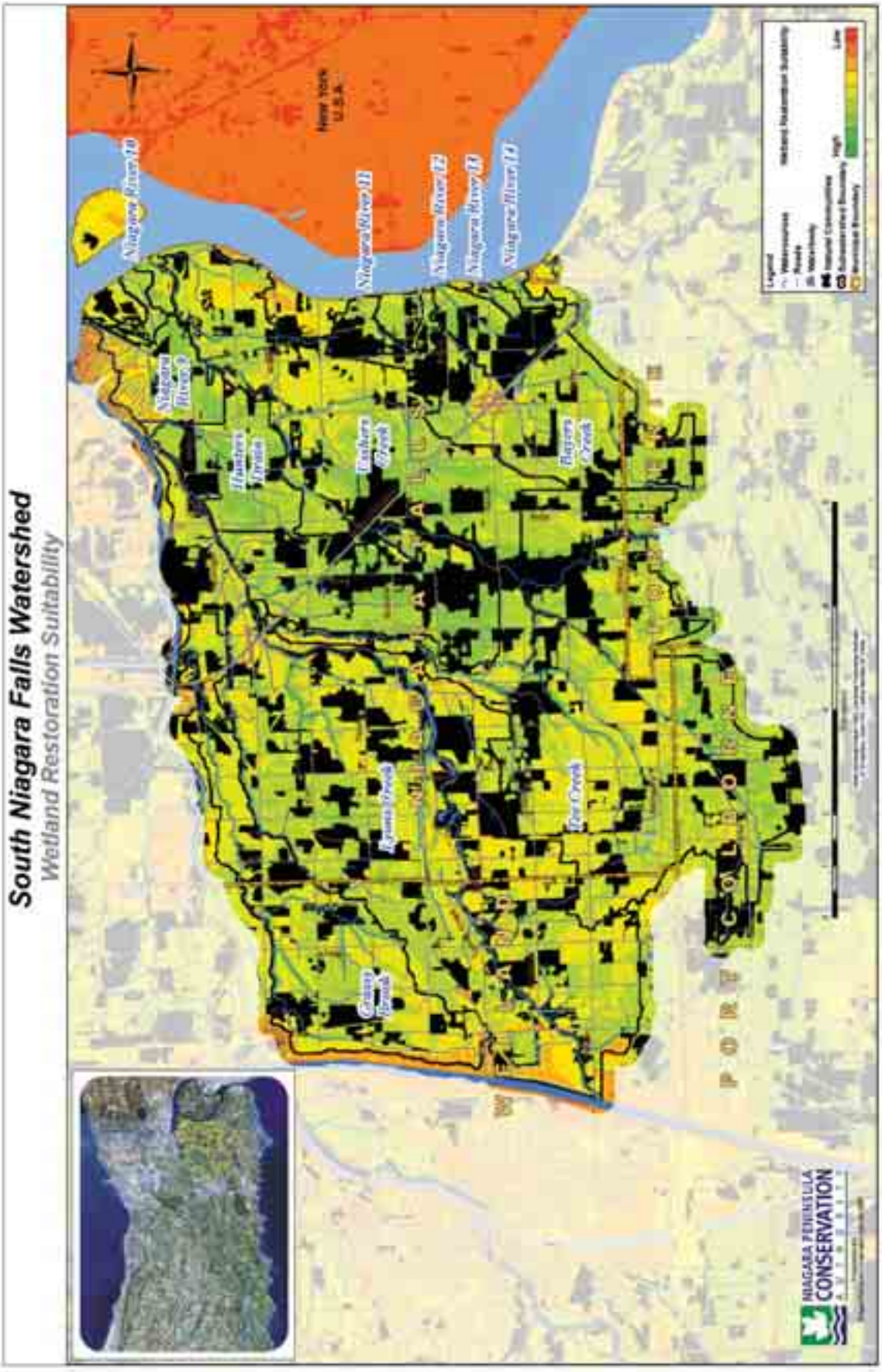

FIGURE 18: WETLAND SUITABILITY MAPPING

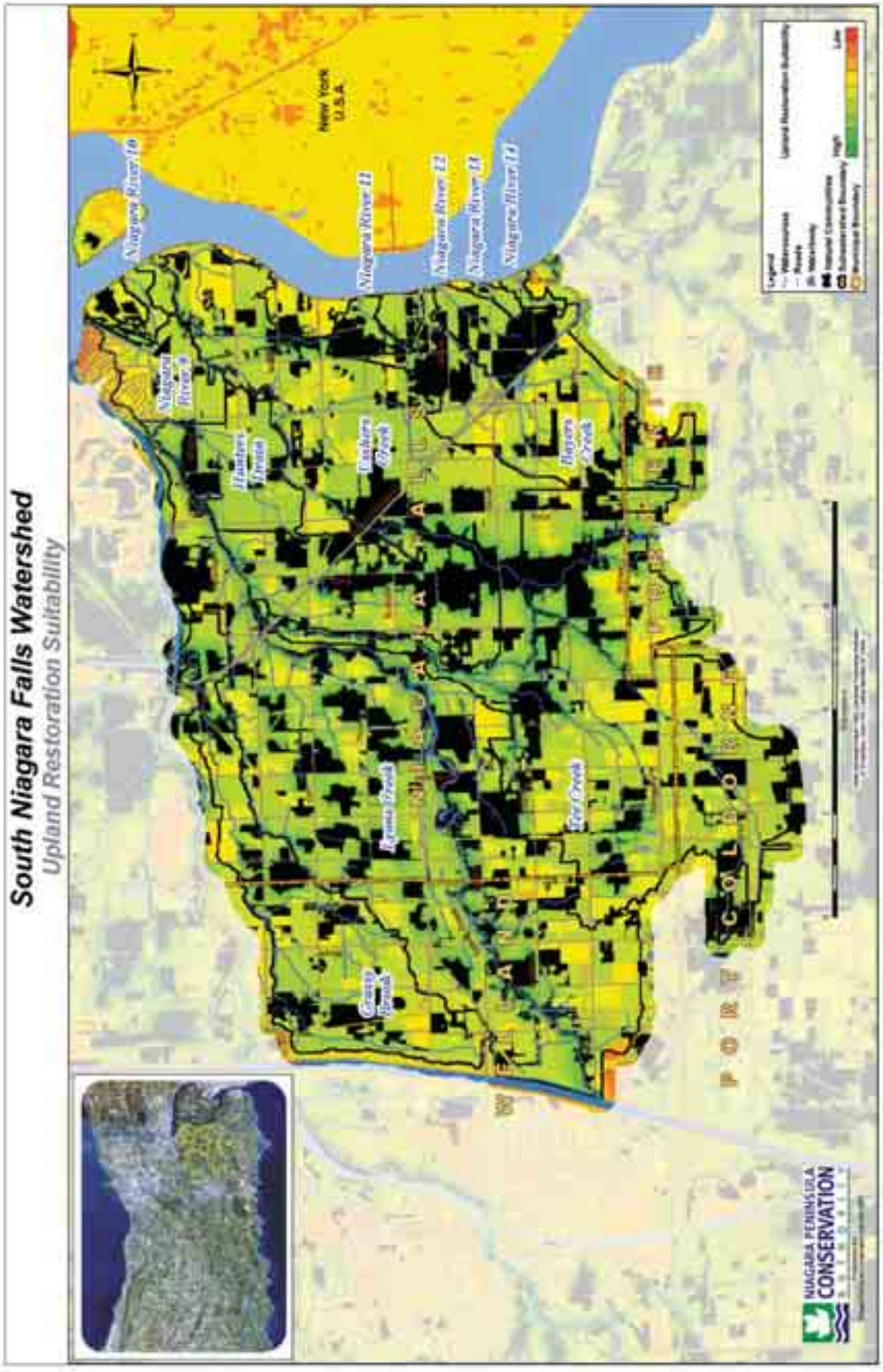

FIGURE 19: UPLAND SUITABILITY MAPPING

GRASSY BROOK RESTORATION STRATEGY

Grassy Brook flows through numerous agricultural fields before emptying into the eastern portion of the Welland River. Most of the watercourses in the Grassy Brook watershed have been classified as critical (Type 1) fish habitat apart from one small branch that has been classified as important (Type 2) fish habitat. Grass pickerel have been observed during fish surveys that were conducted in Grassy Brook by the Ministry of Natural Resources. Several perched culverts have been identified in the watercourses which act as fish barriers preventing the free movement of fish upstream and downstream.

BioMAP samples in this subwatershed indicate water quality is impaired and species composition is indicative of nutrient enrichment. Water quality testing also indicates marginal water quality with elevated concentrations of total phosphorus which exceed the Provincial Water Quality Objective 100 percent of the time and *E. Coli* concentrations which occasionally exceed the Provincial Water Quality Objective (NPCA 2007a). Soil erosion, the use of fertilizers and pesticides coupled with the lack of sufficient riparian buffers are likely sources of total phosphorus in this watershed. Potential sources of *E. Coli* include runoff from urban and agricultural landuse, animal waste, and sewage discharge. Promotion of the NPCA's education programs pertaining to agricultural best management practices and water quality programs would be beneficial for the landowners. These programs also include information on sources of funding for environmental projects on private land to encourage adoption and implementation of best management practices.

The challenge of the Grassy Brook subwatershed is the establishment of a sufficient vegetative riparian buffer which is imperative in assisting with the protection and enhancement of water quality, as well as providing a corridor that will facilitate in wildlife movement along the watercourse. The scattered pattern of the woodlots amongst the landscape offers ample opportunity to create linkages and corridors that will facilitate wildlife movement between woodlots. Two Provincially Significant Wetlands also exist in the Grassy Brook subwatershed; Lyons Creek North Wetlands and Grassy Brook Wetland. Enhancement around these significant natural areas will provide a variety a habitat for wetland-associated fauna that may extend beyond the wetland boundary, such as nesting sites for turtles and birds.

The Grassy Brook Subwatershed Restoration Strategy identifies two zones with specific stewardship and restoration recommendations (Table 7).

1) **Grassy Brook south of Carl Road:** The headwaters of the Grassy Brook subwatershed mainly commence in agricultural fields that offer little to no vegetative buffer. Therefore, riparian restoration in this portion of the subwatershed is important to enhance water quality by providing a buffer to filter out excess nutrients and suspended solids that may run off from the adjacent agricultural fields while providing shade and leaf litter to help maintain a healthy aquatic habitat. Several woodlots are scattered throughout this portion of the subwatershed offering plenty of opportunities for linkages to be created amongst adjacent woodlots. There are no wetlands in this portion of the subwatershed; therefore wetland creation should be considered. The wetland suitability mapping indicates high wetland suitability in the headwater areas which would assist in the maintenance of stream flow and water temperature. High suitability is also prominent adjacent to upland habitat which would enhance ecosystem functions by creating habitat diversity and a critical function zone.

2) **Grassy Brook north of Carl Road:** This portion of the subwatershed also lacks sufficient riparian vegetation with some areas having little to no buffer. A riparian planting program would also benefit this portion of the subwatershed to assist in the enhancement of water quality and fish habitat. This portion of the subwatershed contains numerous small woodlots as well as the McKenney Road Woodlot where rare species have been noted. Two Provincially Significant Wetland complexes are also found within this portion of the Grassy Brook subwatershed. The Upland Suitability Mapping and the Wetland Suitability Mapping both indicate high restoration suitability surrounding these existing significant natural heritage areas. Enhancement of these areas will provide a protection zone around the existing vegetation while providing a diversity of habitat for a wide range of flora and fauna. Linking these areas with a natural corridor would facilitate in the movement of wildlife from woodlot to woodlot. This portion of Grassy Brook watershed also offers numerous of other opportunities for corridor creation and enhancement of existing woodlots and wetlands.

TABLE 7: GRASSY BROOK SUBWATERSHED RESTORATION ACTIONS

RESTORATION OPPORTUNITIES	RECOMMENDED RESTORATION STRATEGIES		
	RIPARIAN	WETLAND	UPLAND AND ECOLOGICAL LINKAGES
GRASSY BROOK SOUTH OF CARL ROAD	• priority should be placed on riparian creation to protect and enhance water quality • headwaters of stream running through agricultural lands with little or no buffer; riparian buffers will help to reduce sediment and cool the water to enhance water quality and fish habitat. In addition, riparian habitat acts as a corridor by providing cover for wildlife between natural areas • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan(yellow-breasted chat, grass pickerel)	• create new wetlands in areas where the wetness index and soil drainage permit (e.g., high wetland suitability in the headwater areas and adjacent to watercourses)	• highly suitable upland restoration in headwater areas and adjacent to existing natural heritage areas; focus should be on increasing core natural heritage areas and ecological linkages with adjacent subwatersheds that are consistent with Carolinian Canada's "Big Picture" and Regional Niagara's Regional Policy Plan Amendment 187 • potential corridor along the southern branch of Grassy Brook extending to Lyons Creek • Carolinian and native species should be used in all restoration projects
GRASSY BROOK NORTH OF CARL ROAD	• priority should be placed on riparian creation • many sections of stream running through agricultural lands with little or no buffer; riparian buffers will help to reduce sediment and cool the water to enhance water quality and fish habitat • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan(yellow-breasted chat, grass pickerel)	• high restoration suitability exists between complexes of Grassy Brook Wetlands to create larger contiguous wetland cover • protect and enhance existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities) • create new wetlands in areas where the wetness index and soil drainage permit; priority should be given to areas adjacent to existing wetlands	• high suitability for upland restoration in this portion of the subwatershed; focus should be on sites adjacent to existing natural heritage areas to create larger contiguous forested areas, that are consistent with Carolinian Canada's "Big Picture" and Regional Niagara's Regional Policy Plan Amendment 187 • high suitability exists between McKenny Road Woodlot and adjacent woodlots • Carolinian and native species should be used in all restoration projects

TABLE 7: GRASSY BROOK SUBWATERSHED RESTORATION ACTIONS

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
GEOMORPHIC ASSESSMENT STUDY (NPCA 2007B)	The South Niagara Falls Watershed Geomorphic Assessment (NPCA 2007b) identified several erosion and sediment accumulation sites in the Grassy Brook subwatershed (Appendix B): 1. Montrose Road (Reach GBMa): Turbid water and the presence of algae were noted during a site visit in 2007. Water quality should continue to be monitored. The presence of steep, bare banks and ATV trails bordering the watercourse are likely contributing to additional sediment in the stream. Prevention of ATV trails adjacent to the stream is important in order to protect riparian habitat and limit bank erosion and additional sediment from entering the stream. Bank erosion has affected two pedestrian bridges that cross over the stream. Due to safety issues, replacing the pedestrian bridges with suitable widths is recommended. 2. Crowland Avenue (Reach GBMb): This site consists of a small riparian buffer zone and a large amount of instream vegetation. The presence of algae was also noted during a site visit in 2007. Water quality should continue to be monitored in this watershed. Increasing the size of the riparian buffer is recommended, as well as the diversity and variety of native plant species in order to create a more diverse ecological habitat. 3. Darby Road (Reach GBMc): The riparian buffer at this site is small and consists predominantly of herbaceous vegetation and shrubs. There are 3 tractor crossings present at this site which potentially increase the amount of sediment entering into the stream. Recommendations for this site include increasing the size of the riparian buffer, as well as the diversity and variety of native plant species in it in order to create a more diverse ecological habitat. In addition, limit the number of farm crossings and construct a proper crossing at this site to prevent further sediment loading of the watercourse. 4. Matthews Road (Reach GBTa): The main concern for this site is to establish a buffer strip where none currently exists and enhance the size of the existing riparian. In addition, increase the diversity and variety of native plant species. Encourage property owners to maintain a buffer strip to provide cover and habitat for fish, insects, and invertebrates along the channel. 5. Darby Road (Reach GBTb): The main concern for this reach is that it does not contain any riparian buffer or channel canopy along the length of the stream. Therefore, establishing a buffer strip along the length of the watercourse is recommended. In addition, there are no deep pools located in the channel and there at least 3 tractor crossings present which potentially increase the amount of sediment entering into the stream. Limiting the number of farm crossings and constructing proper crossing at this site are also recommended. Restoration priorities for Grassy Brook include enhancing the size of the riparian buffer and increasing the variety and diversity of native plant species within it. The lack of a riparian buffer typically occurs in agricultural fields, residential areas, and where the stream acts as a roadside ditch. Some of the benefits of an adequately sized buffer include providing habitat, preventing erosion, controlling the amount of sediment entering the stream from runoff, and filtering any pollutants that may enter the stream. Another restoration priority should be to construct proper crossings in agricultural fields and to prevent ATV trails adjacent to the stream in order to limit excess sediment from entering the channel. In addition, water quality should continue to be monitored in this watershed.
BADEN POWELL PARK PRAIRIE BURNING	Owned by the City of Niagara Falls, this park offers unique educational opportunities in terms of ecosystem restoration. Over the past few years, several restoration projects have been implemented in the park, including a woodland enhancement; wetland project; invasive species removal; and a prairie-meadow complex enhancement. In the spring of 2007 a prescribed burn was conducted on the prairie- meadow complex to initiate the native seed bank and to control cool season grasses and other herbaceous cool season plants. A second prescribed burn is recommended on this site as part of the overall restoration and initiation of this ecosystem. It is recommended that this site enter into a 5 to 7 year maintenance cycle of prescribed burns.

TABLE 7: GRASSY BROOK SUBWATERSHED RESTORATION ACTIONS

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
ECOLOGICAL LINKAGES BETWEEN NATURAL AREAS	The potential to create ecological corridors between the Provincially Significant Wetlands and adjacent natural areas exists in the Grassy Brook subwatershed. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as providing habitat and ecological diversity for a wide range of species.
INVASIVE SPECIES REMOVAL	Invasive species often have no natural competitors resulting in the potential to displace native species. Therefore removal and replacement of these species with native species is important so the diversity of native plants within an ecological community is not threatened. Purple Loosestrife has been identified as a problem. A removal program is recommended coupled with planting of native species.
REGIONAL ROADS— ROAD SALT IMPACTS	The Regional Municipality of Niagara has completed a Salt Study for its Regional Roads (Ecoplans Ltd. 2005). Surface water vulnerability as well as wetland and fish habitat vulnerability from salt along Regional roads is considered high throughout the South Niagara Falls watershed, except for a small portion along the Niagara River which is considered to have a moderate risk (Ecoplans Ltd. 2005). Riparian restoration should be targeted at watercourses and wetlands along regional roads to decrease the impacts from road salt on water quality and aquatic habitat. In addition, areas that support natural heritage features and agricultural areas should also be investigated and remediated to decrease the impacts of salt on these land features/uses.
FISH BARRIER INVENTORY AND REMOVAL	Fish barriers block the channel and can make areas of habitat inaccessible to all aquatic organisms, thereby reducing breeding opportunities for many native species; in addition, they can cause an increase in competition and predation. Examples of fish barriers include dams, weirs, floodgates, perched culverts, road crossings, as well as debris and log jams. Several fish barriers have been noted in the Grassy Brook subwatershed, therefore removal of these barriers is recommended. In addition, an updated inventory is recommended to determine all potential barriers to fish movement in the South Niagara Falls watershed. These sites should be reviewed and where possible, the barrier should be removed to optimize the passage of fish.
NATURALIZING CHANNELIZED PORTIONS OF THE WATERCOURSE	In addition to having a negative impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering the watercourse. Vegetating bare banks and maintaining a buffer strip; restricting cattle access; and allowing a slight meander to reduce bank erosion and flooding are a few measures that could potentially reduce the amount of sediment loading in the watercourse. In addition, when dredging does occur, ensure that the banks are not cut too steep as this will just make the banks more vulnerable to erosion.
WETLANDS ARE WORTH IT PROGRAM	Inadequate drainage from farm fields has been identified as a problem in the South Niagara Falls watershed. Investigation into possible wetland creation on private property may be an alternate solution over costly tiles for landowners with drainage problems. The NPCA's 'Wetlands are Worth It' Program provides grants to a maximum of 75% of the cost of a project with a grant ceiling of $10,000.
WEEPING TILE DISCONNECT PROGRAM	Some of the municipalities within the Niagara Region have already proposed or implemented by-laws that require homeowners to disconnect their weeping tiles from the sanitary sewer systems. This initiative should be extended Region-wide to eliminate excessive stormwater from entering the sanitary and storm sewer systems
URBAN RAIN BARREL AND DOWNSPOUT DISCONNECTION PROGRAMS	Several municipalities within the Niagara Region have already implemented these programs; however these initiatives should be extended Region-wide as an effort to eliminate excessive stormwater from entering the sanitary and storm sewer systems. In addition, a downspout disconnection by-law should be developed and implemented to further encourage landowners to discontinue the practice of directing rainwater from rooftops to sewer systems..

TABLE 7: GRASSY BROOK SUBWATERSHED RESTORATION ACTIONS

SPECIAL STUDIES	RECOMMENDATIONS FOR FURTHER STUDY
MUNICIPAL ROADS ROAD SALT IMPACT STUDIES	The Regional Municipality of Niagara has already completed a Salt Vulnerability Study for its roads (see above). It is recommended that municipalities complete similar studies to determine the impacts from road salt applications on municipal roads to groundwater sensitive areas, surface water resources, natural heritage areas and agricultural crops.
GROUNDWATER INTRINSIC SUSCEPTIBILITY STUDIES	The *Groundwater Study* (2005) has identified several areas with medium and high intrinsic susceptibility in the South Niagara Falls watershed (Figure 14). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's *Groundwater Study* (2005) and proposed *Source Water Protection Plan*.
RIPARIAN BUFFER EDUCATION PROGRAM	Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between $2,000 and $10,000.
SEPTIC SYSTEM EDUCATION AND FUNDING PROGRAM	Improperly maintained septic systems have been identified as a concern in the South Niagara Falls watershed. Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.
ABANDONED WELL DECOMMISSIONING PROGRAM	Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of $2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA.
AGRICULTURAL BEST MANAGEMENT PRACTICES PROGRAM	The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted in the Grassy Brook subwatershed. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between $5,000 and $12,000 depending on the project.
POLICY TOOLS	Policy tools such as stormwater management policies should be developed and included in regional and municipal Official Plans to ensure environmentally-based planning in the watershed. The NPCA has developed stormwater management policies for its jurisdiction for use by Regional Niagara and its municipalities.
POTENTIAL CONTAMINANT SOURCES OF POINT SOURCE POLLUTION	An inventory of potential contaminant sources was identified as part of the objectives for the NPCA's Groundwater Study (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the potential effects these potential contaminants may have on surface water quality and aquatic habitat.

HUNTERS DRAIN RESTORATION STRATEGY

Hunters Drain is a relatively small watercourse that flows through agricultural fields, wooded areas and wetlands before emptying into the northern reach of Lyons Creek. A small portion of Chippawa's urban area resides on the northern edge of this small subwatershed. The entire main channel of Hunters Drain has been classified as critical (Type 1) fish habitat. The existing natural areas are fragmented throughout the subwatershed offering plenty of opportunities to create ecological linkages between natural areas.

The Hunters Drain Subwatershed Restoration Strategy identifies one zone with specific stewardship and restoration recommendations (Table 8).

1) **Hunters Drain Subwatershed:** The watercourses of this primarily rural subwatershed flow mainly through agricultural fields that offer little to no vegetative riparian buffer. A challenge of this subwatershed will be to establish riparian buffers along those sections without cover in an effort to improve water quality and enhance aquatic habitat. Like the Grassy Brook subwatershed, Hunters Drain subwatershed would also benefit from a promotion of the NPCA's education programs pertaining to agricultural best management practices and water quality programs. These programs also include information on sources of funding for environmental projects on private land to encourage adoption and implementation of best management practices.

Numerous opportunities exist in the Hunters Drain subwatershed for wetland and upland restoration. The fragmented pattern of the woodlots and wetlands offer ample of opportunity for enhancement of existing natural areas, resulting in reduced gaps between natural areas. The proximity of the natural areas to each other also presents plenty of opportunity to create linkages and corridors to facilitate in movement of flora and fauna.

TABLE 8: HUNTERS DRAIN SUBWATERSHED RESTORATION ACTIONS

RESTORATION OPPORTUNITIES	RECOMMENDED RESTORATION STRATEGIES		
	RIPARIAN	WETLAND	UPLAND AND ECOLOGICAL LINKAGES
HUNTERS DRAIN SUBWATERSHED	• priority should be placed on buffer strip planting in sections of watercourses that have no cover • headwaters of stream running through agricultural lands with little or no buffer; riparian buffers will help to reduce sediment and cool the water to enhance water quality and fish habitat. In addition, riparian habitat acts as a corridor by providing cover for wildlife between natural areas • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan(arrow-arum)	• high wetland suitability in the headwater areas, adjacent to watercourses and existing natural areas • create new wetlands in areas where the wetness index and soil drainage permit • protect and enhance existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities)	• highly suitable upland restoration areas in headwater areas • create and enhance Carolinian Canada's "Big Picture" • high suitability for upland restoration adjacent to natural heritage areas; focus should be on increasing core natural heritage areas, filling in gaps between adjacent areas and creating ecological linkages with adjacent subwatersheds that are consistent with Carolinian Canada's "Big Picture" and Regional Niagara's Regional Policy Plan Amendment 187 • potential contiguous corridor along Ort Road extending into Usshers Creek subwatershed • Carolinian and native species should be used in all restoration projects

TABLE 8: HUNTERS DRAIN SUBWATERSHED RESTORATION ACTIONS

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
GEOMORPHIC ASSESSMENT STUDY(NPCA 2007B)	The South Niagara Falls Watershed Geomorphic Assessment (NPCA 2007b) identified several erosion and sediment accumulation sites in the Hunters Drain subwatershed (Appendix B): 1. **Sodom Road (HDMa)**: Bank erosion is present along this portion of the watercourse in the form of bare soil extending up the bank, and fallen vegetation. Exposed tree roots, as well as fallen and leaning trees can indicate that channel widening is occurring. Environment Canada (2004) suggests that at least 30m on both sides of the stream be naturally vegetated and therefore it is recommended that an adequately sized vegetative buffer adjacent to the stream be maintained. This buffer should consist of native species with all the structural components necessary to provide adequate stability and habitat to the stream. Due to the presence of algae noted during a site visit in 2007, initiation of a water quality monitoring program is recommended in this subwatershed. 2. **Ort Road (Reach HDMb)**: The buffer zone at this location consists predominantly of herbaceous vegetation and deciduous trees. Deep pools, fish cover, and habitat types are considered poor along the stream. There are a number of ATV trails crossing the stream, as well as evidence of ATV trails within the channel. Prevention or limitation of ATV trails is important in order to limit bank erosion and decrease amount of sediment entering the watercourse. Increasing the diversity and variety of native plant species within the buffer zone is also recommended. Restoration priorities for Hunters Drain include enhancing the size of the riparian buffer and increasing the variety and diversity of native plant species within it. This will help to prevent bank erosion, control the amount of sediment entering the stream from runoff, and filter any pollutants that may enter the stream. Another restoration priority that should be completed is the prevention of ATV trails adjacent to the stream in order to limit excess sediment from entering the channel. In addition, water quality should continue to be monitored in this watershed.
ECOLOGICAL LINKAGES BETWEEN NATURAL AREAS	The potential to create ecological corridors between adjacent natural areas exists in the Hunters Drain subwatershed. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as providing habitat and ecological diversity for a wide range of species.
INVASIVE SPECIES REMOVAL	Invasive species often have no natural competitors resulting in the potential to displace native species. Therefore removal and replacement of these species with native species is important so the diversity of native plants within an ecological community is not threatened. Purple Loosestrife has been identified as a problem. A removal program is recommended coupled with planting of native species.
REGIONAL ROADS— ROAD SALT IMPACTS	The Regional Municipality of Niagara has completed a Salt Study for its Regional Roads (Ecoplans Ltd. 2005). Surface water vulnerability as well as wetland and fish habitat vulnerability from salt along Regional roads is considered high throughout the South Niagara Falls watershed, except for a small portion along the Niagara River which is considered to have a moderate risk (Ecoplans Ltd. 2005). Riparian restoration should be targeted at watercourses and wetlands along regional roads to decrease the impacts from road salt on water quality and aquatic habitat. In addition, areas that support natural heritage features and agricultural areas should also be investigated and remediated to decrease the impacts of salt on these land features/uses.
FISH BARRIER INVENTORY AND REMOVAL	Fish barriers block the channel and can make areas of habitat inaccessible to all aquatic organisms, thereby reducing breeding opportunities for many native species; in addition, they can cause an increase in competition and predation. Examples of fish barriers include dams, weirs, floodgates, perched culverts, road crossings, as well as debris and log jams. An updated inventory is recommended to determine all potential barriers to fish movement in the South Niagara Falls watershed. These sites should be reviewed and where possible, the barrier should be removed to optimize the passage of fish.

TABLE 8: HUNTERS DRAIN SUBWATERSHED RESTORATION ACTIONS

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
NATURALIZING CHANNELIZED PORTIONS OF THE WATERCOURSE	In addition to having a negative impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering the watercourse. Vegetating bare banks and maintaining a buffer strip; restricting cattle access; and allowing a slight meander to reduce bank erosion and flooding are a few measures that could potentially reduce the amount of sediment loading in the watercourse. In addition, when dredging does occur, ensure that the banks are not cut too steep as this will just make the banks more vulnerable to erosion.
WETLANDS ARE WORTH IT PROGRAM	Inadequate drainage from farm fields has been identified as a problem in the South Niagara Falls watershed. Investigation into possible wetland creation on private property may be an alternate solution over costly tiles for landowners with drainage problems. The NPCA's 'Wetlands are Worth It' Program provides grants to a maximum of 75% of the cost of a project with a grant ceiling of $10,000.
WEEPING TILE DISCONNECT PROGRAM	Some of the municipalities within the Niagara Region have already proposed or implemented by-laws that require homeowners to disconnect their weeping tiles from the sanitary sewer systems. This initiative should be extended Region-wide to eliminate excessive stormwater from entering the sanitary and storm sewer systems.
URBAN RAIN BARREL AND DOWNSPOUT DISCONNECTION PROGRAMS	Several municipalities within the Niagara Region have already implemented these programs; however these initiatives should be extended Region-wide as an effort to eliminate excessive stormwater from entering the sanitary and storm sewer systems. In addition, a downspout disconnection by-law should be developed and implemented to further encourage landowners to discontinue the practice of directing rainwater from rooftops to sewer systems.
SPECIAL STUDIES	**RECOMMENDATIONS FOR FURTHER STUDY**
MUNICIPAL ROADS ROAD SALT IMPACT STUDIES	The Regional Municipality of Niagara has already completed a Salt Vulnerability Study for its roads (see above). It is recommended that municipalities complete similar studies to determine the impacts from road salt applications on municipal roads to groundwater sensitive areas, surface water resources, natural heritage areas and agricultural crops.
GROUNDWATER INTRINSIC SUSCEPTIBILITY STUDIES	The *Groundwater Study* (2005) has identified several areas with medium and high intrinsic susceptibility in the South Niagara Falls watershed (Figure 14). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's Groundwater Study (2005) and proposed *Source Water Protection Plan*.
RIPARIAN BUFFER EDUCATION PROGRAM	Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between $2,000 and $10,000.
SEPTIC SYSTEM EDUCATION AND FUNDING PROGRAM	Improperly maintained septic systems have been identified as a concern in the South Niagara Falls watershed. Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.

TABLE 8: HUNTERS DRAIN SUBWATERSHED RESTORATION ACTIONS

SPECIAL STUDIES	RECOMMENDATIONS FOR FURTHER STUDY
ABANDONED WELL DECOMMISSIONING PROGRAM	Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of $2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA.
AGRICULTURAL BEST MANAGEMENT PRACTICES PROGRAM	The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted in the Hunters Drain subwatershed. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between $5,000 and $12,000 depending on the project.
POLICY TOOLS	Policy tools such as stormwater management policies should be developed and included in regional and municipal Official Plans to ensure environmentally-based planning in the watershed. The NPCA has developed stormwater management policies for its jurisdiction for use by Regional Niagara and its municipalities.
POTENTIAL CONTAMINANT SOURCES OF POINT SOURCE POLLUTION	An inventory of potential contaminant sources was identified as part of the objectives for the NPCA's Groundwater Study (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the potential effects these potential contaminants may have on surface water quality and aquatic habitat.

TEE CREEK RESTORATION STRATEGY

The main channel of Tee Creek is designated as two municipal drains; Tee Creek Drain and Young Drain, which is properly termed Hopf-Wagner Drain upstream from Brookfield Road. Both drains are designated as critical (Type 1) fish habitat. Howie Drain which runs north of Forkes Road empties into Young Drain and is also designated as critical fish habitat. The majority of its tributaries have been classified as important (Type 2) fish habitat. Lake chubsucker, greater redhorse and grass pickerel have been identified in Tee Creek during fish sampling conducted by the Ministry of Natural Resources. Several fish barriers have been noted to exist within the watershed, mainly consisting of log jams and debris in the watercourse. Such barriers affect the stream flow as well as prevent the free movement of fish upstream and downstream.

Before emptying into Lyons Creek, Tee Creek flows through several agricultural fields, wooded areas and wetlands, including Tee Creek Provincially Significant Wetland. Natural heritage features in this subwatershed consist of approximately 26 percent woodlands and 22 percent wetlands of which almost one third have been designated as Provincially Significant Wetlands. In addition, 2 Conservation Areas are present; Smith-Ness Conservation Area and a portion of Willoughby Marsh Conservation Area which protects approximately 54 percent of the Willoughby Marsh Clay Plain Muck Basin, an Area of Natural Scientific Interest. Flowering dogwood and spoon-leaved moss, both endangered species, and white wood aster, a threatened species have all been documented in the Tee Creek subwatershed. In addition, several species of special concern and rare species have also been documented in the Tee Creek subwatershed.

BioMAP samples in this subwatershed indicate water quality is impaired and species composition is indicative of nutrient enrichment. Water quality testing also indicates marginal water quality with elevated concentrations of total phosphorus which exceed the Provincial Water Quality Objective 100 percent of the time and *E. Coli* concentrations which occasionally exceed the Provincial Water Quality Objective (NPCA 2007a). Soil erosion, the use of fertilizers and pesticides coupled with the lack of sufficient riparian buffers are likely sources of total phosphorus in this watershed. Potential sources of *E. Coli* include runoff from urban and agricultural landuse, animal waste, and sewage discharge. Promotion of the NPCA's education programs pertaining to agricultural best management practices and water quality programs would be beneficial for the landowners. These programs also include information on sources of funding for environmental projects on private land to encourage adoption and implementation of best management practices.

An abundance of opportunity exists in the Tee Creek subwatershed in terms of enhancement, corridor establishment and connection of adjacent natural areas by filling in fragments of natural areas.

The Tee Creek Subwatershed Restoration Strategy identifies three zones with specific stewardship and restoration recommendations (Table 9).

1. Tee Creek south of Lemon Street and west of Montrose Road: This portion of the subwatershed includes the headwaters for Tee Creek; Smith-Ness Conservation Area; numerous wetlands as well as several significant woodlots. The woodlots include Old Lincoln Street Woodlot and portions of Bill's Bush, Yokom Woodlot and Upper's Woodlot.

The fragmented pattern of the natural areas in this portion of the subwatershed presents sufficient opportunity to create corridors and fill in the gaps to create larger contiguous natural areas. Large sections of watercourse flow through agricultural fields that offer little to no vegetative cover. Establishment of a riparian buffer would not only enhance water quality and benefit aquatic habitat, but would create a corridor along the watercourse that would facilitate in movement of wildlife between the fragmented natural areas. In this portion of the watershed, riparian restoration is ideal.

The upland suitability mapping indicates high suitability in this portion of Tee Creek. Enhancement of existing natural areas would aid in closing gaps between adjacent natural areas creating larger contiguous natural areas that would support a higher diversity of flora and fauna. In addition, enhancement of existing NPCA's Water Quality Improvement Program reforestation projects along Netherby Road is recommended to increase core size as well as the woodlots ability to support a higher diversity of wildlife.

2. Tee Creek south of Lemon Street and east of Montrose Road: This section of the Tee Creek subwatershed includes portions of Willoughby Marsh Conservation Area, Willoughby Marsh Provincially Significant Wetland and Willoughby Clay Plain Muck Basin; all of which support the headwaters for the eastern branch of Tee Creek. Although the fore mentioned natural areas share a large portion of the same area, they do not share the same outer boundaries. Within the boundaries of Willoughby Marsh Conservation Area programs are already established for the protection of this significant ecosystem, which in turn protects the headwaters that fall within this boundary. Willoughby Marsh PSW continues to shelter the watercourse outside of the Conservation Area boundary. Wetland suitability indicates a high suitability in the small gap along the watercourse between Willoughby Marsh PSW and Tee Creek PSW, as well as between the fragments of the Tee Creek PSW. Filling in these gaps and creating one continuous wetland along the watercourse would be beneficial for water quality, aquatic habitat and in facilitating the movement of flora and fauna along the watercourse and through the wetland.

Upland and wetland suitability is also quite high surrounding existing natural features. Enhancement around these areas would not only provide a buffer for these significant areas, but would increase the core size which would support a higher diversity of wildlife. Filling in gaps between fragmented adjacent areas would create corridors that would facilitate in the movement of flora and fauna throughout the watershed. Opportunity exists to extend these natural areas into adjacent watersheds which would also be favorable to support a larger diversity of wildlife by creating one contiguous natural area.

3. Tee Creek north of Lemon Street: This portion of the main channel receives cover from Tee Creek Provincially Significant Wetland. However, the wetland complex is fragmented leaving opportunity for riparian-wetland restoration to fill in the gaps creating a single continuous naturalized system along the watercourse.

Upland restoration suitability is quite high in this portion of the Tee Creek subwatershed. Plenty of opportunity exists to connect natural heritage features in adjacent subwatersheds creating one contiguous natural area.

TABLE 9: TEE CREEK SUBWATERSHED RESTORATION ACTIONS

RESTORATION OPPORTUNITIES	RECOMMENDED RESTORATION STRATEGIES		
	RIPARIAN	WETLAND	UPLAND AND ECOLOGICAL LINKAGES
TEE CREEK SOUTH OF LEMON STREET AND WEST OF MONTROSE	• establishment of riparian habitat is ideal in this portion of the subwatershed for creating corridors that will connect fragmented natural areas • priority should be placed on buffer strip planting in sections of watercourses that have no cover; riparian buffers will help to reduce sediment and cool the water to enhance water quality and fish habitat • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (lake chubsucker) • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (hirsute sedge)	• wetland-riparian restoration is high along the watercourse between adjacent wetlands (e.g., between Lyons Creek Woodlot 43 and 36, as well as between Upper Tee Creek Complex and Lyons Creek Woodlot 36) • protect and enhance existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities) • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (spoon-leaved moss, shumard oak) • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (black gum, pin oak, weak stellate sedge, marsh st. john's wort, sharp-wing monkey flower)	• high suitability for upland restoration adjacent to natural heritage areas; focus should be on increasing core natural heritage areas, filling in gaps between adjacent areas and creating ecological linkages with adjacent subwatersheds that are consistent with Carolinian Canada's "Big Picture" and Regional Niagara's Regional Policy Plan Amendment 187 • potential contiguous corridor north of Netherby Road, extending north of Ridge Road into Lyons Creek subwatershed • enhancement of NPCA's existing reforestation projects is recommended • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (flowering dogwood, butternut, white wood aster) • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (hirsute sedge, weak stellate sedge) • Carolinian and native species should be used in all restoration projects

TABLE 9: TEE CREEK SUBWATERSHED RESTORATION ACTIONS

RESTORATION OPPORTUNITIES	RECOMMENDED RESTORATION STRATEGIES		
	RIPARIAN	WETLAND	UPLAND AND ECOLOGICAL LINKAGES
TEE CREEK SOUTH OF LEMON STREET AND EAST OF MONTROSE	• establishment of riparian habitat between fragmented wetland complexes is ideal in this portion of the subwatershed for creating corridors that will connect fragmented natural areas • buffer strip planting in sections of water-courses that have no cover (e.g., sections of the watercourse north of Ridge road have little to no buffer) • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (lake chubsucker) • whenever possible projects should benefit the provincially rare species in the subwater-shed, and therefore should be taken into consideration when developing a restora-tion plan (hirsute sedge)	• wetland-riparian restoration is high along watercourse between fragmented wetland complexes (e.g. between Willoughby Marsh PSW and Tee Creek PSW) • enhancement of existing wetlands would provide a buffer to protect significant natural area as well as providing habitat diversity for a wider range of wildlife • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (spoon-leaved moss, shumard oak) • whenever possible projects should benefit the provincially rare species in the subwater-shed, and therefore should be taken into consideration when developing a restora-tion plan (black gum, pin oak, weak stellate sedge, marsh st. john's wort, sharp-wing monkey flower)	• upland suitability mapping indicates high suitability for upland restoration adjacent to natural heritage areas; focus should be on filling in gaps between adjacent areas and creating ecological linkages with adjacent subwatersheds that are consistent with Carolinian Canada's "Big Picture" and Regional Niagara's Regional Policy Plan Amendment 187 • potential contiguous corridors surrounding Willoughby Marsh and adjacent wetlands and woodlots would increase diversity supporting a wider range of flora and fauna as well as supporting species that extend outside the boundaries of a woodlot and wetland • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (flowering dogwood, butternut, white wood aster) • whenever possible projects should benefit the provincially rare species in the subwater-shed, and therefore should be taken into consideration when developing a restora-tion plan (hirsute sedge, weak stellate sedge) • Carolinian and native species should be used in all restoration projects

TABLE 9: TEE CREEK SUBWATERSHED RESTORATION ACTIONS

RESTORATION OPPORTUNITIES	RECOMMENDED RESTORATION STRATEGIES		
	RIPARIAN	WETLAND	UPLAND AND ECOLOGICAL LINKAGES
TEE CREEK NORTH OF LEMON STREET	• establishment of riparian habitat between fragmented wetland complexes is ideal in this portion of the subwatershed for creating a continuous natural areas along the watercourse • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (lake chubsucker) • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (hirsute sedge)	• wetland-riparian restoration is high along watercourse between fragmented wetland complexes of Tee Creek PSW • wetland suitability mapping indicates a high suitability surrounding existing wetlands providing a buffer to protect significant natural area • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (spoon-leaved moss, shumard oak) • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (black gum, pin oak, weak stellate sedge, marsh st. john's wort, sharp-wing monkey flower)	• upland suitability mapping indicates high suitability for upland restoration adjacent to natural heritage areas; focus should be on filling in gaps between adjacent areas and creating ecological linkages with adjacent subwatersheds that are consistent with Carolinian Canada's "Big Picture" and Regional Niagara's Regional Policy Plan Amendment 187 • potential contiguous corridors surrounding Tee Creek PSW and adjacent wetlands and woodlots would increase diversity supporting a wider range of flora and fauna as well as supporting species that extend outside the boundaries of a woodlot and wetland • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (flowering dogwood, butternut, white wood aster) • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (hirsute sedge, weak stellate sedge) • Carolinian and native species should be used in all restoration projects

TABLE 9: TEE CREEK SUBWATERSHED RESTORATION ACTIONS

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
GEOMORPHIC ASSESSMENT STUDY (NPCA 2007B)	The South Niagara Falls Watershed Geomorphic Assessment (NPCA 2007b) identified several erosion and sediment accumulation sites in the Tee Creek subwatershed (Appendix B): 1. **Montrose Road/Yokom Road (Reach TCMa/TCMb/TCTa)**: This section of the stream is moderately to slightly entrenched which results in flood waters having limited to no access to the floodplain; therefore, the energy within the flow is contained to the channel. Allowing a floodplain to develop within entrenched streams and increasing the sinuosit along straightened reaches will help dissipate the energy within the flow. Bank erosion is present in this section in the form of bare soil extending up the bank. The presence of algae, oil sheen on the water, and an odour from disturbed sediment was noted during a site visit in 2007. Recommendations for this site include increasing the extent, variety and diversity of native plant species within the near bank zone to help stabilize the banks. In the occurrence of dredging, banks should not be graded too steep. Water quality should continue to be monitored in this watershed. 2. **Koabel Road (Reach TCMb)**: This portion of the stream is moderately to slightly entrenched resulting in flood waters having limited to no access to the floodplain; therefore, the energy within the flow is contained to the channel. Allowing a floodplain to develop within entrenched streams and increasing the sinuosity along straightened reaches will help dissipate the energy within the flow. Bank erosion is present in the form of bare soil extending up the bank. The presence of algae, duckweed, and turbid water was noted during site visits in 2006 and 2007. In addition, sediment deposition is occurring downstream of the bridge on Koabel Road. Recommendations for this site include increasing the variety and diversity of native plant species within the near bank zone to help stabilize the banks. In the occurrence of dredging, banks should not be graded too steep.Water quality should continue to be monitored in this watershed. 3. **Schaubel Road (Reach TCMc)**: This section of the stream is moderately to slightly entrenched which results in flood waters having limited to no access to the floodplain; therefore, the energy within the flow is contained to the channel. Allowing a floodplain to develop within entrenched streams and increasing the sinuosity along straightened reaches will help dissipate the energy within the flow. The riparian buffer vegetation consists mostly of herbaceous vegetation. There are few pools present along the stream bed. Recommendations for this site include increasing the variety and diversity of native plant species within the buffer zone, which will create a more diverse ecological habitat. In the occurrence of dredging, banks should not be graded too steep 4. **White Road (Reach TCMd)**: This section of the stream is adjacent to a wetland area. Trees in the middle of the stream indicate some channel widening may be occurring. A blocked culvert is present which may also be contributing to the channel widening. The presence of duckweed was identified during a site visit in 2007. Recommendations for this site include unblocking the culvert so water can flow freely and no excessive flooding or sediment accumulation occurs in this area. 5. **Forkes Road (Reach TCMd-2)**: There is little to no near bank vegetation within this portion of Tee Creek, which leaves exposed soil along the edge of the channel. Indications of channel widening occurring in this section include trees growing within the channel and at the toe of the bank and the presence of numerous debris jams. Recommendations for this site include increasing the variety and diversity of native plant species within the buffer zone, which will create a more diverse ecological habitat.

TABLE 9: TEE CREEK SUBWATERSHED RESTORATION ACTIONS

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
GEOMORPHIC ASSESSMENT STUDY (NPCA 2007B)	11. **Misner Road (Reach TCTbA-3)**: The riparian buffer present at this site is poor due to the adjacent agricultural field and its insufficient size. The culvert below the driveway has failed and a mid-channel bar is forming upstream which indicates that backwater is occurring during high water events. There is at least one tractor crossing through the stream in this section. Recommendations for this site include increasing the variety and diversity of native plant species within the buffer zone. This will help to limit the amount of sediment entering the stream, as well as provide cover and habitat for fish, insects, and invertebrates. Severe bank erosion occurring at channel bends should be properly stabilized. The failed culvert should be replaced and properly sized. Part of Tee Creek is designated as a municipal drain and some field sites were identified as entrenched, which means that flood waters have little to no access to the floodplain. Confining the flood waters to the channel results in the loss of the adjacent floodplain, which impacts the hydraulic function of the stream (floodplains are storage areas for flood waters) and the physical habitat (loss of floodplain vegetation and the organisms that live there). It will also change the channel geometry over time due to increased velocity, stream power and channel slope. Restoration priorities include enhancing the size of the riparian buffer and increasing the variety and diversity of native plant species within it. This will help to prevent bank erosion, provide habitat and cover, control the amount of sediment entering the stream from runoff, and filter any pollutants that may enter the stream. Another restoration priority should be to construct proper crossings in agricultural fields in order to limit excess sediment from entering the channel. The stream banks should not be graded too steep during dredging so that vegetation can become established and stabilize the soil. Allowing a floodplain to develop in entrenched sections, as well as continuing to monitor water quality would be beneficial to the watershed. Blocked, undersized, or failed culverts should be identified due to potential drainage problems through the watershed
ECOLOGICAL LINKAGES BETWEEN NATURAL AREAS	The potential to create ecological corridors between adjacent natural areas creating larger contiguous natural areas exists in the Tee Creek subwatershed. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as providing habitat and ecological diversity for a wide range of species.
INVASIVE SPECIES REMOVAL	Invasive species often have no natural competitors resulting in the potential to displace native species. Therefore removal and replacement of these species with native species is important so the diversity of native plants within an ecological community is not threatened. Purple Loosestrife has been identified as a problem. A removal program is recommended coupled with planting of native species.
REGIONAL ROADS - ROAD SALT IMPACTS	The Regional Municipality of Niagara has completed a Salt Study for its Regional Roads (Ecoplans Ltd. 2005). Surface water vulnerability as well as wetland and fish habitat vulnerability from salt along Regional roads is considered high throughout the South Niagara Falls watershed, except for a small portion along the Niagara River which is considered to have a moderate risk (Ecoplans Ltd. 2005). Riparian restoration should be targeted at watercourses and wetlands along regional roads to decrease the impacts from road salt on water quality and aquatic habitat. In addition, areas that support natural heritage features and agricultural areas should also be investigated and remediated to decrease the impacts of salt on these land features/uses.
FISH BARRIER INVENTORY AND REMOVAL	Fish barriers block the channel and can make areas of habitat inaccessible to all aquatic organisms, thereby reducing breeding opportunities for many native species; in addition, they can cause an increase in competition and predation. Examples of fish barriers include dams, weirs, floodgates, perched culverts, road crossings, as well as debris and log jams. Several fish barriers have been noted in the Tee Creek subwatershed, therefore removal of these barriers is recommended. In addition, an updated inventory is recommended to determine all potential barriers to fish movement in the South Niagara Falls watershed. These sites should be reviewed and where possible, the barrier should be removed to optimize the passage of fish.

TABLE 9: TEE CREEK SUBWATERSHED RESTORATION ACTIONS

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
NATURALIZING CHANNELIZED PORTIONS OF THE WATERCOURSE	In addition to having a negative impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering the watercourse. Vegetating bare banks and maintaining a buffer strip; restricting cattle access; and allowing a slight meander to reduce bank erosion and flooding are a few measures that could potentially reduce the amount of sediment loading in the watercourse. In addition, when dredging does occur, ensure that the banks are not cut too steep as this will just make the banks more vulnerable to erosion.
WETLANDS ARE WORTH IT PROGRAM	Inadequate drainage from farm fields has been identified as a problem in the South Niagara Falls watershed. Investigation into possible wetland creation on private property may be an alternate solution over costly tiles for landowners with drainage problems. The NPCA's 'Wetlands are Worth It' Program provides grants to a maximum of 75% of the cost of a project with a grant ceiling of $10,000.
WEEPING TILE DISCONNECT PROGRAM	Some of the municipalities within the Niagara Region have already proposed or implemented by-laws that require homeowners to disconnect their weeping tiles from the sanitary sewer systems. This initiative should be extended Region-wide to eliminate excessive stormwater from entering the sanitary and storm sewer systems.
URBAN RAIN BARREL AND DOWNSPOUT DISCONNECTION PROGRAMS	Several municipalities within the Niagara Region have already implemented these programs; however these initiatives should be extended Region-wide as an effort to eliminate excessive stormwater from entering the sanitary and storm sewer systems. In addition, a downspout disconnection by-law should be developed and implemented to further encourage landowners to discontinue the practice of directing rainwater from rooftops to sewer systems.
SPECIAL STUDIES	**RECOMMENDATIONS FOR FURTHER STUDY**
RESTORATION OF UNAUTHORIZED DRAINS	Unauthorized drains have been identified in Willoughby Marsh Conservation Area. Investigation of the effects and restoration of these unauthorized drains is recommended to ensure that these drains are not negatively impacting Conservation Area property and the resources it is trying to protect, which may also in avertedly be affecting Willoughby Clay Plain Muck Basin and Willoughby Marsh Provincially Significant Wetland.
MUNICIPAL DRAIN MAINTENANCE BEST MANAGEMENT PRACTICES	The Tee Creek subwatershed contains four municipal drains; Tee Creek Drain, Young Drain, Howie Drain and Hopf-Wagner Drain. Best Management Practices for drain maintenance should be developed in consultation with the Ministry of Natural Resources, Department of Fisheries and Oceans, NPCA, municipalities and the agricultural community to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain.
MUNICIPAL ROADS ROAD SALT IMPACT STUDIES	The Regional Municipality of Niagara has already completed a Salt Vulnerability Study for its roads (see above). It is recommended that municipalities complete similar studies to determine the impacts from road salt applications on municipal roads to groundwater sensitive areas, surface water resources, natural heritage areas and agricultural crops.
GROUNDWATER INTRINSIC SUSCEPTIBILITY STUDIES	The *Groundwater Study* (2005) has identified several areas with medium and high intrinsic susceptibility in the South Niagara Falls watershed (Figure 14). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's *Groundwater Study* (2005) and proposed *Source Water Protection Plan*.

TABLE 9: TEE CREEK SUBWATERSHED RESTORATION ACTIONS

SPECIAL STUDIES	RECOMMENDATIONS FOR FURTHER STUDY
RIPARIAN BUFFER EDUCATION PROGRAM	Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between $2,000 and $10,000.
SEPTIC SYSTEM EDUCATION AND FUNDING PROGRAM	Improperly maintained septic systems have been identified as a concern in the South Niagara Falls watershed. Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.
ABANDONED WELL DECOMMISSIONING PROGRAM	Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of $2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA.
AGRICULTURAL BEST MANAGEMENT PRACTICES PROGRAM	The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted in the Tee Creek subwatershed. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between $5,000 and $12,000 depending on the project.
POLICY TOOLS	Policy tools such as stormwater management policies should be developed and included in regional and municipal Official Plans to ensure environmentally-based planning in the watershed. The NPCA has developed stormwater management policies for its jurisdiction for use by Regional Niagara and its municipalities.
POTENTIAL CONTAMINANT SOURCES OF POINT SOURCE POLLUTION	An inventory of potential contaminant sources was identified as part of the objectives for the NPCA's Groundwater Study (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the potential effects these potential contaminants may have on surface water quality and aquatic habitat.

LYONS CREEK RESTORATION STRATEGY

The main channel of Lyons Creek in its entirety flows through a Provincially Significant Wetland; Lyons Creek Floodplain Wetland which extends from the Welland Canal to the Welland River where it finally drains. This system in part is also designated as an Area of Natural and Scientific Interest. The flow of Lyons Creek is maintained by water that is pumped from the Welland Canal, except for the headwaters of the eastern branch which originate in Willoughby Clay Plain Muck Basin; also an Area of Natural Scientific Interest, a designated Provincially Significant Class 1 Wetland, and an Environmentally Sensitive Area. Residents living along Lyons Creek have expressed concern regarding the lack of flow in the watercourse in comparison to pre-canal times. Therefore, further investigation into the current and historical flow regimes would be beneficial in gaining a better understanding of the Lyons Creek natural system.

Wetland cover makes up approximately 19 percent of the Lyons Creek subwatershed; almost half of this has been designated Provincially Significant Wetland. A portion of the Willoughby Marsh Conservation Area also falls within the subwatershed boundary. This conservation area protects approximately 15 percent of the Willoughby Marsh Clay Plain Muck Basin.

Approximately 28 percent of the Lyons Creek subwatershed is covered with wooded areas including the following significant woodlots; Yokom Woodlot, Horse Track Woodlot and Young Woodlot.

The main channel has been classified as critical (Type 1) fish habitat and the majority of the tributaries have been classified as important (Type 2) fish habitat. Grass pickerel and lake chubsucker have also been identified in Lyons Creek during fish sampling conducted by the Ministry of Natural Resources. In addition to the fish species, the Ministry of Natural Resources has also identified several other species at risk in the Lyons Creek subwatershed including the federally and provincially threatened blandings turtle, american waterwillow and round-leaved greenbrier as well as several provincially rare species.

BioMAP samples in this subwatershed indicate that water quality is impaired and species composition is indicative of nutrient enrichment. Water quality testing also indicates marginal water quality with elevated levels of phosphorus and levels of *E. coli* and copper that occasionally exceeds the Provincial Water Quality Objectives (NPCA 2007a). The dominant landuse in the Lyons Creek subwatershed is agriculture. Several watercourses flow through agricultural fields that offer little to no riparian buffer. Poor nutrient management practices and the lack of sufficient buffer are likely contributing to the poor water quality. Lyons Creek subwatershed would benefit from a promotion of the NPCA's education programs pertaining to agricultural best management practices and water quality programs. These programs also include information on sources of funding for environmental projects on private land to encourage adoption and implementation of best management practices.

Two golf courses are located in the Lyons Creek subwatershed; the Links of Niagara and Rolling Meadows Golf and Country Club. By integrating golf course management practices with wildlife management, such as incorporating enhanced natural areas into the landscaping, golf courses have the potential to offer a wide range of habitat for wildlife. In addition, encouragement of environmentally responsible maintenance practices, if not already adopted, will be beneficial to water quality and the aquatic habitat.
As part of the objectives for the NPCA Groundwater Study (Waterloo Hydrogeologic Inc.2005), several potential contaminant sites have been identified in the Lyons Creek subwatershed. These include a closed landfill, a hazardous waste receiver depot, several automotive wrecker facilities and numerous sand and gravel pits. An updated inventory to confirm potential contaminant sources and locations may be beneficial as well as further investigation into the potential effects of these potential contaminants on surface water quality and aquatic habitat.

The Lyons Creek subwatershed is rich in biodiversity; therefore the challenge for Lyons Creek will be protection of its unique and diverse natural heritage features. Numerous opportunities exist for enhancement of vulnerable areas; creating linkages and corridors to fill in gaps to facilitate movement of flora and fauna; and establish riparian vegetation where there currently is no buffer strip.

The Lyons Creek Subwatershed Restoration Strategy identifies three zones with specific stewardship and restoration recommendations (Table 10).

1. **Lyons Creek from the Welland Canal to Doan's Ridge Road**: In the 1995 Niagara River Remedial Action Plan (RAP) Stage 1 Update report, the area between the Welland Canal and Hwy 140 (referred to as Lyons Creek East) was identified for further investigation. During implementation of the RAP Stage 2 Recommendations, Environment Canada and the Ontario Ministry of the Environment conducted an Ecological Risk Assessment and undertook detailed sampling from the Welland Canal downstream to the Queen Elizabeth Way (QEW). The sediment studies revealed that the PCB concentration is highest just downstream from the former Welland Pipe outfall, with an overall decrease in PCB concentration downstream to the QEW where there are no PCBs detected (Milani and Fletcher 2005)

Concurrently, in March 2006, the Niagara Peninsula Conservation Authority, Environment Canada and the Ministry of Natural Resources retained the services of Dougan & Associates and C. Portt & Associates to carry out an in-depth inventory of wetland and aquatic features in this portion of the watercourse titled Lyons Creek East Wetland Inventory & Monitoring Study (2007). The purpose of this study was to document all wetland resources (flora and fauna) that may be potentially affected by remediation works of the contaminated sediment. The Final Interim Report notes that the study has identified numerous significant elements in the

study area, some of which include; a possible update status from nationally extirpated to nationally critically imperilled of a vascular plant; several provincially rare species; and nesting habitat for vulnerable bird species. The Wetland Restoration Suitability mapping indicates a high suitability for enhancement surrounding this significant feature which would buffer it from adjacent landuse which primarily consists of agriculture. Several of the small watercourses entering the Lyons Creek Floodplain PSW from the adjacent fields have little to no riparian vegetation. The establishment of a buffer strip on these watercourses is recommended not only to enhance water quality and aquatic habitat downstream, but to filter out nutrients and sediments from runoff before entering the watercourse which could potentially have a negative effect on the health and diversity of the wetland it feeds into.
The Upland Restoration Suitability mapping indicates opportunities for connecting adjacent woodlots; enhancing existing wooded areas to increase the core size; as well as creating contiguous natural areas that extend into Tee Creek and Grassy Brook subwatersheds.

2. **Lyons Creek from Doan's Ridge Road to Outlet at Welland River**: This portion of the Lyons Creek subwatershed includes the remainder of the Lyons Creek Floodplain PSW which extends to the Welland River. As previously mentioned an indepth inventory was conducted on Lyons Creek Floodplain Wetland from the canal to Doan's Ridge Road. A continuation of this assessment for the remainder of this wetland is recommended to gain a full understanding of this unique, diverse and significant ecosystem. North of the Lyons Creek Floodplain PSW is the fragmented Lyons Creek North Wetlands Complex, also a provincially significant wetland. In addition, two significant woodlots, Horse Track Woodlot and Young Woodlot, occupy a portion of this wetland area, though not sharing the same boundaries. A portion of Yokom Woodlot which acts as a water storage for the headwaters, straddles the southern border of this subwatershed. The Upland Restoration Suitability Mapping indicates very high suitability surrounding these areas. Enhancements around these significant areas would buffer and protect them from the surrounding landuse which is predominately agriculture. Ample opportunity exists to create corridors for wildlife along the fields, providing cover for wildlife while moving between natural areas.

Several small tributaries in this portion of the subwatershed also flow through agricultural fields that offer little to no vegetative buffer, therefore establishment of a buffer strip is recommended. The riparian buffer strip will enhance water quality and aquatic habitat as well as filter out nutrients and sediments from runoff before entering the watercourse which could potentially have a negative effect on the health and diversity of the wetland it feeds into. The Riparian Restoration Suitability Mapping indicates a very high suitability for the most northern tributary, which currently has little to no cover. Some of the smaller tributaries commence in wooded areas. Establishing a buffer outside these boundaries is important to maintain the water temperature downstream of the storage areas. Two golf courses are also located in this portion of the watershed. Investigation into the quality of the riparian (if any) as well as encouragement of environmentally responsible maintenance practices (if not already adopted) is recommended.

3. **Lyons Creek east branch south of Lyons Creek Floodplain Wetland**: This section of the Lyons Creek subwatershed includes portions of Willoughby Marsh Conservation Area, Willoughby Marsh PSW and Willoughby Clay Plain Muck Basin; the latter two support the headwaters for the eastern branch of Lyons Creek. Once the watercourse flows from the boundaries of these significant natural areas, it receives little to no cover. A riparian buffer strip is recommended to aid in the maintenance of water temperature and water quality as it flows downstream.

Numerous unevaluated (awaiting evaluations by MNR) wetlands surround the Willoughby Marsh PSW providing ample opportunity for filling in these small gaps creating one continuous wetland that could potentially extend through Usshers Creek and Niagara River 11 subwatersheds to the Niagara River. The Upland Restoration Suitability Mapping also indicates very high suitability surrounding existing natural heritage features providing opportunities to create linkages between adjacent natural areas and creating corridors that extend to the adjacent subwatersheds.

TABLE 10: LYONS CREEK SUBWATERSHED RESTORATION ACTIONS

RESTORATION OPPORTUNITIES	RECOMMENDED RESTORATION STRATEGIES		
	RIPARIAN	WETLAND	UPLAND AND ECOLOGICAL LINKAGES
LYONS CREEK FROM THE WELLAND CANAL TO DOAN'S RIDGE ROAD	• priority should be placed on buffer strip planting on small tributaries that have no cover; riparian buffers will help to reduce sediment and aid in maintaining the integrity of the significant features downstream	• protect and enhance existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities) • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consider-ation when developing a restoration plan (blandings turtle, round-leaved green-brier, shumard oak)	• high suitability for upland restoration adjacent to natural heritage areas; focus should be on increasing core natural heritage areas, filling in gaps between adjacent areas and creating ecological linkages with adjacent subwatersheds that are consistent with Carolinian Canada's "Big Picture" and Regional Niagara's Regional Policy Plan Amendment 187

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RESTORATION OPPORTUNITIES	RECOMMENDED RESTORATION STRATEGIES		
	RIPARIAN	WETLAND	UPLAND AND ECOLOGICAL LINKAGES
LYONS CREEK FROM THE WELLAND CANAL TO DOAN'S RIDGE ROAD	• whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (american waterwillow, lake chubsucker, grass pickerel) • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (hirsute sedge, buttonbush mineral thicket)	• whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (black gum, buttonbush mineral thicket, halberd-leaved tear-thumb, marsh st. john's wort, pin oak, smartweed dodder, weak stellate sedge, black-crowned night-heron)	• whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (hirsute sedge, weak stellate sedge, whitehair witchgrass, pignut hickory) • Carolinian and native species should be used in all restoration projects
LYONS CREEK FROM DOAN'S RIDGE ROAD TO OUTLET AT WELLAND RIVER	• most northern tributary has little to no buffer, as well as large portions of the other tributaries • priority should be placed on buffer strip planting on tributaries that have no cover; riparian buffers will help to reduce sediment and aid in maintaining the integrity of the significant features downstream • establishment of riparian habitat between fragmented wetland complexes is ideal in this portion of the subwatershed for creating corridors that will connect fragmented natural areas • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (american waterwillow, lake chubsucker, grass pickerel)	• wetland suitability is high between adjacent fragments of the Lyons Creek North Wetland Complex • enhancement of existing wetlands would provide a buffer to protect significant natural area as well as providing habitat diversity for a wider range of wildlife • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (blandings turtle, round-leaved greenbrier, shumard oak) • whenever possible projects should benefit the provincially mineral thicket, halberd-leaved tear-thumb, marsh st. john's wort, pin oak, smartweed dodder, weak stellate sedge, black-crowned night-heron)	• upland suitability mapping indicates high suitability for upland restoration adjacent to natural heritage areas; focus should be on filling in gaps between adjacent areas and creating ecological linkages with adjacent subwatersheds that are consistent with Carolinian Canada's "Big Picture" and Regional Niagara's Regional Policy Plan Amendment 187 • potential contiguous corridor by filling in gaps of Horse Track Woodlot and adjacent wetlands, increasing diversity and supporting a wider range of flora and fauna as well as supporting species that extend outside the boundaries of a woodlot and wetland • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into

TABLE 10: LYONS CREEK SUBWATERSHED RESTORATION ACTIONS

RESTORATION OPPORTUNITIES	RECOMMENDED RESTORATION STRATEGIES		
	RIPARIAN	WETLAND	UPLAND AND ECOLOGICAL LINKAGES
LYONS CREEK FROM DOAN'S RIDGE ROAD TO OUTLET AT WELLAND RIVER	• whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (hirsute sedge, buttonbush mineral thicket)		consideration when developing a restoration plan (hirsute sedge, weak stellate sedge, whitehair witchgrass, pignut hickory) • Carolinian and native species should be used in all restoration projects
LYONS CREEK FROM DOAN'S RIDGE ROAD TO OUTLET AT WELLAND RIVER	• priority should be placed on buffer strip planting on small tributaries that have no cover; riparian buffers will help to reduce sediment and aid in maintaining the integrity of the significant features downstream • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (american waterwillow, lake chubsucker, grass pickerel) • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (hirsute sedge, buttonbush mineral thicket)	• wetland suitability mapping indicates a very high suitability surrounding Willoughby Marsh and the adjacent fragmented wetlands • Potential contiguous natural area extension to Niagara River • create new wetlands in areas where the wetness index and soil drainage permit; priority should be given to areas where wetlands already exist or adjacent to forested areas • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (blandings turtle, round-leaved greenbrier, shumard oak) • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (black gum, buttonbush mineral thicket, halberd-leaved tear-thumb, marsh st. john's wort, pin oak, smartweed dodder, weak stellate sedge, black-crowned night-heron)	• very high suitability in this portion of the subwatershed for upland restoration adjacent to natural heritage areas; focus should be on filling in gaps between adjacent areas and creating ecological linkages with adjacent subwatersheds that are consistent with Carolinian Canada's "Big Picture" and Regional Niagara's Regional Policy Plan Amendment 187 • potential contiguous corridors surrounding Willoughby Marsh and adjacent natural areas with potential corridors extending into Grassy Brook, Tee Creek and Usshers Creek watersheds • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (hirsute sedge, weak stellate sedge, whitehair witchgrass, pignut hickory) • Carolinian and native species should be used in all restoration projects

TABLE 10: LYONS CREEK SUBWATERSHED RESTORATION ACTIONS

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
GEOMORPHIC ASSESSMENT STUDY (NPCA 2007B)	The South Niagara Falls Watershed Geomorphic Assessment (NPCA 2007b) identified several erosion and sediment accumulation sites in the Lyons Creek subwatershed (Appendix B): 1. **Carl Road (LCTb2)**: This portion of the stream is considered to be moderately entrenched resulting in flood waters having limited to no access to the floodplain; therefore, the energy within the flow is contained in the channel. Allowing a floodplain to develop within entrenched streams and increasing the sinuosity along straightened reaches will help to dissipate the energy within the flow. In addition, this portion also has a fairly high width to depth ratio, indicating that excessive sedimentation may be occurring. The presence of trees growing within the channel and a number of debris jams indicate that the channel may be widening. Recommendations for this site include increasing the size of the buffer as well as the diversity and variety of the native plant species. Vegetation will stabilize the soil and provide cover and habitat for fish, insects, and invertebrates along the channel. 2. **Crowland Road (Reach LCTb2-2)**: In addition to a small riparian buffer zone; deep pools, fish cover, and habitat types are considered poor along the stream. The presence of algae was noted during a site visit in 2007. Recommendations for this site include increasing the size of the riparian buffer, as well as the diversity and variety of native plant species in the buffer zone creating a more diverse ecological habitat. Water quality should continue to be monitored in this subwatershed. 3. **McCredie Road (Reach LCTc)**: Bank erosion along this section is predominantly in the form of slumping, which indicates that vegetative roots are too shallow. There are few to no trees present in the upper section, resulting in poor canopy cover. The presence of algae and turbid water was noted during a site visit in 2007. Recommendations for this site include increasing the variety and diversity of native plant species within the buffer zone, especially in the upper portion. Deep rooted vegetation will help to stabilize the bank and will limit the amount of sediment entering the stream. Water quality should continue to be monitored in this subwatershed. 4. **Schisler Road (Reach LCTe)**: This portion of the stream is moderately to slightly entrenched (stream becomes roadside ditch) which results in flood waters having limited to no access to the floodplain and the energy within the flow being contained to the channel. Allowing a floodplain to develop within entrenched streams and increasing the sinuosity along straightened reaches will help to dissipate the energy within the flow. A fairly high width to depth ratio in this portion indicates that excessive sedimentation may be occurring. Bank erosion in the form of bare banks and the presence of rills on the adjacent field are potentially contributing sediment to the watercourse. Canopy cover, fish cover, and habitat types are considered poor along the stream. Recommendations for this site include increasing the variety and diversity of native plant species within the buffer zone creating a more diverse ecological habitat, provide canopy cover, and limit the amount of sediment entering the channel. Rill prevention measures such as slope re-grading, erosion control blankets, and seeding should also be implemented. 5. **Old Schisler Road (Reach LCTe-2)**: The riparian buffer zone in this section consists of mowed grass and a small section of evergreen trees. Deep pools, fish cover, and habitat types are considered poor along the stream. Two crossings exist at this site, one of which contains a culvert. The landowner also expressed concerns about property flooding. Increasing the size of the riparian buffer is recommended, as well as the variety and diversity of native plant species in order to create a more diverse ecological habitat. In addition, the use of proper crossings is also recommended in order to limit the amount of sediment entering the channel. Culverts should be properly sized and continually monitored to ensure they are clear of debris.

TABLE 10: LYONS CREEK SUBWATERSHED RESTORATION ACTIONS

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
GEOMORPHIC ASSESSMENT STUDY (NPCA 2007B)	6. **Pearson Road (Reach LCTf)**: Bank erosion is present along the banks in the form of: exposed roots and fallen vegetation; bare soil extending up the bank; and slumped soil. Exposed tree roots and the presence of debris jams indicate channel widening, and bank slumping indicates that vegetative roots are too shallow. Sediment deposition is occurring along this section and may cause problems such as lateral channel adjustments and increased turbidity. Recommendations for this site include increasing the variety and diversity of native plant species within the buffer zone. 7. **Buchener Road (Reach LCTf-headwater)**: This portion of the stream is located within the headwaters of this tributary. The condition of this section is fairly good and it is recommended to maintain the channel in its current state. 8. **Doans Ridge/Lyons Creek Road (Reach LCTg)**: This section of the stream is moderately to slightly entrenched resulting in flood waters having limited to no access to the floodplain; therefore, the energy within the flow is contained to the channel. Allowing a floodplain to develop within entrenched streams and increasing the sinuosity along straightened reaches will help to dissipate the energy within the flow. Bank erosion is present along the banks in the form of exposed roots, fallen vegetation, and bare soil extending up the bank. Exposed tree roots and the presence of debris jams indicate that some channel widening may be occurring. The lack of a riparian buffer adjacent to residential properties and the slope of the streambed are likely contributing to bank erosion. Turbidity, macrophytes, duckweed, and algae were identified during a site visit in 2007. Recommendations for this site include increasing the size of the riparian buffer using a variety of native plant species and continue to monitor water quality. 9. **Willodell Road (Reach LCMa/LCMb)**: This section of the stream is in fairly good condition. Increasing the size of the riparian buffer zone is recommended in areas where little riparian is present. The vegetation will provide cover and habitat for fish, insects, and invertebrates along the channel. Some of the field sites identified along Lyons Creek are entrenched, which means that flood waters have little to no access to the floodplain. Confining the flood waters to the channel results in the loss of the adjacent floodplain, which impacts the hydraulic function of the stream (floodplains are storage areas for flood waters) and the physical habitat (loss of floodplain vegetation and the organisms that live there). It will also change the channel geometry overtime due to increased velocity, stream power and channel slope. Restoration priorities include enhancing the size of the riparian buffer and increasing the variety and diversity of native plant species within it. This will help to prevent bank erosion, provide habitat and cover, control the amount of sediment entering the stream from runoff, and filter any pollutants that may enter the stream. Another restoration priority should be to construct proper crossings in agricultural fields in order to limit excess sediment from entering the channel. Allowing a floodplain to develop in entrenched sections, as well as continuing to monitor water quality would be beneficial to the watershed. Blocked, undersized, or failed culverts should be identified due to potential drainage problems through the watershed.
ENVIRONMENTALLY RESPONSIBLE MAINTENANCE PRACTICES FOR GOLF COURSES	By integrating golf course management practices with wildlife management, such as incorporating enhanced natural areas into the landscaping, golf courses have the potential to offer a wide range of habitat for wildlife. In addition, encouragement of environmentally responsible maintenance practices, if not already adopted, will be beneficial to water quality and the aquatic habitat. Investigation into the Audubon Cooperative Sanctuary Program for Golf Courses should be explored for golf courses if such a program has not already been adopted. In addition, environmentally friendly practices should be encouraged (e.g. chemical free practices).

TABLE 10: LYONS CREEK SUBWATERSHED RESTORATION ACTIONS

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
IN-STREAM DEBRIS REMOVAL	Debris (e.g. fallen trees, lawn trimmings) in the stream channel has been identified as a concern by residents living along the watercourse. Debris jams can cause bank erosion which increases the sediment load in the watercourse having a negative impact on fish habitat. In addition, debris jams can potentially create upstream flooding increasing the risk of property adjacent to the watercourse to experience flooding; therefore the removal of debris jams is recommended.
ECOLOGICAL LINKAGES BETWEEN NATURAL AREAS	The potential to create ecological corridors between adjacent natural areas creating larger contiguous natural areas exists in the Lyons Creek subwatershed. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as providing habitat and ecological diversity for a wide range of species.
INVASIVE SPECIES REMOVAL	Invasive species often have no natural competitors resulting in the potential to displace native species. Therefore removal and replacement of these species with native species is important so the diversity of native plants within an ecological community is not threatened. Purple Loosestrife has been identified as a problem. A removal program is recommended coupled with planting of native species.
REGIONAL ROADS-ROAD SALT IMPACTS	The Regional Municipality of Niagara has completed a Salt Study for its Regional Roads (Ecoplans Ltd. 2005). Surface water vulnerability as well as wetland and fish habitat vulnerability from salt along Regional roads is considered high throughout the South Niagara Falls watershed, except for a small portion along the Niagara River which is considered to have a moderate risk (Ecoplans Ltd. 2005). Riparian restoration should be targeted at watercourses and wetlands along regional roads to decrease the impacts from road salt on water quality and aquatic habitat. In addition, areas that support natural heritage features and agricultural areas should also be investigated and remediated to decrease the impacts of salt on these land features/uses.
FISH BARRIER INVENTORY AND REMOVAL	Fish barriers block the channel and can make areas of habitat inaccessible to all aquatic organisms, thereby reducing breeding opportunities for many native species; in addition, they can cause an increase in competition and predation. Examples of fish barriers include dams, weirs, floodgates, perched culverts, road crossings, as well as debris and log jams. An updated inventory is recommended to determine all potential barriers to fish movement in the South Niagara Falls watershed. These sites should be reviewed and where possible, the barrier should be removed to optimize the passage of fish.
NATURALIZING CHANNELIZED PORTIONS OF THE WATERCOURSE	In addition to having a negative impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering the watercourse. Vegetating bare banks and maintaining a buffer strip; restricting cattle access; and allowing a slight meander to reduce bank erosion and flooding are a few measures that could potentially reduce the amount of sediment loading in the watercourse. In addition, when dredging does occur, ensure that the banks are not cut too steep as this will just make the banks more vulnerable to erosion.
WETLANDS ARE WORTH IT PROGRAM	Inadequate drainage from farm fields has been identified as a problem in the South Niagara Falls watershed. Investigation into possible wetland creation on private property may be an alternate solution over costly tiles for landowners with drainage problems. The NPCA's 'Wetlands are Worth It' Program provides grants to a maximum of 75% of the cost of a project with a grant ceiling of $10,000.
WEEPING TILE DISCONNECT PROGRAM	Some of the municipalities within the Niagara Region have already proposed or implemented by-laws that require homeowners to disconnect their weeping tiles from the sanitary sewer systems. This initiative should be extended Region-wide to eliminate excessive stormwater from entering the sanitary and storm sewer systems.
URBAN RAIN BARREL AND DOWNSPOUT DISCONNECTION PROGRAMS	Several municipalities within the Niagara Region have already implemented these programs; however these initiatives should be extended Region-wide as an effort to eliminate excessive stormwater from entering the sanitary and storm sewer systems. In addition, a downspout disconnection by-law should be developed and implemented to further encourage landowners to discontinue the practice of directing rainwater from rooftops to sewer systems.

TABLE 10: LYONS CREEK SUBWATERSHED RESTORATION ACTIONS

SPECIAL STUDIES	RECOMMENDATIONS FOR FURTHER STUDY
MITIGATE FLOW OF LYONS CREEK	Since the construction of the Welland Canal by-pass, the flow of Lyons Creek has been an ongoing concern for landowners along Lyons Creek. Currently, water is pumped by the St. Lawrence Seaway Authority from the canal to augment Lyons Creek flow cut off as a result of the by-pass. Concerns regarding both the reliability of the flow as well as the current level of flow have been expressed by landowners in the area. A strong interest exists to increase the flow closer to historic levels; therefore it is recommended that investigation into historical flow levels be conducted to resolve both issues. Should higher flows be considered, the investigation should consider the possibility of disturbing the PCB's in the sediment if the "in situ" remediation alternative is implemented for all or part of the site.
WETLAND INVENTORY ON LYONS CREEK	A detailed wetland inventory for the remainder of Lyons Creek Floodplain Wetland is recommended. Several rare species and species at risk as designated by COSEWIC and COSSARO have been noted by the Ministry of Natural Resources and through the first inventory conducted by Dougan & Associates; therefore a full inventory would be valuable in gaining insight into this rich and diverse ecosystem.
RESTORATION OF UNAUTHORIZED DRAINS	Unauthorized drains have been identified in Willoughby Marsh Conservation Area. Investigation of the effects and restoration of these unauthorized drains is recommended to ensure that these drains are not negatively impacting Conservation Area property and the resources it is trying to protect, which may also inadvertently be affecting Willoughby Clay Plain Muck Basin and Willoughby Marsh Provincially Significant Wetland.
MUNICIPAL ROADS ROAD SALT IMPACT STUDIES	The Regional Municipality of Niagara has already completed a Salt Vulnerability Study for its roads (see above). It is recommended that municipalities complete similar studies to determine the impacts from road salt applications on municipal roads to groundwater sensitive areas, surface water resources, natural heritage areas and agricultural crops.
GROUNDWATER INTRINSIC SUSCEPTIBILITY STUDIES	The *Groundwater Study* (2005) has identified several areas with medium and high intrinsic susceptibility in the South Niagara Falls watershed (Figure 14). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's *Groundwater Study* (2005) and proposed *Source Water Protection Plan*.
RIPARIAN BUFFER EDUCATION PROGRAM	Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between $2,000 and $10,000.
SEPTIC SYSTEM EDUCATION AND FUNDING PROGRAM	Improperly maintained septic systems have been identified as a concern in the South Niagara Falls watershed. Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.
ABANDONED WELL DECOMMISSIONING PROGRAM	Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of $2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA.

TABLE 10: LYONS CREEK SUBWATERSHED RESTORATION ACTIONS

SPECIAL STUDIES	RECOMMENDATIONS FOR FURTHER STUDY
AGRICULTURAL BEST MANAGEMENT PRACTICES PROGRAM	The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted in the Lyons Creek subwatershed. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between $5,000 and $12,000 depending on the project.
POLICY TOOLS	Policy tools such as stormwater management policies should be developed and included in regional and municipal Official Plans to ensure environmentally-based planning in the watershed. The NPCA has developed stormwater management policies for its jurisdiction for use by Regional Niagara and its municipalities.
POTENTIAL CONTAMINANT SOURCES OF POINT SOURCE POLLUTION	An inventory of potential contaminant sources was identified as part of the objectives for the NPCA's *Groundwater Study (2005)*. An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the potential effects these potential contaminants may have on surface water quality and aquatic habitat.

USSHERS CREEK RESTORATION STRATEGY

Upstream from the Legends on the Niagara golf course, Usshers Creek is designated as a municipal drain; Union Marsh Drain. The main channel and its major tributaries have all been designated as critical (Type 1) fish habitat. Greater redhorse and grass pickerel have both been identified in Usshers Creek during fish sampling conducted by the Ministry of Natural Resources. Several fish barriers have also been identified in the Usshers Creek subwatershed, mainly consisting of log jams and debris in the watercourse. Such barriers affect the stream flow as well as prevent the free movement of fish upstream and downstream.

Usshers Creek flows through several woodlots, wetlands, agricultural and abandoned fields as well as a golf course before emptying into the Niagara River. Numerous rural residential areas are also scattered throughout the subwatershed.

BioMAP samples in this watershed indicate water quality is impaired and species composition is indicative of nutrient enrichment. Water quality testing also indicates poor water quality with elevated concentrations of total phosphorus which exceed the Provincial Water Quality Objective 100 percent of the time and *E. Coli* concentrations which occasionally exceed the Provincial Water Quality Objective. In addition, elevated concentrations of chloride which occasionally exceed the federal guideline for the protection of irrigation water have been noted in Usshers Creek (NPCA 2007a). Sewage discharge, runoff from urban and agricultural landuse, and soil erosion are likely sources of total phosphorus in Usshers Creek. Potential sources for *E. Coli* include urban and agricultural landuse, sewage discharge and animal waste (NPCA 2007a).

In addition to Tee Creek and Lyons Creek, Willoughby Marsh Provincially Significant Wetland also acts as a water storage and recharge area for the headwaters of Usshers Creek. A small portion of Willoughby Marsh Conservation Area also falls within the boundary of Usshers Creek protecting approximately 6 percent of this wetland in this watershed. Numerous wetlands and woodlands are scattered amongst the landscape, covering approximately 38 percent of the subwatershed; including Bayers Creek Bush and Bowmans Archery Club Black Gum Woods where ultra ancient Black Gums have been identified. In addition, several rare species have been identified throughout the watershed, including Shumard Oak which has been designated as a species of Special Concern under COSEWIC.

An abundance of opportunity exists in the Usshers Creek subwatershed for creating ecological linkages between fragmented natural areas. Potential corridors exist all throughout the subwatershed, as well as potential corridors that extend into adjacent subwatersheds. The Upland Restoration Suitability mapping indicates a very high suitability for upland restoration in this subwatershed; in particular enhancement around existing features is very high. Riparian cover is lacking in several sections of the watercourse, therefore establishment of a buffer strip where currently not present is recommended. Riparian and upland restoration should be priority in this subwatershed.

The Usshers Creek Subwatershed Restoration Strategy identifies two zones with specific stewardship and restoration recommendations (Table 11).

1. Usshers Creek south of the QEW: Opportunity exists to create corridors between a number of fair sized wetlands and woodlots which would result in a large continuous natural area extending into Lyons Creek subwatershed. Coupled with enhancement around Willoughby Marsh PSW and filling in the gaps between its adjacent natural areas, would result in an increase of this areas ability to support a wide diversity of species while facilitating in the movement of flora and fauna throughout this portion of the subwatershed as well as adjacent Lyons Creek and Tee Creek subwatersheds. With the headwaters receiving cover from Willoughby Marsh PSW, riparian restoration is not a priority in this portion of the subwatershed.

2. Usshers Creek north of the QEW: Numerous woodlots and wetlands are scattered throughout this portion of the subwatershed, including Bowmans Archery Club Black Gum Woods and Bayers Creek Bush which straddles the subwatershed boundary between Usshers and Bayers Creeks. In addition, Legends on the Niagara golf course is also located in this portion of the subwatershed. The fragmented pattern of the woodlots and wetlands in this portion of the subwatershed provides an abundance of opportunity to create large contiguous natural areas that extend throughout this portion of the subwatershed, as well as extending into the adjacent subwatersheds. Enhancement around the existing features to increase the core size would increase its ability to support a wider diversity of wildlife and increase ecosystem functionality. Numerous segments of watercourse flow through fields that offer little to no riparian buffer, therefore establishment of a buffer strip in these areas is recommended.

TABLE 11: USSHERS CREEK SUBWATERSHED RESTORATION ACTIONS

RESTORATION OPPORTUNITIES	RECOMMENDED RESTORATION STRATEGIES		
	RIPARIAN	WETLAND	UPLAND AND ECOLOGICAL LINKAGES
USSHERS CREEK SOUTH OF THE QEW	• the watercourse in this portion of the subwatershed receives cover from Willoughby Marsh PSW, therefore the focus should be maintenance of existing riparian • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (grass pickerel) • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (arrow-arum, greater redhorse, lizards tail)	• wetland restoration suitability surrounding Willoughby Marsh is high • enhancement of existing wetlands would provide a buffer to protect significant natural areas as well as providing habitat diversity for a wider range of wildlife • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (shumard oak) • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (arrow-arum, black gum, halberd- leaved tear-thumb, pin oak)	• very high suitability for upland restoration adjacent to natural heritage areas; focus should be on increasing core natural heritage areas, filling in gaps between adjacent areas and creating ecological linkages with adjacent subwatersheds that are consistent with Carolinian Canada's "Big Picture" and Regional Niagara's Regional Policy Plan Amendment 187. • potential contiguous natural area extending into Tee Creek subwatershed by filling in gaps along King Street • Carolinian and native species should be used in all restoration projects
USSHERS CREEK NORTH OF THE QEW	• large portions of main channel and tributaries run through fields that offer little to no riparian buffer. • priority should be placed on buffer strip planting on sections of watercourse that have no cover; riparian buffers will help to reduce sediment and cool the water to enhance water quality and fish habitat	• wetland suitability is high surrounding wetland on north side of QEW • protect and enhance existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities) • whenever possible projects should benefit the *Species at Risk* in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (shumard oak)	• upland suitability mapping indicates a high suitability for upland restoration adjacent to natural heritage areas; focus should be on increasing core size of natural heritage areas, filling in gaps between adjacent areas and creating ecological linkages with adjacent subwatersheds that are consistent with Carolinian Canada's "Big Picture" and Regional Niagara's Regional Policy Plan Amendment 187(e.g., enhance woodlots along main channel and establish riparian to use as corridor.)

TABLE 11: USSHERS CREEK SUBWATERSHED RESTORATION ACTIONS

RESTORATION OPPORTUNITIES	RECOMMENDED RESTORATION STRATEGIES		
	RIPARIAN	WETLAND	UPLAND AND ECOLOGICAL LINKAGES
USSHERS CREEK NORTH OF THE QEW	• establishment of riparian habitat is ideal in this portion of the subwatershed for creating corridors that will connect fragmented natural areas(e.g., along main channel ideal for creating linkage between woodlots) • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (grass pickerel) • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (arrow-arum, greater redhorse, lizards tail)	• whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (arrow-arum, black gum, halberd-leaved tear-thumb, pin oak)	• Carolinian and native species should be used in all restoration projects

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
GEOMORPHIC ASSESSMENT STUDY (NPCA 2007B)	The South Niagara Falls Watershed Geomorphic Assessment (NPCA 2007b) identified several erosion and sediment accumulation sites in the Usshers Creek watershed (Appendix B): 1. **Niagara River Parkway (Reach UCMa)**: This section of the stream is in fairly good condition. Increasing the amount of woody vegetation in the near bank zone and the size of the riparian buffer in certain areas is recommended. The vegetation will provide cover and habitat for fish, insects, and invertebrate along the channel. Duckweed was identified during a site visit in 2006. 2. **Marshall Road (Reach UCMc)**: This section of the stream is moderately to slightly entrenched which results in flood waters having limited access to the floodplain and the energy within the flow being contained in the channel. Allowing a floodplain to develop within entrenched streams and increasing the sinuosity along straightened reaches will help to dissipate the energy within the flow. This section also has a fairly high width to depth ratio, indicating that excessive sedimentation may be occurring. The buffer zone consists primarily of herbaceous and wetland vegetation with very few trees which impacts habitat and cover. A slight oil sheen, duckweed, and algae were identified during a site visit in 2007. Recommendations for this site include not grading the banks too steep during dredging so that vegetation can become established and stabilize the soil. The vegetation will also provide cover and habitat for fish, insects, and invertebrate along the channel. Water quality should be continually monitored in this watershed.

TABLE 11: USSHERS CREEK SUBWATERSHED RESTORATION ACTIONS

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
GEOMORPHIC ASSESSMENT STUDY (NPCA 2007B)	3. **Ort Road (Reach UCMc-2)**: This section of the stream is moderately to slightly entrenched which results in flood waters having limited access to the floodplain. Therefore, the energy within the flow is contained in the channel. Allowing a floodplain to develop within entrenched streams and increasing the sinuosity along straightened reaches will help to dissipate the energy within the flow. Some areas have a high width to depth ratio indicating that excessive sedimentation may be occurring. A slight oil sheen, duckweed, and algae were identified during a site visit in 2007. Recommendations for this site include not grading the banks too steep during dredging so that vegetation can become established and stabilize the soil in addition to providing cover and habitat for fish, insects, and invertebrate along the channel. Water quality should be continually monitored in this watershed. 4. **Bossert Road (Reach UCMd)**: The majority of this reach is flat with wetland type vegetation. This section is also entrenched resulting in flood waters having limited to no access to the floodplain; therefore, the energy within the flow is contained in the channel. Numerous debris jams are also present here indicating that some widening may be occurring. Recommendations for this site include not grading the banks too steep during dredging so that vegetation can become established and stabilize the soil, and increase the amount of wetland vegetation to provide cover and habitat for fish, insects, and invertebrate along the channel. 5. **Sodom Road (UCTb)**: This section of the stream is moderately to slightly entrenched which results in flood waters having limited access to the floodplain; therefore, the energy within the flow is contained in the channel. Allowing a floodplain to develop within entrenched streams and increasing the sinuosity along straightened reaches will help to dissipate the energy within the flow. Deep sediment deposits, as well as high width to depth ratios in some areas indicate that excessive sedimentation is occurring. Numerous debris jams also indicate that channel widening may be occurring. The presence of algae was identified during a site visit in 2007. Recommendations for this site include not grading the banks too steep during dredging so that vegetation can become established and stabilize the soil. In addition, the vegetation will provide cover and habitat for fish, insects, and invertebrate along the channel. Water quality should be continually monitored in this watershed. 6. **Sodom Road (Reach UCTb-2)**: This section of the stream is entrenched (due to dredging) which results in flood waters having limited to no access to the floodplain; therefore, the energy within the flow is contained in the channel. Allowing a floodplain to develop within entrenched streams and increasing the sinuosity along straightened reaches will help to dissipate the energy within the flow. Some areas have a high width to depth ratio indicating that excessive sedimentation may be occurring. Bank erosion is present along the steep banks in the form of: exposed roots; bare soil extending up the bank; and slumped soil. Exposed tree roots are an indication of channel widening, and bank slumping indicates that vegetative roots are too shallow. The presence of algae was identified during a site visit in 2007. Recommendations for this site include not grading the banks too steep during dredging so that vegetation can become established and stabilize the soil. The vegetation will also provide cover and habitat for fish, insects, and invertebrate along the channel. Water quality should be continually monitored in this watershed. Usshers Creek is designated as Union Marsh municipal drain. Some of the field sites were identified as entrenched, which means that flood waters have little to no access to the floodplain. Confining the flood waters to the channel results in the loss of the adjacent floodplain, which impacts the hydraulic function of the stream (floodplains are storage areas for flood waters) and the physical habitat (loss of floodplain vegetation and the organisms that live there). It will also change the channel geometry overtime due to increased velocity, stream power and channel slope. Bank erosion and sediment

TABLE 11: USSHERS CREEK SUBWATERSHED RESTORATION ACTIONS

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
GEOMORPHIC ASSESSMENT STUDY (NPCA 2007B)	deposition were identified at various field sites. Restoration priorities include not grading the banks too steep during dredging so that vegetation can become established and stabilize the soil. Enhancing the size of the riparian buffer and increasing the variety and diversity of native plant species within it will help to prevent bank erosion, provide habitat and cover, control the amount of sediment entering the stream from runoff, and filter any pollutants that may enter the stream. Allowing a floodplain to develop would also be beneficial to the watershed. Water quality should continue to be monitored in this watershed.
ECOLOGICAL LINKAGES BETWEEN NATURAL AREAS	The potential to create ecological corridors between adjacent natural areas creating larger contiguous natural areas exists in the Usshers Creek subwatershed. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as providing habitat and ecological diversity for a wide range of species.
INVASIVE SPECIES REMOVAL	Invasive species often have no natural competitors resulting in the potential to displace native species. Therefore removal and replacement of these species with native species is important so the diversity of native plants within an ecological community is not threatened. Purple Loosestrife has been identified as a problem. A removal program is recommended coupled with planting of native species.
REGIONAL ROADS — ROAD SALT IMPACTS	The Regional Municipality of Niagara has completed a Salt Study for its Regional Roads (Ecoplans Ltd. 2005). Surface water vulnerability as well as wetland and fish habitat vulnerability from salt along Regional roads is considered high throughout the South Niagara Falls watershed, except for a small portion along the Niagara River which is considered to have a moderate risk (Ecoplans Ltd. 2005). Riparian restoration should be targeted at watercourses and wetlands along regional roads to decrease the impacts from road salt on water quality and aquatic habitat. In addition, areas that support natural heritage features and agricultural areas should also be investigated and remediated to decrease the impacts of salt on these land features/uses.
FISH BARRIER INVENTORY AND REMOVAL	Fish barriers block the channel and can make areas of habitat inaccessible to all aquatic organisms, thereby reducing breeding opportunities for many native species; in addition, they can cause an increase in competition and predation. Examples of fish barriers include dams, weirs, floodgates, perched culverts, road crossings, as well as debris and log jams. Several fish barriers have been noted in the Usshers Creek subwatershed, therefore removal of these barriers is recommended. In addition, an updated inventory is recommended to determine all potential barriers to fish movement in the South Niagara Falls watershed. These sites should be reviewed and where possible, the barrier should be removed to optimize the passage of fish.
NATURALIZING CHANNELIZED PORTIONS OF THE WATERCOURSE	In addition to having a negative impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering the watercourse. Vegetating bare banks and maintaining a buffer strip; restricting cattle access; and allowing a slight meander to reduce bank erosion and flooding are a few measures that could potentially reduce the amount of sediment loading in the watercourse. In addition, when dredging does occur, ensure that the banks are not cut too steep as this will just make the banks more vulnerable to erosion.
WETLANDS ARE WORTH IT PROGRAM	Inadequate drainage from farm fields has been identified as a problem in the South Niagara Falls watershed. Investigation into possible wetland creation on private property may be an alternate solution over costly tiles for landowners with drainage problems. The NPCA's 'Wetlands are Worth It' Program provides grants to a maximum of 75% of the cost of a project with a grant ceiling of $10,000.

TABLE 11: USSHERS CREEK SUBWATERSHED RESTORATION ACTIONS

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
WEEPING TILE DISCONNECT PROGRAM	Some of the municipalities within the Niagara Region have already proposed or implemented by-laws that require homeowners to disconnect their weeping tiles from the sanitary sewer systems. This initiative should be extended Region-wide to eliminate excessive stormwater from entering the sanitary and storm sewer systems.
URBAN RAIN BARREL AND DOWNSPOUT DISCONNECTION PROGRAMS	Several municipalities within the Niagara Region have already implemented these programs; however these initiatives should be extended Region-wide as an effort to eliminate excessive stormwater from entering the sanitary and storm sewer systems. In addition, a downspout disconnection by-law should be developed and implemented to further encourage landowners to discontinue the practice of directing rainwater from rooftops to sewer systems.
SPECIAL STUDIES	**RECOMMENDATIONS FOR FURTHER STUDY**
RESTORATION OF UNAUTHORIZED DRAINS	Unauthorized drains have been identified in Willoughby Marsh Conservation Area. Investigation of the effects and restoration of these unauthorized drains is recommended to ensure that these drains are not negatively impacting Conservation Area property and the resources it is trying to protect, which may also inadvertently be affecting Willoughby Clay Plain Muck Basin and Willoughby Marsh Provincially Significant Wetland.
MUNICIPAL DRAIN MAINTENANCE BEST MANAGEMENT PRACTICES	The Usshers Creek subwatershed contains one municipal drain; Union Marsh Drain. Best Management Practices for drain maintenance should be developed in consultation with the Ministry of Natural Resources, Department of Fisheries and Oceans, NPCA, municipalities and the agricultural community to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain.
MUNICIPAL ROADS ROAD SALT IMPACT STUDIES	The Regional Municipality of Niagara has already completed a Salt Vulnerability Study for its roads (see above). It is recommended that municipalities complete similar studies to determine the impacts from road salt applications on municipal roads to groundwater sensitive areas, surface water resources, natural heritage areas and agricultural crops.
GROUNDWATER INTRINSIC SUSCEPTIBILITY STUDIES	The *Groundwater Study (2005)* has identified several areas with medium and high intrinsic susceptibility in the South Niagara Falls watershed (Figure 14). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's *Groundwater Study (2005)* and proposed *Source Water Protection Plan*.
RIPARIAN BUFFER EDUCATION PROGRAM	Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between $2,000 and $10,000.
SEPTIC SYSTEM EDUCATION AND FUNDING PROGRAM	Improperly maintained septic systems have been identified as a concern in the South Niagara Falls watershed. Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.

TABLE 11: USSHERS CREEK SUBWATERSHED RESTORATION ACTIONS

SPECIAL STUDIES	RECOMMENDATIONS FOR FURTHER STUDY
ABANDONED WELL DECOMMISSIONING PROGRAM	Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of $2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA.
AGRICULTURAL BEST MANAGEMENT PRACTICES PROGRAM	The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted in the Usshers Creek subwatershed. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between $5,000 and $12,000 depending on the project.
POLICY TOOLS	Policy tools such as stormwater management policies should be developed and included in regional and municipal Official Plans to ensure environmentally-based planning in the watershed. The NPCA has developed stormwater management policies for its jurisdiction for use by Regional Niagara and its municipalities.
POTENTIAL CONTAMINANT SOURCES OF POINT SOURCE POLLUTION	An inventory of potential contaminant sources was identified as part of the objectives for the NPCA's *Groundwater Study (2005)*. An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the potential effects these potential contaminants may have on surface water quality and aquatic habitat.

BAYERS CREEK RESTORATION STRATEGY

Like Usshers Creek, Bayers Creek works its way through scattered wetlands, woodlands, agricultural and abandoned fields as well as rural residential areas before draining into the Niagara River. The main channel of Bayers Creek is designated as a municipal drain; Boyers Creek Drain, which is designated as critical (Type 1) fish habitat. Grass pickerel have been identified in Bayers Creek during fish sampling conducted by the Ministry of Natural Resources. Several fish barriers have been identified within the subwatershed, mainly consisting of log jams, debris in the watercourse and a failed culvert. Such barriers affect stream flow as well as prevent the free movement of fish upstream and downstream.

BioMAP samples in this subwatershed indicate water quality is impaired and species composition is indicative of nutrient enrichment. Water quality testing also indicates marginal water quality with elevated concentrations of total phosphorus which exceed the Provincial Water Quality Objective 100 percent of the time and *E. Coli* concentrations which frequently exceed the Provincial Water Quality Objective. In addition, elevated concentrations of chloride which occasionally exceed the federal guideline for the protection of irrigation water have been noted in Bayers Creek (NPCA 2007a). Sewage discharge, runoff from urban and agricultural landuse, and soil erosion are likely sources of total phosphorus in Bayers Creek. Potential sources for *E. Coli* include urban and agricultural landuse, sewage discharge and animal waste.

Like Lyons Creek subwatershed, Bayers Creek subwatershed also contains a closed landfill. An updated inventory to confirm potential contaminant sources and locations may be beneficial as well as further investigation into the potential effects of these potential contaminants on surface water quality and aquatic habitat.

Natural heritage features make up approximately 30 percent of the Bayers Creek subwatershed. Significant natural areas include a small portion of Black Creek PSW in the southern

portion of the subwatershed, and a portion of Bayers Creek Bush which includes Bowmans Archery Club Black Gum Woods. The natural areas on the southwest portion of the subwatershed consist of a scattered pattern. Linkages between adjacent woodlots and wetlands should be a priority for this portion of the subwatershed. In addition, establishment of a consistent riparian buffer strip should also be a priority. This would not only enhance water quality but would provide a means of cover for wildlife movement throughout this portion of the subwatershed. Large portions of the watercourse flow through fields that offer little to no vegetative cover. Remediation of the lack of vegetation along the watercourse also should be a priority.

The majority of the natural areas in the Bayers Creek subwatershed are concentrated on the northeast side of the QEW with corridors extending into the adjacent subwatersheds. Therefore enhancement of existing natural areas should be the focus for this portion of the subwatershed. Several small gaps exist between some of the areas; with some reinforcement, the possibility exists that these gaps could be filled creating larger natural areas.

The Bayers Creek Subwatershed Restoration Strategy identifies two zones with specific stewardship and restoration recommendations (Table 12).

1. Bayers Creek southwest of the QEW: Establishment of a riparian buffer strip should be a priority for this portion of the subwatershed. Large extents of the watercourse are without cover. A vegetative buffer is imperative in the headwater region to ensure integrity of the watercourse downstream by moderating water temperature, providing organic litter for aquatic organisms and minimizing nutrient loading from runoff of adjacent fields. In addition, riparian habitat is ideal in this portion of the subwatershed for linking distant natural areas, providing cover for wildlife between wooded areas. In the southern portion of the subwatershed, the Upland Restoration Suitability mapping indicates a high suitability for upland restoration. The opportunity exists to create one large natural area that extends into the adjacent subwatershed by enhancing the adjacent wooded areas south of Baker Street. The Wetland Suitability Mapping does not indicate high restoration suitability for wetlands in this area; therefore priority should be placed on upland and riparian restoration.

2. Bayers Creek northeast of the QEW: Due to the concentrated pattern of the natural areas, there are numerous opportunities to create linkages between adjacent natural areas and corridors that extend into the neighbouring subwatersheds. Enhancement around smaller neighbouring natural areas, increasing their core size and creating corridors between them should be considered a priority in this portion of the subwatershed. The watercourse receives cover from the wetlands and wooded areas as it travels through, therefore restoration priority for riparian should be placed on areas that do not currently have a vegetated buffer.

TABLE 12: BAYERS CREEK SUBWATERSHED RESTORATION ACTIONS

RESTORATION OPPORTUNITIES	RECOMMENDED RESTORATION STRATEGIES		
	RIPARIAN	WETLAND	UPLAND AND ECOLOGICAL LINKAGES
BAYERS CREEK SOUTHEAST OF THE QEW	• large portions of main channel and tributaries run through fields that offer little to no riparian buffer, therefore priority should be placed on buffer strip planting on sections of watercourse that have no cover; riparian buffers will help to reduce sediment and cool the water to enhance water quality and fish habitat • the establishment of riparian habitat is ideal in this portion of the subwatershed for creating corridors that will connect fragmented natural areas	• wetland suitability mapping indicates moderate suitability for wetland restoration, therefore any restoration should be limited to enhancement of existing wetlands; creating a buffer to protect the significant natural areas. • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (round-leaved greenbrier)	• very high suitability for upland restoration adjacent to natural heritage areas; focus should be on increasing core natural heritage areas, filling in gaps between adjacent areas and creating ecological linkages with adjacent subwatersheds that are consistent with Carolinian Canada's "Big Picture" and Regional Niagara's Regional Policy Plan Amendment 187 • potential contiguous natural area extending into Usshers Creek subwatershed by filling in gaps south of Baker Street)

TABLE 12: BAYERS CREEK SUBWATERSHED RESTORATION ACTIONS

RESTORATION OPPORTUNITIES	RECOMMENDED RESTORATION STRATEGIES		
	RIPARIAN	WETLAND	UPLAND AND ECOLOGICAL LINKAGES
BAYERS CREEK SOUTHEAST OF THE QEW	• whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (grass pickerel) • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (greater redhorse, sweet joe-pye- weed)	• whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (black gum, pin oak)	• whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (sweet joe-pye-weed) • Carolinian and native species should be used in all restoration projects
BAYERS CREEK NORTHEAST OF THE QEW	• priority should be placed on buffer strip planting on sections of watercourse that have no cover; • whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (grass pickerel)	• protect and enhance existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities) • wetland suitability mapping indicates moderate suitability for wetland restoration, therefore any restoration should be limited to enhancement of existing wetlands; creating a buffer to protect the significant natural areas.	• upland suitability mapping indicates a high suitability for upland restoration adjacent to natural heritage areas; focus should be on increasing core size of natural heritage areas, filling in gaps between adjacent areas and creating ecological linkages with adjacent subwatersheds that are consistent with Carolinian Canada's "Big Picture" and Regional Niagara's Regional Policy Plan Amendment 187

TABLE 12: BAYERS CREEK SUBWATERSHED RESTORATION ACTIONS

RESTORATION OPPORTUNITIES	RECOMMENDED RESTORATION STRATEGIES		
	RIPARIAN	WETLAND	UPLAND AND ECOLOGICAL LINKAGES
BAYERS CREEK NORTHEAST OF THE QEW	• whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (greater redhorse, sweet joe-pye- weed)	• whenever possible projects should benefit the Species at Risk in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (round-leaved greenbrier) • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (black gum, pin oak)	• enhance and join cluster of natural areas between Sherk and Bossart Roads. A possible contiguous natural area extending from north of Baker Street north to Miller Street in Usshers Creek subwatershed • whenever possible projects should benefit the provincially rare species in the subwatershed, and therefore should be taken into consideration when developing a restoration plan (sweet joe-pye-weed) • Carolinian and native species should be used in all restoration projects

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
GEOMORPHIC ASSESSMENT STUDY (NPCA 2007B)	The South Niagara Falls Watershed Geomorphic Assessment (NPCA 2007b) identified several erosion and sediment accumulation sites in the Bayers Creek subwatershed (Appendix B): 1. **Sherk Road (Reach BCMa)**: This section of the stream is moderately to slightly entrenched resulting in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Allowing a floodplain to develop within entrenched streams and increasing the sinuosity along straightened reaches will help to dissipate the energy within the flow. Bank erosion is present along the steep banks in the form of: exposed roots and fallen vegetation; bare soil extending up the bank; and slumped soil. Exposed tree roots can indicate channel widening, and bank slumping indicates that vegetative roots are too shallow. Sediment deposition is occurring along this section and can cause such problems as lateral channel adjustment and increased turbidity. Recommendations for this site include not grading the banks too steep during dredging so that vegetation can become established and stabilize the soil. The vegetation will also provide cover and habitat for fish, insects, and invertebrate along the channel. Continue to monitor water quality in this watershed. 2. **Sodom Road (Reach BCTb)**: This section of the stream is entrenched which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Allowing a floodplain to develop within entrenched streams and increasing the sinuosity along straightened reaches will help to dissipate the energy within the flow. The riparian buffer at this site is small and consists predominantly of herbaceous vegetation. Recommendations for this site include not grading the banks too steep during dredging so that vegetation can become established and stabilize the soil. The size of the riparian buffer should be increased, as well as the diversity and variety of native plant species in it. The culverts within this reach should be continually monitored to ensure they are clear of debris.

TABLE 12: BAYERS CREEK SUBWATERSHED RESTORATION ACTIONS

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
GEOMORPHIC ASSESSMENT STUDY (NPCA 2007B)	Bayers Creek is designated as Boyers Creek municipal drain. Field sites were identified as entrenched, which means that flood waters have little to no access to the floodplain. Confining the flood waters to the channel results in the loss of the adjacent floodplain, which impacts the hydraulic function of the stream (floodplains are storage areas for flood waters) and the physical habitat (loss of floodplain vegetation and the organisms that live there). It will also change the channel geometry overtime due to increased velocity, stream power and channel slope. Bank erosion was identified at both field sites and sediment deposition along the bed is occurring at the downstream location. Restoration priorities include not grading the banks too steep during dredging so that vegetation can become established and stabilize the soil. Allowing a floodplain to develop would also be beneficial to the watershed. Blocked, undersized, or failed culverts should be identified due to potential drainage problems through the watershed.
ECOLOGICAL LINKAGES BETWEEN NATURAL AREAS	The potential to create ecological corridors between adjacent natural areas creating larger contiguous natural areas exists in the Bayers Creek subwatershed. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as providing habitat and ecological diversity for a wide range of species.
INVASIVE SPECIES REMOVAL	Invasive species often have no natural competitors resulting in the potential to displace native species. Therefore removal and replacement of these species with native species is important so the diversity of native plants within an ecological community is not threatened. Purple Loosestrife has been identified as a problem. A removal program is recommended coupled with planting of native species.
REGIONAL ROADS — ROAD SALT IMPACTS	The Regional Municipality of Niagara has completed a Salt Study for its Regional Roads (Ecoplans Ltd. 2005). Surface water vulnerability as well as wetland and fish habitat vulnerability from salt along Regional roads is considered high throughout the South Niagara Falls watershed, except for a small portion along the Niagara River which is considered to have a moderate risk (Ecoplans Ltd. 2005). Riparian restoration should be targeted at watercourses and wetlands along regional roads to decrease the impacts from road salt on water quality and aquatic habitat. In addition, areas that support natural heritage features and agricultural areas should also be investigated and remediated to decrease the impacts of salt on these land features/uses.
FISH BARRIER INVENTORY AND REMOVAL	Fish barriers block the channel and can make areas of habitat inaccessible to all aquatic organisms, thereby reducing breeding opportunities for many native species; in addition, they can cause an increase in competition and predation. Examples of fish barriers include dams, weirs, floodgates, perched culverts, road crossings, as well as debris and log jams. Several fish barriers have been noted in the Bayers Creek subwatershed, therefore removal of these barriers is recommended. In addition, an updated inventory is recommended to determine all potential barriers to fish movement in the South Niagara Falls watershed. These sites should be reviewed and where possible, the barrier should be removed to optimize the passage of fish.
NATURALIZING CHANNELIZED PORTIONS OF THE WATERCOURSE	In addition to having a negative impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering the watercourse. Vegetating bare banks and maintaining a buffer strip; restricting cattle access; and allowing a slight meander to reduce bank erosion and flooding are a few measures that could potentially reduce the amount of sediment loading in the watercourse. In addition, when dredging does occur, ensure that the banks are not cut too steep as this will just make the banks more vulnerable to erosion.

TABLE 12: BAYERS CREEK SUBWATERSHED RESTORATION ACTIONS

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
WETLANDS ARE WORTH IT PROGRAM	Inadequate drainage from farm fields has been identified as a problem in the South Niagara Falls watershed. Investigation into possible wetland creation on private property may be an alternate solution over costly tiles for landowners with drainage problems. The NPCA's 'Wetlands are Worth It' Program provides grants to a maximum of 75% of the cost of a project with a grant ceiling of $10,000.
WEEPING TILE DISCONNECT PROGRAM	Some of the municipalities within the Niagara Region have already proposed or implemented by-laws that require homeowners to disconnect their weeping tiles from the sanitary sewer systems. This initiative should be extended Region-wide to eliminate excessive stormwater from entering the sanitary and storm sewer systems.
URBAN RAIN BARREL AND DOWNSPOUT DISCONNECTION PROGRAMS	Several municipalities within the Niagara Region have already implemented these programs; however these initiatives should be extended Region-wide as an effort to eliminate excessive stormwater from entering the sanitary and storm sewer systems. In addition, a downspout disconnection by-law should be developed and implemented to further encourage landowners to discontinue the practice of directing rainwater from rooftops to sewer systems.
SPECIAL STUDIES	**RECOMMENDATIONS FOR FURTHER STUDY**
RESTORATION OF UNAUTHORIZED DRAINS	Unauthorized drains have been identified in Willoughby Marsh Conservation Area. Investigation of the effects and restoration of these unauthorized drains is recommended to ensure that these drains are not negatively impacting Conservation Area property and the resources it is trying to protect, which may also in avertedly be affecting Willoughby Clay Plain Muck Basin and Willoughby Marsh Provincially Significant Wetland.
MUNICIPAL DRAIN MAINTENANCE BEST MANAGEMENT PRACTICES	The Bayers Creek subwatershed contains one municipal drain; Boyers Creek Drain. Best Management Practices for drain maintenance should be developed in consultation with the Ministry of Natural Resources, Department of Fisheries and Oceans, NPCA, municipalities and the agricultural community to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain.
MUNICIPAL ROADS ROAD SALT IMPACT STUDIES	The Regional Municipality of Niagara has already completed a Salt Vulnerability Study for its roads (see above). It is recommended that municipalities complete similar studies to determine the impacts from road salt applications on municipal roads to groundwater sensitive areas, surface water resources, natural heritage areas and agricultural crops.
GROUNDWATER INTRINSIC SUSCEPTIBILITY STUDIES	The *Groundwater Study* (2005) has identified several areas with medium and high intrinsic susceptibility in the South Niagara Falls watershed (Figure 14). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's *Groundwater Study* (2005) and proposed *Source Water Protection Plan*.
RIPARIAN BUFFER EDUCATION PROGRAM	Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between $2,000 and $10,000.
SEPTIC SYSTEM EDUCATION AND FUNDING PROGRAM	Improperly maintained septic systems have been identified as a concern in the South Niagara Falls watershed. Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.

TABLE 12: BAYERS CREEK SUBWATERSHED RESTORATION ACTIONS

SPECIAL STUDIES	RECOMMENDATIONS FOR FURTHER STUDY
ABANDONED WELL DECOMMISSIONING PROGRAM	Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of $2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA.
AGRICULTURAL BEST MANAGEMENT PRACTICES PROGRAM	The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted in the Bayers Creek subwatershed. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between $5,000 and $12,000 depending on the project.
POLICY TOOLS	Policy tools such as stormwater management policies should be developed and included in regional and municipal Official Plans to ensure environmentally-based planning in the watershed. The NPCA has developed stormwater management policies for its jurisdiction for use by Regional Niagara and its municipalities.
POTENTIAL CONTAMINANT SOURCES OF POINT SOURCE POLLUTION	An inventory of potential contaminant sources was identified as part of the objectives for the NPCA's *Groundwater Study* (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the potential effects these potential contaminants may have on surface water quality and aquatic habitat.

NIAGARA RIVER 9 RESTORATION STRATEGY

The Niagara River 9 subwatershed is a small subwatershed primarily made up of residential, agricultural and recreational landuses. The watercourse starts in an agricultural field, and then flows toward the southern end of Chippawa residential area where for the remainder of its course to the Niagara River it has been channelized. The entire watercourse has been designated as marginal (Type 3) fish habitat. Adjacent landuses to the channelized portion of the watercourse include residential on one side and the Legends of the Niagara golf course on the other.

Natural heritage features include a few scattered wooded and wetland areas and windbreaks between fields. The challenge that exists for the Niagara River 9 subwatershed is the establishment of a buffer strip in the headwater region of the watercourse. In addition, enhancement of the small natural areas in order to increase the core size would be beneficial to support of higher diversity of wildlife.

The Niagara River 9 Subwatershed Restoration Strategy identifies one zone with specific stewardship and restoration recommendations (Table 13). In addition, recommendations for the Niagara Parkway and Navy Island have been included in the Restoration Actions table.

1. Niagara River 9 subwatershed: The Riparian Restoration Suitability Mapping indicates high suitability for riparian restoration in the headwater region of the watercourse. This portion of the watercourse starts in an agricultural field that offers little to no cover. Therefore priority for this subwatershed should be the establishment of a buffer strip in areas that currently have no cover. In addition, linkages between distant natural areas should be reinforced as well as enhancement around existing natural areas increase the core size.

TABLE 13: NIAGARA RIVER 9 SUBWATERSHED RESTORATION ACTIONS

RESTORATION OPPORTUNITIES	RECOMMENDED RESTORATION STRATEGIES		
	RIPARIAN	WETLAND	UPLAND AND ECOLOGICAL LINKAGES
NIAGARA RIVER 9 SUBWATERSHED	• headwaters run through fields that offer little to no riparian buffer, therefore priority should be placed on buffer strip planting in the headwater section of watercourse; riparian buffers will help to reduce sediment and cool the water to enhance water quality and fish habitat • maintain riparian on channelized portion of watercourse	• wetland suitability mapping indicates moderate suitability for wetland restoration, therefore any restoration should be limited to enhancement of existing wetlands • protect and enhance existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities)	• moderate suitability for upland restoration adjacent to natural heritage areas; focus should be on increasing core natural heritage areas, filling in gaps between adjacent areas and creating ecological linkages with adjacent subwatersheds that are consistent with Carolinian Canada's "Big Picture" and Regional Niagara's Regional Policy Plan Amendment 187 • reinforcement of corridors along southern portion of subwatershed, extending into Usshers Creek subwatershed. • Carolinian and native species should be used in all restoration projects

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
GEOMORPHIC ASSESSMENT STUDY (NPCA 2007B)	The South Niagara Falls Watershed Geomorphic Assessment (NPCA 2007b) identified several erosion and sediment accumulation sites in the Niagara River 9, 12 and 13 subwatersheds (Appendix B): 1. **Niagara River Parkway (Reach NRNineMa)**: This section of the stream is entrenched resulting in flood waters having no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Allowing a floodplain to develop within entrenched streams and increasing the sinuosity along straightened reaches will help to dissipate the energy within the flow. Evidence of downcutting includes a 35cm drop from a culvert outlet to the stream bed. There is little to no near bank vegetation and the buffer width is small on the left bank due to the adjacent subdivision. Bank erosion along this section is predominantly in the form of slumping, which indicates that the vegetative roots are too shallow. Landowners throw vegetative debris over the bank, which eventually ends up in the stream resulting in debris jams and impacting water quality. Recommendations for this site are to increase the variety and diversity of native plant species within the buffer zone. Due to the impact on water quality, landowners need to stop throwing vegetative debris over the bank. 2. **Willoughby Drive/Sommerville Road (Reach NRTwelveMa)**: This section of the stream has a fairly high width to depth ratio, indicating that excessive sedimentation may be occurring. Bare soil is exposed along the near bank zone and stream bed in this section. Trees growing within the channel and a number of debris jams present indicate that the channel may be widening. There is one tractor crossing at this field site with no culvert present. Recommendations for this site include increasing the variety and diversity of native plant species within the near bank zone however the dense canopy cover may make it difficult for vegetation to grow. Increasing the wetland and near bank vegetation where possible will help to increase habitat and stabilize the soil along the bank. A proper crossing should be created at this field site.

TABLE 13: NIAGARA RIVER 9 SUBWATERSHED RESTORATION ACTIONS

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
GEOMORPHIC ASSESSMENT STUDY (NPCA 2007B)	3. **Niagara River Parkway (Reach NRThirteenMa)**: Due to the adjacent agricultural field, this portion flows through an area where bare sediment is exposed along the bed and bank. A fairly high width to depth ratio in this area indicates that excessive sedimentation may be occurring. There are 3 tractor crossings present which will potentially increase the amount of sediment entering the stream. The lack of riparian buffer, canopy cover, and deep pools result in poor habitat and cover for fish, insects, and invertebrates. Recommendations for this site include establishing a buffer strip using a variety of native plant species to increase diversity. This will limit the amount of sediment entering the channel and create a more diverse ecological habitat. The number of farm crossings should be limited and construction of a proper crossing at this site is recommended. Restoration priorities for the Niagara River Subwatersheds 9, 12, and 13 include enhancing the size of the riparian buffer and increasing the variety and diversity of native plant species within it. This will help to prevent bank erosion, provide habitat and cover, control the amount of sediment entering the stream from runoff, and filter any pollutants that may enter the stream. Another restoration priority should be to construct proper crossings in agricultural fields in order to limit excess sediment from entering the channel. The field site along Niagara River Subwatershed 9 was identified as entrenched, which means that flood waters have little to no access to the floodplain. Confining the flood waters to the channel results in the loss of the adjacent floodplain, which impacts the hydraulic function of the stream (floodplains are storage areas for flood waters) and the physical habitat (loss of floodplain vegetation and the organisms that live there). It will also change the channel geometry overtime due to increased velocity, stream power and channel slope. Allowing a floodplain to develop would be beneficial to this watershed. In addition, water quality should continue to be monitored in this watershed.
ECOLOGICAL LINKAGES BETWEEN NATURAL AREAS	The potential exists to extend the windbreak along WIllick Road west into Hunters Drain subwatershed, creating an ecological corridor between natural areas. Such areas have the potential to enhance movement of flora and fauna between natural areas while providing cover and habitat diversity for a wide range of species.
NIAGARA RIVER INVASIVE SPECIES CONTROL PROJECT	A potential opportunity exists to partner with the Niagara Parks Commission for an invasive species control along the Niagara River. This project is unique because it would involve the potential use of an Articulated Flail Boom Mower. The machine is able to manoeuvre around trees and shrubs while mulching the unwanted invasive vegetation. This machine is appropriate for tracts of vegetation where the majority is unwanted, since it is unable to selectively remove. Benefits of the Articulated Flail Boom Mower include time efficiency, reduced labour costs and reduced risk of injury to workers. This project should be accompanied with a native species planting program.
INVASIVE SPECIES REMOVAL	Invasive species often have no natural competitors resulting in the potential to displace native species. Therefore removal and replacement of these species with native species is important so the diversity of native plants within an ecological community is not threatened. Purple Loosestrife has been identified as a problem. A removal program is recommended coupled with planting of native species.
REGIONAL ROADS — ROAD SALT IMPACTS	The Regional Municipality of Niagara has completed a Salt Study for its Regional Roads (Ecoplans Ltd. 2005). Surface water vulnerability as well as wetland and fish habitat vulnerability from salt along Regional roads is considered high throughout the South Niagara Falls watershed, except for a small portion along the Niagara River which is considered to have a moderate risk (Ecoplans Ltd. 2005). Riparian restoration should be targeted at watercourses and wetlands along regional roads to decrease the impacts from road salt on water quality and aquatic habitat. In addition, areas that support natural heritage features and agricultural areas should also be investigated and remediated to decrease the impacts of salt on these land features/uses.

TABLE 13: NIAGARA RIVER 9 SUBWATERSHED RESTORATION ACTIONS

PROJECT OPPORTUNITIES	RECOMMENDED ACTIONS FOR PUBLIC AND PRIVATE LANDS
FISH BARRIER INVENTORY AND REMOVAL	Fish barriers block the channel and can make areas of habitat inaccessible to all aquatic organisms, thereby reducing breeding opportunities for many native species; in addition, they can cause an increase in competition and predation. Examples of fish barriers include dams, weirs, floodgates, perched culverts, road crossings, as well as debris and log jams. An updated inventory is recommended to determine all potential barriers to fish movement in the South Niagara Falls watershed. These sites should be reviewed and where possible, the barrier should be removed to optimize the passage of fish.
NATURALIZING CHANNELIZED PORTIONS OF THE WATERCOURSE	In addition to having a negative impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering the watercourse. Vegetating bare banks and maintaining a buffer strip; restricting cattle access; and allowing a slight meander to reduce bank erosion and flooding are a few measures that could potentially reduce the amount of sediment loading in the watercourse. In addition, when dredging does occur, ensure that the banks are not cut too steep as this will just make the banks more vulnerable to erosion.
WETLANDS ARE WORTH IT PROGRAM	Inadequate drainage from farm fields has been identified as a problem in the South Niagara Falls watershed. Investigation into possible wetland creation on private property may be an alternate solution over costly tiles for landowners with drainage problems. The NPCA's 'Wetlands are Worth It' Program provides grants to a maximum of 75% of the cost of a project with a grant ceiling of $10,000.
WEEPING TILE DISCONNECT PROGRAM	Some of the municipalities within the Niagara Region have already proposed or implemented by-laws that require homeowners to disconnect their weeping tiles from the sanitary sewer systems. This initiative should be extended Region-wide to eliminate excessive stormwater from entering the sanitary and storm sewer systems.
URBAN RAIN BARREL AND DOWNSPOUT DISCONNECTION PROGRAMS	Several municipalities within the Niagara Region have already implemented these programs; however these initiatives should be extended Region-wide as an effort to eliminate excessive stormwater from entering the sanitary and storm sewer systems. In addition, a downspout disconnection by-law should be developed and implemented to further encourage landowners to discontinue the practice of directing rainwater from rooftops to sewer systems.
SPECIAL STUDIES	**RECOMMENDATIONS FOR FURTHER STUDY**
NAVY ISLAND NATURAL AREAS INVENTORY	Navy Island is unique in its diversity with numerous natural communities including a coastal marsh, a hawthorn forest and an old growth red-maple swamp. Navy Island consists predominately of old growth and has been designated an Area of Natural Scientific Interest with areas designated as a provincially significant wetland and an environmentally sensitive area. A detailed natural heritage inventory is recommended in gaining insight into this pristine environment.
MUNICIPAL ROADS ROAD SALT IMPACT STUDIES	The Regional Municipality of Niagara has already completed a Salt Vulnerability Study for its roads (see above). It is recommended that municipalities complete similar studies to determine the impacts from road salt applications on municipal roads to groundwater sensitive areas, surface water resources, natural heritage areas and agricultural crops.
GROUNDWATER INTRINSIC SUSCEPTIBILITY STUDIES	The *Groundwater Study* (2005) has identified several areas with medium and high intrinsic susceptibility in the South Niagara Falls watershed (Figure 14). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's *Groundwater Study* (2005) and proposed *Source Water Protection Plan*.

TABLE 13: NIAGARA RIVER 9 SUBWATERSHED RESTORATION ACTIONS

SPECIAL STUDIES	RECOMMENDATIONS FOR FURTHER STUDY
RIPARIAN BUFFER EDUCATION PROGRAM	Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between $2,000 and $10,000.
SEPTIC SYSTEM EDUCATION AND FUNDING PROGRAM	Improperly maintained septic systems have been identified as a concern in the South Niagara Falls watershed. Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.
ABANDONED WELL DECOMMISSIONING PROGRAM	Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of $2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA.
AGRICULTURAL BEST MANAGEMENT PRACTICES PROGRAM	The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between $5,000 and $12,000 depending on the project.
POLICY TOOLS	Policy tools such as stormwater management policies should be developed and included in regional and municipal Official Plans to ensure environmentally-based planning in the watershed. The NPCA has developed stormwater management policies for its jurisdiction for use by Regional Niagara and its municipalities.
POTENTIAL CONTAMINANT SOURCES OF POINT SOURCE POLLUTION	An inventory of potential contaminant sources was identified as part of the objectives for the NPCA's *Groundwater Study* (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the potential effects these potential contaminants may have on surface water quality and aquatic habitat.

IMPLEMENTATION RESPONSIBILITIES AND RECOMMENDED MANAGEMENT ACTIONS

The above South Niagara Falls Watershed restoration strategy is of no use unless it is guided by an implementation framework. An implementation framework follows that has been designed to account for the watershed plan objectives, which were derived from key issues in the watershed and extensive public input. The implementation framework is guided by the Government of Canada's vision for integrated community sustainability planning, which envisions all parties involved to focus limited financial and human resources in ways that well best serve common objectives at all levels of government (Godfrey 2005). To this end, the implementation framework identifies project stakeholders (e.g., provincial agencies, regional government watershed municipalities, public interest groups and landowners), and recommended management actions for each watershed plan objective.

IMPLEMENTING THE RECOMMENDED ACTIONS

Lead project stakeholders and those who should be involved in the project have been identified in the following framework. The recommended management actions for the South Niagara Falls Watershed include planning and regulatory actions (e.g., Official Plan amendments), project opportunities on private and public lands (e.g., riparian buffer planting, wetland creation), and areas requiring additional research and monitoring (e.g., ecological linkages, geomorphic assessments) in the watershed. The cost of most projects is identified in the table. If the project is identified as ongoing then it is likely an action that requires continual updating such as the five year review process for regional and municipal Official Plans, which is not allocated a dollar amount. If an existing program already has funding, and the project and funding have a termination date, then these projects have a specific dollar amount attached to them. In addition, funds allocated as part of annual budgeting have also been assigned dollar amounts.

WATERSHED PLAN OBJECTIVES	RESPONSIBLE AGENCIES AND GROUPS											RECOMMENDED MANAGEMENT ACTIONS		COST
WATER RESOURCES	NPCA	MUNICIPALITIES	REGIONAL NIAGARA	NPC	MNR	MOE	OMAFRA	DFO	CONSERVATION GROUPS	AGRICULATURAL COMMUNITY	PRIVATE LANDOWNERS		IMPLEMENTATION	$
Maintain, enhance or restore natural stream processes to support human uses, agricultural needs and ecological functions in accordance with Ontario Water Quality Objectives		▲	▲									Include water quality protection in regional and municipal planning documents		ONGOING
	▲	●	●		●			●				Continue to restrict no new on-line pond construction		ONGOING
	▲	▲	▲			●	●		●	●	●	Continue to monitor water quality to achieve Provincial Water Quality Objectives		10,000/yr
Protect, improve or restore all vulnerable areas (surface and groundwater features that can be easily changed or impacted by activities or events)	▲	●	●		●	●	●		●	●		Develop and implement a Source Water Protection Plan		EXISTING FUNDING
	▲	●	●		●	●	●					Implement the Groundwater Management and Protection Strategy proposed in the Groundwater Study (NPCA 2005)		EXISTING PROGRAM
	▲	●	●		●	●	●					Develop and implement a specific Groundwater and Management Protection Strategy for medium and high susceptibility areas identified in the Groundwater Study (NPCA 2005)		EXISTING FUNDING
	▲	●	●			●				●	●	Continue to implement the water well decommissioning program in the South Niagara Falls watershed		EXISTING FUNDING
	▲	●	▲			●						Identify and map surface and groundwater "hot spots" to determine areas with poor water quality including salt vulnerable areas		EXISTING FUNDING
		▲	▲						●		●	Develop and adopt by-laws for the elimination of lawn fertilizers, pesticides and herbicides		ONGOING
	▲		▲						●	●	●	Implement a septic system awareness and educational program		15,000/yr**
	▲				●	●						Examine the ongoing effect of quarries and sand/gravel pits on groundwater, the impacts when they cease dewatering, and the potential for long-term augmentation of base flows		ONGOING
	●	▲	▲									Incorporate surface and groundwater protection policies into regional and municipal planning documents		ONGOING
Ensure the equitable distribution and sustainable use of available surface and groundwater to protect water quality and quantity, aquatic and terrestrial ecosystems, and human health and to supply existing and planned uses including municipal drains	●	●	●			▲			●	●	●	Improve monitoring of base flows and water use (e.g., Permit to Take Water)		ONGOING
	▲	●	●		●	●	●					Subwatershed scale data input (e.g. continuous surface water flows) for calibration of the Source Water Protection Water Budget and Balance		50,000
	▲											Conduct a fluvial geomorphology study on Lyons Creek to address concerns regarding flow		26,000

LEGEND

▲ LEAD STAKEHOLDER
● INVOLVED STAKEHOLDER
SHORT TERM
MEDIUM TERM
LONG TERM

WATERSHED PLAN OBJECTIVES	RESPONSIBLE AGENCIES AND GROUPS											RECOMMENDED MANAGEMENT ACTIONS	IMPLEMENTATION	COST
WATER RESOURCES	NPCA	MUNICIPALITIES	REGIONAL NIAGARA	NPC	MNR	MOE	OMAFRA	DFO	CONSERVATION GROUPS	AGRICULATURAL COMMUNITY	PRIVATE LANDOWNERS			$
Ensure that storm water management practices minimize storm water volumes and contaminant loads, and maintain or increase the extent of vegetative and pervious surfaces Manage and mitigate flooding risks to human life and property within acceptable limits		▲	▲									Implement NPCA Stormwater Policies and BMPs into regional and municipal planning documents		ONGOING
		▲									●	Implement downspout disconnection by-laws for settlement areas in the City of Niagara Falls		100/downspout 600/home
		▲									●	Implement by-laws that require homeowners to disconnect their weeping tiles from the sanitary sewer systems		EXISTING PROGRAM
		▲	▲								●	Implement a rain barrel program for entire South Niagara Falls watershed		EXISTING PROGRAM
	▲	●	●							●	●	Continue to permit no new development in the 1 in 100 year floodplain		ONGOING
	▲	●	●									Maintain NPCA flood warning system		ONGOING
	▲	●	●							●	●	Continue to implement regulations adopted under Section 28 of the Conservation Authorities Act		ONGOING
Minimize erosion caused by human activity through the establishment and implementation of a comprehensive, priority based erosion control program	▲	●	●		●				●	●	●	Implement the recommended restoration actions outlined in the South Niagara Falls Watershed Geomorphic Assessment (NPCA 2007)		10,000/yr
Maintain, improve and provide opportunities for farm-related infrastructures such as drainage and irrigation	▲				▲			▲			●	Where legislation permits, maintain stream flows by removing debris and sediment in watercourses		2,500/yr**
FISH & AQUATIC HABITAT														
Protect, enhance and restore populations of native species and their habitats in the watershed	▲	●	●		●			●	▲	●	●	Identify and remove barriers to fish movement		60,000
	▲	●	●		●			●	●			Develop a Fisheries Management Plan for the South Niagara Falls watershed		45,000
	●				▲	▲		●	●	●	▲	Where possible, remove, relocate or modify online ponds		50,000
	▲								●	●	▲	Plant riparian buffer strips around watercourses and wetlands		7,000/yr (5,000/250m)**

LEGEND

▲ LEAD STAKEHOLDER
● INVOLVED STAKEHOLDER
SHORT TERM
MEDIUM TERM
LONG TERM

WATERSHED PLAN OBJECTIVES	RESPONSIBLE AGENCIES AND GROUPS											RECOMMENDED MANAGEMENT ACTIONS		COST
NATURAL HERITAGE AND RESOURCES	NPCA	MUNICIPALITIES	REGIONAL NIAGARA	NPC	MNR	MOE	OMAFRA	DFO	CONSERVATION GROUPS	AGRICULATURAL COMMUNITY	PRIVATE LANDOWNERS	LEGEND ▲ LEAD STAKEHOLDER ● INVOLVED STAKEHOLDER SHORT TERM MEDIUM TERM LONG TERM	IMPLEMENTATION	$
Protect, enhance and restore the health, diversity and ecological functions of the natural heritage systems in the watershed and their linkages to natural heritage systems in adjoining watersheds	▲	●	●		●				▲		●	Complete a comprehensive biological inventory and map of natural heritage areas including wetlands		EXISTING FUNDING
	▲								▲	▲	▲	Implement the upland reforestation program based on upland suitability mapping targeting interior forest expansion, and ecological linkage opportunities		21,000/yr (1,500/acre)**
Maintain, restore and improve the linkages among surface water features, groundwater features, hydrologic functions and natural heritage features and areas, and their ecological functions	●	▲										Conduct a secondary prescribed burn at Baden Powell Park to initiate native seed bank of restoration project site		4,000
	▲	▲	▲						●	●	●	Utilize conservation easements, land dedication and acquisition to secure critical linkages as desired lands become available for purchase		EXISTING FUNDING
	▲	▲	▲		▲	▲	▲	▲	▲	▲		Continue partnership building with public interest groups to access funding for reforestation programs (e.g., NRC)		ONGOING
	▲				●						●	Restoration of unauthorized drains in Willoughby Marsh Conservation Area		10,000
Preserve all wetlands in the watershed	▲	▲	▲									Continue review of new developments and building permits; ensure compliance with PPS and NPCA Generic Regulations		ONGOING
	▲	●	●		▲			●	▲	▲	▲	Create new wetlands or enlarge existing wetlands based on wetland suitability mapping		10,000/yr 10,000/project**
	●				▲							Conduct a detailed invetory for the remainder of Lyons Creek Floodplain Provincially Significant Wetland		70,000
Research and recommend management practices for invasive species (flora and fauna)	▲	●	●	▲	▲				▲		●	Identify the extent of both flora and fauna invasive species in the Fifteen-Sixteen-Eighteen Mile Creeks watershed and make scientific recommendations for their removal		ONGOING
	▲			▲								Invasive Species Control and Native Planting Program on Niagara River		10,000*

WATERSHED PLAN OBJECTIVES	RESPONSIBLE AGENCIES AND GROUPS											RECOMMENDED MANAGEMENT ACTIONS	IMPLEMENTATION	COST
COMMUNICATION, EDUCATION AND RECREATION	NPCA	MUNICIPALITIES	REGIONAL NIAGARA	NPC	MNR	MOE	OMAFRA	DFO	CONSERVATION GROUPS	AGRICULATURAL COMMUNITY	PRIVATE LANDOWNERS	LEGEND ▲ LEAD STAKEHOLDER ● INVOLVED STAKEHOLDER SHORT TERM MEDIUM TERM LONG TERM		$
Foster and develop partnerships between and amongst agencies, interest groups and landowners	▲	●	●						●	●	●	Continue to recognize groups and individuals for their environmental efforts in the South Niagara Falls watershed		ONGOING
	▲	●	●									Present Watershed Plan findings and successes to regional and municipal government officials and policy makers		ONGOING
	▲	●	●		●	●	●	●	●	●	●	Develop communication networks with agricultural groups, Niagara College, Brock University, and others for information sharing and project implementation		ONGOING
	▲								●	●	●	Continue the NPCA's Water Quality Improvement Program whereby landowners are provided with incentives to carry out projects on their lands		120,000/yr**
	▲	●	●	●	▲				●	●	●	Work with landowners and conservation groups to foster partnerships pertaining to Species at Risk and inform interested parties of funding programs such as the Habitat Stewardship Fund		EXISTING PROGRAM
	▲	●	●		●				●	●	●	Assemble and meet with a Watershed Plan Implementation Committee made up of local representation (government agencies, organizations, landowners) to annually re-evaluate the Fifteen-Sixteen-Eighteen Mile Creeks Watershed Plan's components, and provide input on new or revised restoration initiatives in the watershed		ONGOING
Promote awareness of the linkages between healthy water, healthy lifestyles and economic viability of rural and urban land uses	▲										▲	Continue creating demonstration sites to educate landowners about the water quality benefits of riparian buffers, wetlands and upland restoration		EXISTING PROGRAM
	●	▲	▲						▲		●	Disseminate material pertaining to alternative fertilizer use for residential lawns		EXISTING PROGRAM
Promote the wise use of groundwater and surface water resources in terms of human, agricultural and ecological needs	▲											Create and disseminate a Watershed Report Card highlighting restoration initiatives in the watershed after 3 to 5 years watershed plan implementation		12,000/Report Card
	▲	▲	▲	▲					▲			Seek partnerships with local recreation groups to improve natural heritage feature and recreational opportunities (e.g., Niagara Parks Commission, conservation groups)		ONGOING
DEVELOPMENT														
Promote environmentally-sound land use decision making in the watershed for current and future urban development and rural/agricultural land use	●	▲	▲	●	●							Identify and incorporate significant natural areas and ecological linkages into planning documents and policies to ensure they are buffered from development		ONGOING
	▲	▲	▲	▲								Continue to implement NPCA Plan Input and Review Policies (NPCA 1993 as amended in 2003; 2005)		ONGOING

* Includes project costs and NPCA salaries

** Based on grant ceiling under NPCA's Water Quality Improvement Program for landowners

The recommended actions have also been identified in terms of their implementation. Green denotes short term implementation, yellow represents medium term implementation and red is used to indicate long term implementation. For example, projects that are ongoing are almost always implemented over the long term and are therefore, represented in red. Projects that have specific funding requirements or require approvals, for example, are often represented in green and yellow, thereby indicating short term or medium term implementation respectively.

MONITORING

Monitoring serves two purposes in watershed planning. Monitoring is required to update the watershed plan as land uses change and new issues are identified, and monitoring also serves to measure the success of restoration projects in terms of enhancing and protecting water quality for all users in a watershed. Monitoring the achievement of a watershed plan's objectives involves continually reviewing the South Niagara Falls Watershed Plan. The Plan will be reviewed by the NPCA Restoration Team and the South Niagara Falls Watershed Plan Implementation Committee (comprised of public interest groups, watershed municipalities, agency, and citizen representatives) annually. As part of the review process, the plan will be amended whenever necessary to reflect the changing environmental, economic, technical, or social trends within the jurisdiction of the NPCA, and more specifically within the South Niagara Falls watershed. A complete review and necessary revisions will occur ever 5 years.

In addition to monitoring the objectives or outcomes of the Watershed Plan, the monitoring process includes measuring the performance and success of the management actions used to achieve the objectives. In this regard, monitoring serves to collect and analyze aquatic, terrestrial and socio-economic data to identify changes in the watershed; both from restoration activities, and growth and development. This component of the monitoring program should include:

- Water quality sampling, benthic studies (BioMap), and water temperature monitoring through the NPCA's Water Quality Monitoring Program. This data can be used as an indicator of whether or not the recommendations provided in the Watershed Plan have maintained and/or improved the physical and chemical characteristics of water quality in the watershed. Continued groundwater monitoring should also be included as part of the water quality monitoring program.
- On-going classification of vegetative communities using standardized protocols (Ecological Land Classification). These habitat areas are recorded as Geographic Information System layers and are updated bi-annually to evaluate changes in community composition, habitat size and fragmentation.
- Biological life assessments (qualitative and quantitative) such as insects/pollinators, fish and birds.
- A compilation of the number and location of BMPs implemented in the watershed. This will also include pollutant loading reduction measurements. This information will be housed in a restoration database and updated as projects are completed.
- Watershed landowners should also be surveyed (at least every 5 years prior to the Watershed Plan review) to help watershed planners and the restoration team identify new watershed issues, and evaluate changes in knowledge and behaviour.

Land use and land use change in the watershed will also be evaluated. This can be completed using the Agricultural Non-Point Source Pollution (AGNPS) model. AGNPS is a computer model that is used for evaluating the effect of management decisions impacting a watershed system, such as predicting nonpoint source pollutant loadings within agricultural watersheds. For example, AGNPS can simulate the effects of various management practices on pollution in the watershed. The model can predict where runoff from rain, snowmelt, or irrigation may carry pesticides, fertilizers, or sediment throughout a watershed. The AGNPS model should be amended as land use change occurs, especially when those changes do not coincide with future land use planning.

TIME FRAME	ACTION
Monthly during ice free season(March-October)	Surface water quality sampling
Yearly	Project Monitoring: photos and notes of restoration projects are taken to document status of project (i.e., improvements, growth, change)
Typically every 3 years (spring and fall)	Biological Monitoring and Assessment Program sampling
5 Year Review	Review of the watershed plan: Investigation of identified issues and status of recommended actions is completed. Any new issues will be identified and an updated restoration strategy will be created.
Continuous Monitoring	Landowners are given a monitoring journal to document any changes they observe occurring in the project area.
Continuous Monitoring	Update Natural Heritage Information Database and GIS layers to reflect Natural Heritage Areas Inventory field surveys and project findings.

TABLE 15: WATERSHED MONITORING SCHEDULE

The overall objectives of the South Niagara Falls Watershed Plan monitoring program are to:

- continually evaluate and amend the watershed plan whenever necessary to reflect changing environmental, economic, technical, or social trends;
- continually assess the overall health and water quality of watercourses;
- improve the AGNPS model calibration; and
- gauge the success of the restoration action plans in protecting and improving water quality and aquatic health.

CONCLUSION

The South Niagara Falls watershed is a distinct watershed primarily comprised of an agricultural land base. A wide-ranging set of watershed issues have been gathered resulting in a comprehensive set of watershed objectives that includes water resources; fish and aquatic habitat; natural heritage and resources; communication, education and recreation; and development.

The watershed objectives have formed the basis of restoration strategies at the watershed level for riparian, wetland and upland habitat that have been derived from detailed restoration suitability mapping. In addition, project opportunities on private and public lands have been identified such as erosion control and upland forest restoration to create ecological linkages between existing forested areas. Special studies, including policy tools and urban water conservation programs, have also been proposed.

The implementation plan identifies responsible stakeholders for each recommended management action. The recommended management actions have been organized to include riparian, wetland and upland restoration and creation to enhance water quality, fish habitat and recreation; specific policy tools including municipal and regional official plan amendments; outreach and communication for various aspects of water resources management; and research and monitoring programs to obtain additional data from which the South Niagara Falls Watershed Plan can be updated and revised every 5 years.

The Niagara Peninsula Conservation Authority will oversee the implementation of the South Niagara Falls watershed strategy and recommendations made in this report with the assistance of the South Niagara Falls Watershed Plan Implementation Committee, which is comprised of public interest groups, watershed municipalities, agencies and landowners. Watershed plan progress will be communicated annually by means of a qualitative report card that details progress in the watershed.

Together the watershed strategy and recommended management actions aim to contribute to supporting healthy natural areas, farms, watercourses, and habitat for a diversity of flora and fauna. Through this plan, the preservation, conservation and restoration of the watershed's ecosystem will protect society's resource needs by sustaining the ecological processes that naturally protect air, water and land resources. All of this will be achieved through environmental stewardship that fosters a collaborative approach to conservation that respects landowners while providing exciting opportunities for education and recreation for all citizens in the South Niagara Falls watershed.

REFERENCES

Barrett, I. 2007. Aquatic Habitat Biologist - Personal Communication. Niagara Peninsula Conservation Authority.

Berketa, R. *Niagara Falls Thunder Alley*. http://www.niagarafrontier.com/~falls/index.html Date Visited: 21 September 2006.

Bert Miller Nature Club, 2004. *Old Growth Forest Survey of Eastern Niagara Peninsula.* Prepared for The Ontario Trillium Foundation

Brady, R.F. 1980. *Regional Municipality of Niagara Environmentally Sensitive Areas.* St. Catharines, Ontario: Department of Geography, Brock University.

British Columbia Ministry of the Environment, Environmental Protection Division. 2001. *British Columbia Approved Water Quality Guidelines (Criteria).* British Columbia, Canada

Canadian Council of Ministers of the Environment. 2005. *Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses.* Canadian Environmental Quality Guidelines.

Canadian Council of Ministers of the Environment. 2007. *Canadian Water Quality Guidelines for the Protection of Aquatic Life.* Canadian Environmental Quality Guidelines.

Campbell, J. 2007. Source Protection Hydrogeologist. Niagara Peninsula Conservation Authority.

City of Niagara Falls. 1990 and amended 2000. *City of Niagara Falls Official Plan.* Planning and Development Department, Office Consolidation.

Cromie, V. 2007. Niagara River RAP Liaison- Personal Communication. Niagara Peninsula Conservation Authority.

de Loë, R. and A. Berg. 2006. *Mainstreaming Climate Change in Drinking Water Source Protection Planning in Ontario.* Pollution Probe.

Dougan & Associates. 2007. *Lyons Creek East Wetland Inventory and Monitoring Study.* Prepared for the Niagara Peninsula Conservation Authority, Environment Canada, & Ontario Ministry of Natural Resources, Ontario.

Eagles, Paul F.J. and Adindu, Godson. 1978. *Environmentally Sensitive Area Planning and Management.* University of Waterloo, Waterloo

Ecoplans Limited. 2005. *Identification of Salt Vulnerable Areas, Regional Municipality of Niagara.* Prepared for the Regional Municipality of Niagara, Ontario.

Environment Canada and Ontario Ministry of the Environment. No Date. *Working Together for the Great Lakes.* Pamphlet.

Environment Canada. 2004a. *Code of Practice for the Environmental Management of Road Salts.* EPS 1/CC/5: Her Majesty the Queen in Right of Canada.

Environment Canada. 2004b. *Best Management Practices for Salt Use on Private Roads, Parking Lots and Sidewalks.* Her Majesty the Queen in Right of Canada.

Environment Canada. 2004c. *How Much Habitat is Enough?* Second Edition. Minister of Public Works and Government Services Canada.

Fisheries and Oceans Canada. No Date. *Fisheries Act Habitat Protection and Pollution Prevention Provisions.*

Fisheries and Oceans Canada. No Date. *Working Around Water: A Class Authorization System for Agricultural Municipal Drains in the Southern Ontario Region.* Canada.

Godfrey, John. 2005. *Integrated community sustainability planning; bringing sustainable development to our critics and communities.* Municipal World: November : 5-7

Government of Canada. 2003 *Species at Risk Act*. Her Majesty the Queen in Right of Canada.

Government of Canada. COSEWIC: *Committee on the Status of Endangered Wildlife in Canada.* Accessed online at http://www.cosewic.gc.ca/ , Date Visited: 15 October 2007.

Griffiths, R.W. 1999. *BioMAP: Bioassessment of Water Quality.* The Centre for Environmental Training, Niagara College. Niagara-on-the-Lake, Ontario.

Johnson, L. 2005. *Carolinian Canada: Signature Sites.* Carolinian Canada Coalition, London, Ontario. 79 pages.

Kingston, M.S. and E.W. Presant. 1989. *The Soils of the Regional Municipality of Niagara Volumes 1 and 2.* Report No. 60 of the Ontario Institute of Pedology. Ministry of Agriculture and Food and Agriculture Canada.

Kwicinksi, J., S. Hudson, P. Nash, M. Bacro, and J. Littleton. 1988a. Wetland Data Record and Evaluation- Grassy Brook. Second Edition. Ontario Ministry of Natural Resources.

Kwicinksi, J. and J. Littleton. 1988b. Wetland Data Record and Evaluation- Tea Creek. Second Edition. Ontario Ministry of Natural Resources.

Kwicinski, J. 1988. Wetland Data Record and Evaluation- Lyon's Creek Corridor Woodlot 36. Second Edition. Ontario Ministry of Natural Resources.

Limnoterra Ltd. 1998. Willoughby Marsh Project – Phase 1 Background Report. Prepared for the Niagara Peninsula Conservation Authority.

Littleton, J., and M. Berains. 1986. Wetland Data Record and Evaluation- Black Creek. Second Edition. Ontario Ministry of Natural Resources

Michaud, A. 2006. Water Quality Specialist – Personal Communication. Niagara Peninsula Conservation Authority.

Milani, Danielle & R. Fletcher. 2005. *PCB contamination and biological impacts in Lyons Creek East: Implementation of a Canada-Ontario Decision-making framework for contaminated sediments.* Prepared for the Niagara AOC Steering Committee

Ministry of the Environment. 2006. *Assessment Report: Draft Guidance Module 4*

Ministry of the Environment. 2006. *Clean Water Act* Accessed online: www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_06c22_e.htm Date Visited: 21 January 2008

Ministry of Natural Resources. 1994. *Conserving Ontario's Old Growth Forests Ecosystems – Final Report of the Old Growth Forests Policy Advisory Committee.* Toronto: Queen's Printer for Ontario.

Niagara Peninsula Conservation Authority. No Date. *A Guide To Celebrate Niagara Peninsula's Native Plants.*

Niagara Peninsula Conservation Authority. 1993. *Resources Planning Program, Plan Input and Review Policies and Guidelines.* With amendments 2003 and 2005. Welland, Ontario.

Niagara Peninsula Conservation Authority. 2002. *The Niagara River Update.* Pamphlet.

Niagara Peninsula Conservation Authority. 2003. *Buffers are Better.* Brochure.

Niagara Peninsula Conservation Authority. 2004. *Niagara River RAP Update 2004.* Pamphlet.

Niagara Peninsula Conservation Authority. 2007a. *NPCA Water Quality Monitoring Program: 2006 Annual Report.* Welland, Ontario.

Niagara Peninsula Conservation Authority. 2007b *The South Niagara Falls Watershed Geomorphic Assessment*

Niagara River Remedial Action Plan. *1995 Stage 1 –Update. Environmental Conditions and Problem Definition.*

Niagara River RAP. 1995. *Niagara River Remedial Action Plan – The Cleanup Connection.* Pamphlet.

Nottawasaga Valley Conservation Authority. 1995. *Nottawasaga Valley Watershed Plan.* Utopia, Ontario.

Ontario Ministry of Agriculture and Food. 1996. *10 Steps to Complete a Nutrient Management Plan for Livestock and Poultry Manure.* Queen's Printer for Ontario, Ontario.

Ontario Ministry of Agriculture and Food and Ontario Ministry of the Environment. *Nutrient Management Act.* S.O. 2002, Ontario Regulation 267/03.

Ontario Ministry of Agriculture, *Food and Rural Affairs 2004.* 2004 Farm Class Property Tax Rate. Queens Printer for Ontario, Ontario, Canada.

Ontario Ministry of Agriculture, Food and Rural Affairs and Ontario Ministry of the Environment. 2003. *Nutrient Management Protocol – Part 4, Introduction to Nutrient Management Strategies and Plans.* Queen's Printer for Ontario, Ontario, Canada.

Ontario Ministry of the Environment and Energy and Ontario Ministry of Natural Resources. 1993. W*ater Management on a Watershed Basis: Implementing an Ecosystem Approach.* Queen's Printer for Ontario: Ontario, Canada.

Ontario Ministry of the Environment. 1994. *Water Management, Policies, Guidelines and Provincial Water Quality Objectives.* Government of Ontario, Toronto

Ontario Ministry of Municipal Affairs and Housing. 2005a. *Greenbelt Plan.* Queen's Printer for Ontario.

Ontario Ministry of Municipal Affairs and Housing. 2005b. *Provincial Policy Statement.* Queen's Printer for Ontario.

Ontario Ministry of Municipal Affairs and Housing 1998. *Condominium Act.* Queen's Printer for Ontario 2006.

Ontario Ministry of Natural Resources. 2000. *Niagara Regional Municipality Fish Habitat Types with Management Rationale.* Niagara Area, Guelph District.

Ontario Ministry of Natural Resources. 2002. *Natural Heritage Information Centre.* Accessed online: nhic.mnr.gov.on.ca/MNR/nhic/areas, Date Visited: 21 September 2006.

Ontario Ministry of Natural Resources. 2004. *Conservation Land Tax Incentive Program.* Backgrounder

Ontario Ministry of Natural Resources. *Species at Risk.* Accessed online: http://www.mnr.gov.on.ca/mnr/speciesatrisk/, Date Visited: 15 October 2007.

Ontario Ministry of Natural Resources. 2007. *Bill 184, Endangered Species Act, 2007.* Legislative Assembly of Ontario.

Ontario Ministry of Public Infrastructure Renewal. 2006. *Places to Grow: A Guide to the Growth Plan for the Greater Golden Horseshoe.* Queen's Printer for Ontario.

Ontario Woodlot Association. 2005. *Success at Last! Changes to the Managed Forest Tax Incentive Program (MFTIP) Reward Woodlot Owners.* News Release.

Pollution Probe. 2004. *The Source Water Protection Primer.* Written in partnership with the Ontario Ministry of Environment. Toronto, Ontario.

Regional Municipality of Niagara. 2003. *Regional Municipality of Niagara Regional Agricultural Economic Impact Study.* Prepared for the Regional Municipality of Niagara by Planscape in association with Regional Analytics Incorporated, B. Donald, Riley and Associates, and DBH Soil Services Incorporated.

Regional Municipality of Niagara. 2003. *Niagara Water Quality Protection Strategy, Final Technical Report (Volume 2).* Prepared for the Regional Municipality of Niagara by MacViro, Philips Engineering and CH2MHill.

Regional Municipality of Niagara. 2006. *Niagara Water Strategy, Final Technical Report (Volume 2).* Prepared for the Regional Municipality of Niagara by MacViro, Philips Engineering and CH2MHill.

Regional Municipality of Niagara. 2006. *Niagara's Growth Management Strategy: Backgrounder; Charting Our Shared Future.* Accessed online: www.regional.niagara.on.ca/government/initiatives/2031/pdf/GMSBackgrounder.pdf. Date Visited: 21 January 2008.

Regional Municipality of Niagara. 2007. *Regional Niagara Policy Plan,* Thorold, Ontario

Riley, J.L., M.J. McMurtry, P.J. Sorrill, T.D. Sorrill, and J. Henson. 2003. *Big Picture 2002: Identifying Key Natural Areas and Linkages in Southern Ontario.* compact disc and poster. Natural Heritage Information Centre, Ontario Ministry of Natural Resources, Peterborough, Ontario, and Nature Conservancy of Canada, Toronto, Ontario.

TSH Engineers, Architects, Planners. March 2007. *Stormwater Management, Erosion, and Sediment Policies and Criteria. Draft Report.* Prepared for Niagara Peninsula Conservation Authority and Regional Municipality of Niagara.

Waterloo Hydrogeologic, Inc., Blackport and Associates, Blackport Hydrogeology Inc., CH2M Hill Canada Ltd., K. Bruce MacDonald Consulting, MacViro Consultants Inc., and Philips Engineering Ltd. 2005. *Niagara Peninsula Conservation Authority Groundwater Study Final Report.* Prepared for Niagara Peninsula Conservation Authority, Regional Municipality of Niagara, City of Hamilton and Haldimand County.

ACRONYMS

ALUS: Alternate Land Use Services
ANSI: Area of Natural and Scientific Interest
AOC: Area of Concern
BIOMAP: Biological Monitoring and Assessment Program
BMP: Best Management Practice
CLTIP: Conservation Land Tax Incentive Program
COSEWIC: Committee on the Status of Endangered Wildlife in Canada
COSSARO: Committee on the Status of Species at Risk in Ontario
E. COLI: *Escherichia coli*
EPA: Environmental Protection Agency
GTA: Greater Toronto Area
IJC: International Joint Commission
IPZ: Intake Protection Zone
LMA: Local Management Area
MFTIP: Managed Forest Tax Incentive Program
MNR: Ministry of Natural Resources
MOE: Ministry of the Environment
MTO: Ontario Ministry of Transportation
NPC: Niagara Parks Commission
NPCA: Niagara Peninsula Conservation Authority
NPSPC: Niagara Peninsula Source Protection Committee
NWS: Niagara Water Strategy
OFA: Ontario Federation of Agriculture
OMAFRA: Ontario Ministry of Agriculture, Food and Rural Affairs
OMNR: Ontario Ministry of Natural Resources
OMOE: Ontario Ministry of the Environment
PCB: Polychlorinated Biphenyls
PPS: Provincial Policy Statement
PSW: Provincially Significant Wetland
RAP: Remedial Action Plan
QEW: Queen Elizabeth Way

GLOSSARY

AREA OF CONCERN: An area is designated as an area of concern when it has been determined that the aquatic environment has been severely affected.

AREA OF NATURAL AND SCIENTIFIC INTEREST: 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 (Provincial Policy Statement 2005).

BEST MANAGEMENT PRACTICE: A land management practice implemented to control sources or causes of pollution. The 3 types of Best Management Practices that treat, prevent, or reduce water pollution include: structural, vegetative and managerial.

BIOENGINEERING: Combination of vegetative and structural practices to prevent erosion or stabilize slopes or stream banks.

BIOLOGICAL MONITORING AND ASSESSMENT PROGRAM: The use of benthic invertebrates as indicators of water quality.

CAROLINIAN LIFE ZONE: Also known as the Eastern Deciduous Forest Region, the Carolinian Life Zone stretches across southwestern Ontario from Toronto to Grand Bend. It is estimated that approximately one third of Canada's rare and endangered species are found within this zone.

COMMITTEE ON THE STATUS OF ENDANGERED WILDLIFE IN CANADA: Is an independent body responsible for identifying species that are considered to be at risk in Canada. Their findings are reported to the federal government who then determines which at-risk species qualify for protection under the Species At Risk Act (2003).

COMMITTEE ON THE STATUS OF SPECIES AT RISK IN ONTARIO: The provincial review process implemented by the Ontario Ministry of Natural Resources: also an independent body made up of non-OMNR members.

ECOLOGICAL FUNCTION: The natural processes, products, or services that living and non-living environments provide or perform within or between species, ecosystems and landscapes. These may include biological, physical and socio-economic interactions (Provincial Policy Statement 2005).

ELECTROFISHING: An in-stream fish sampling technique that uses an electric current and an electric field to temporarily immobilize fish allowing capture.

ENDANGERED SPECIES: A species facing imminent extinction or extirpation in Ontario which has been regulated under Ontario's Endangered Species Act (MNR No Date)

ENTRENCHED CHANNEL: A channel that has eroded downward or was constructed such that it no longer has access to its original floodplain during moderate flow events.

FISH HABITAT: means spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes (Fisheries Act, Section 31 (5)).

GEOMORPHIC: Relates to the physical properties of the rock, soil, and water in and around the stream.

INTAKE PROTECTION ZONE: The land or water area that is the most vulnerable around surface water intakes.

INTERNATIONAL JOINT COMMISSION: Is an independent binational organization established by the Boundary Waters Treaty of 1909 to help prevent and resolve disputes relating to the use and quality of boundary waters and to advise the United States and Canada and on related questions.

INTRINSIC SUSCEPTIBILITY: The vulnerability of the groundwater system to potential contamination from surface sources.

ISOSTATIC REBOUND: The upward movement of the earths crust following an increase of weight on the crustal surface from the weight of the glacier.

LOCAL MANAGEMENT AREA: As part of the Niagara Water Quality Protection Strategy, Niagara Peninsula Conservation Authority's district was divided into 32 Local Management Areas, each representing an ecologically valid and functioning water management unit derived from the over 140 subwatersheds in its jurisdiction.

MUNICIPAL DRAIN: Municipal drains can be either open watercourses or closed systems buried in the ground (i.e., tiles, pipes) designed and constructed to primarily improve drainage of agricultural lands, but also improve drainage of roads and rural lands.

NIAGARA WATER QUALITY PROTECTION STRATEGY: The strategy is part of a multi-stakeholder and multi-jurisdictional effort to work towards the common goal of management, restoration and protection of water resources across Niagara's watershed.

NUTRIENT MANAGEMENT ACT: Under this Act, farms must develop and implement a nutrient management strategy or a nutrient management plan. A nutrient management strategy is completed by non-agricultural and manure generators to manage the production, storage and use of manure and other nutrients produced and used on a farm. Nutrient management plans are completed for agricultural operations that apply nutrients to the land (OMAFRA and OMOE 2003). The purpose of proper nutrient management is to protect surface and ground water from contamination.

OLD GROWTH ECOSYSTEMS: the presence of old trees and their associated plants, animals, and ecological processes. They show little or no evidence of human disturbance (MNR 1994).

PHYSIOGRAPHY: The natural configuration of the landscape.

POTENTIOMETRIC SURFACE: The area where the ground surface intersects the water table

PROVINCIAL SIGNIFICANCE: Important on a provincial scale; this may refer to a species; a habitat; or a natural area.

PROVINCIALLY SIGNIFICANT WETLAND: A Class I, II and III Wetland identified as Provincially Significant as defined in 'An Evaluation System for Wetlands of Southern Ontario, South of the Precambrian Shield, Third Edition.'

SPECIES OF SPECIAL CONCERN: A species with characteristics that make it sensitive to human activities or natural events (MNR No Date).

THREATENED SPECIES: A species that is at risk of becoming endangered in Ontario if limiting factors are not reversed (MNR No Date)

WATERSHED: An area of land from which surface runoff (water, sediments, nutrients and contaminants) drain into a common water body.

WATERSHED MANAGEMENT PLAN: A proactive document created cooperatively by government agencies and the community to manage the water, land/water interactions, aquatic life and aquatic resources within a particular watershed to protect the health of the ecosystem as land uses change (Ministry of Environment and Energy and Ministry of Natural Resources 1993).

WETLANDS: 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. In either case the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic plants or water tolerant plants. The four major types of wetlands are swamps, marshes, bogs and fens (Provincial Policy Statement 2005).

WILDLIFE HABITAT: Areas where plants, animals and other organisms live, and find adequate amounts of food, water, shelter and space needed to sustain their populations. Specific wildlife habitats of concern may include areas where species concentrate at a vulnerable point in the annual or life cycle; and areas which are important to migratory or non-migratory species (Provincial Policy Statement 2005).

WOODLANDS: Treed areas that provide environmental and economic benefits to both the private landowner and the general public, such as erosion prevention, hydrological and nutrient cycling, provision of clean air and the long-term storage of carbon, provision of wildlife habitat, outdoor recreational opportunities, and the sustainable harvest of a wide range of woodland products (Provincial Policy Statement 2005).

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Suzanne McInnis: Watershed Planning Coordinator: Niagara Peninsula Conservation Authority

NIAGARA PENINSULA CONSERVATION AUTHORITY

SOUTH NIAGARA FALLS APPENDICES

APPENDIX A

LAND MANAGEMENT ISSUES AND AGRICULTURAL BEST MANAGEMENT PRACTICES

Please complete the following survey and return in the self-addressed, stamped envelope.

"The Niagara Peninsula Conservation Authority collects and uses your personal information pursuant to Section 29(2) of the Municipal Freedom of Information Act 1991, and under the legal authority of the Conservation authorities Act R.S.O. 1990 as amended." Questions regarding the policy or its administration should be directed to: Niagara Peninsula Conservation Authority, 250 Thorold Rd. W., 3rd Floor, Welland, ON L3C 2W3, Attn. Privacy Officer.

BACKGROUND INFORMATION

1. Please indicate the municipality in which you live.

❑ Fort Erie ❑ Niagara Falls ❑ Niagara-on-the-Lake ❑ Thorold ❑ Welland ❑ _____

2. Please indicate, based on the map provided, the watershed in which you live.

❑ Fort Erie Creeks ❑ Niagara-on-the-Lake ❑ South Niagara Falls

3. Please indicate the title that best describes your situation.

❑ Non-farm Landowner
❑ Landowner / Farm Operator
❑ Absentee Landowner
❑ Tenant Farm Operator
❑ Landowner / Farm Operator / Tenant Farm Operator
❑ Other (specify): _____

4. How much agricultural land do you currently own in the watershed? _____

5. How much agricultural land do you currently rent in the watershed? _____

6. How much land do you have in production? _____

and/or how many livestock do you have? _____

7. What type of agricultural commodity(s) do you produce? _____

8. Are you a member of any agricultural associations?

❑ Yes ❑ No

If yes, please specify the name of the organization(s): _____

9. Do you make land management decisions for property that borders a stream or creek?

❑ Yes ❑ No ❑ Not Sure

10. What is the source of your drinking water (e.g., water well, cistern)? _____

11. Do you rely on a septic system for wastewater treatment?

❑ Yes ❑ No

LAND MANAGEMENT ISSUES AND CONCERNS

12. Please rank your top three concerns related to your land.

A rank of 1 would represent your most important concern, a rank of 2 would represent your next most important concern, and a rank of 3 would represent the least of your top three most important concerns.

FIRST CONCERN: _____

_____

_____

SECOND CONCERN: _____

_____

_____

THIRD CONCERN: _____

_____

_____

13. Please estimate how much of a problem you think each of the following issues will be in the next 5 to 10 years.

ISSUE	NOT A PROBLEM	SLIGHT PROBLEM	MODERATE PROBLEM	SERIOUS PROBLEM	DO NOT KNOW
A. NITRATE, PHOSPHATE AND BACTERIA LEVELS IN STREAMS, RIVERS, AND LAKES	☐	☐	☐	☐	☐
B. NITRATE, PHOSPHATE AND BACTERIA LEVELS IN GROUNDWATER	☐	☐	☐	☐	☐
C. PESTICIDE LEVELS IN STREAMS, RIVERS AND LAKES	☐	☐	☐	☐	☐
D. PESTICIDE LEVELS IN GROUNDWATER	☐	☐	☐	☐	☐
E. SOIL DEPOSITION IN STREAMS, RIVERS AND LAKES	☐	☐	☐	☐	☐
F. DRINKING WATER QUALITY	☐	☐	☐	☐	☐
G. SOIL LOSS FROM AGRICULTURAL FIELDS	☐	☐	☐	☐	☐

APPENDIX A

ISSUE	NOT A PROBLEM	SLIGHT PROBLEM	MODERATE PROBLEM	SERIOUS PROBLEM	DO NOT KNOW
H. RIVERS AND STREAMS WITH ERODING BANKS	☐	☐	☐	☐	☐
I. SMELLS, NOISE, OR DUST FROM LIVESTOCK OPERATIONS	☐	☐	☐	☐	☐
J. SMELLS, NOISE OR DUST FROM NON-AGRICULTURAL BUSINESS	☐	☐	☐	☐	☐
K. SEEPAGE FROM SEPTIC TANKS ISSUE	☐	☐	☐	☐	☐
L. SOLID WASTE DISPOSAL	☐	☐	☐	☐	☐
M. FREQUENCY OF FLOODING	☐	☐	☐	☐	☐
N. ECONOMIC LOSSES DUE TO FLOODING	☐	☐	☐	☐	☐
O. ECONOMIC COSTS OF COMPLYING WITH LANDUSE REGULATIONS	☐	☐	☐	☐	☐
P. LOSS OF WETLANDS	☐	☐	☐	☐	☐
Q. LOSS OF FORESTED OR WOODED AREAS	☐	☐	☐	☐	☐
R. LOSS OF AGRICULTURAL LAND TO DEVELOPMENT	☐	☐	☐	☐	☐
S. LOSS OF AGRICULTURAL LAND TO NATURAL LAND	☐	☐	☐	☐	☐
T. LOSS OF NATURAL LAND TO DEVELOPMENT	☐	☐	☐	☐	☐
U. LOSS OF NATURAL LAND TO AGRICULTURAL PRODUCTION	☐	☐	☐	☐	☐
V. WELLS DRYING UP	☐	☐	☐	☐	☐
W. LOW SURFACE WATER CONDITIONS (DROUGHT)	☐	☐	☐	☐	☐
X. OTHER (PLEASE SPECIFY):	☐	☐	☐	☐	☐

_____

BEST MANAGEMENT PRACTICES AND RESTORATION RESOURCES

14. Which of the following Best Management Practices (BMPs) do you currently use? Please select all that apply and specify the specific BMP.

- ❑ Tillage and seeding practices: _____
- ❑ Erosion control: _____
- ❑ Crop rotations: _____
- ❑ Residue management: _____
- ❑ Nutrient management: _____
- ❑ Pest management and pesticides: _____
- ❑ Irrigation: _____
- ❑ Other (please specify): _____

15. In your opinion, how would you rate the availability of restoration/conservation resources in the watershed?

ISSUE	BAD	POOR	FAIR	GOOD	EXCELLENT	DO NOT KNOW
A. THE AVAILABILTY OF RESTORATION/ CONSERVATION FUNDING PROGRAMS	❑	❑	❑	❑	❑	❑
B. THE AVAILABILTY OF RESTORATION/ CONSERVATION TECHNICAL ASSISTANCE	❑	❑	❑	❑	❑	❑

16. List the restoration/conservation funding programs that you are aware of:

_____

_____

_____

_____

17. If funding was available, would you be interested in pursing a project on your property? If yes, please identify the type of project you would be interested in.

_____

_____

_____

_____

_____

_____

APPENDIX A

COMMUNICATION

18. How do you prefer to obtain information about watershed planning in your watershed? Please select all that apply.

- ❑ Local newspaper (please indicate which newspaper) _____
- ❑ Direct mail newsletter
- ❑ Email
- ❑ Website
- ❑ Meetings of local groups and organizations
- ❑ Other (please specify): _____
- ❑ None

19. Please provide any additional comments:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

THANK YOU

APPENDIX B

SCORING DESCRIPTIONS FOR STREAM VISUAL ASSESSMENT PROTOCOL

Below are the scoring descriptions for the Visual Assessment taken directly from the protocol (United States Department of Agriculture and Natural Resources Conservation Service, 1998).

CHANNEL CONDITION

Natural channel; no structures, dikes. No evidence of downcutting or excessive lateral cutting	Evidence of past channel alteration, but with significant recovery of channel and banks. Any dikes or levies are set back to provide access to an adequate flood plain.	Altered channel; <50% of the reach with riprap and/ or channelization. Excess aggradation: braided channel. Dikes or levees restrict flood plain width.	Channel is actively downcutting or widening. >50% of the reach with riprap or channelization. Dikes or levees prevent access to the flood plain.
10	**7**	**3**	**1**

HYDROLOGIC ALTERATION

Flooding every 1.5 to 2 years. No dams, no water withdrawals, no dikes or other structures limiting the stream's access to the flood plain. Channel is not incised.	Flooding occurs only once every 3 to 5 years; limited channel incision. **or** Withdrawals, although present, do not affect available habitat for biota.	Flooding occurs only once every 6 to 10 years; channel deeply incised. **or** Withdrawals significantly affect available low flow habitat for biota.	No flooding; channel deeply incised or structures prevent access to flood plain or dam operations prevent flood flows. **or** Withdrawals have caused severe loss of low flow habitat. **or** Flooding occurs on a 1 Year rain event or less.
10	**7**	**3**	**1**

RIPARIAN ZONE

Natural vegetation extends at least two active channel widths on each side.	Natural vegetation extends one active channel width on each side. **or** If less than one width, covers entire flood plain.	Natural vegetation extends half of the active channel width on each side.	Natural vegetation extends a third of the active channel width on each side. **or** Filtering function moderately compromised.	Natural vegetation less than a third of the active channel width on each side. **or** Lack of regeneration. **or** Filtering function severely compromised.
10	**8**	**5**	**3**	**1**

BANK STABILITY

Banks are stable; banks are low (at elevation of active flood plain): 33% or more of eroding surface area of banks in outside bends is protected by roots that extend to the base-flow elevation.	Moderately stable; banks are low (at elevation of active flood plain): less than 33% of eroding surface area of banks in outside bends is protected by roots that extend to the baseflow elevation.	Moderately unstable; banks may be low, but typically are high (flooding occurs 1 year out of 5 or less frequently); outside bends are actively eroding (overhanging vegetation at top of bank, some mature trees falling into stream annually, some slope failures apparent).	Unstable; banks may be low, but typically are high; some straight reaches and inside edges of bends are actively eroding as well as outside bends (overhanging vegetation at top of bare bank, numerous mature trees falling into stream annually, numerous slope failures apparent).
10	**7**	**3**	**1**

APPENDIX B

WATER APPEARANCE

Very clear, or clear but tea-coloured; objects visible at depth 3 to 6 feet (less if slightly coloured); no oil sheen on surface; no noticeable film on submerged objects or rocks.	Occasionally cloudy, especially after storm event, but clears rapidly; objects visible at depth 1.5 to 3 feet; may have slightly green color; no oil sheen on water surface.	Considerable cloudiness most of the time; objects visible to depth 0.5 top 1.5 feet; slow sections may appear pea-green; bottom rocks or submerged objects covered with heavy green or olive-green film **or** Moderate odor of ammonia or rotten eggs.	Very turbid or muddy appearance most of the time; objects visible to <0.5 feet; slow moving water maybe bright-green; other obvious water pollutants; floating algal mats, surface scum, sheen or heavy coat of foam on surface. **or** Strong odor of chemicals, oil, sewage, other pollutants.
10	**7**	**3**	**1**

NUTRIENT ENRICHMENT

Clear water along entire reach; diverse aquatic plant community includes low quantities of many species of macrophytes; little algal growth present.	Fairly clear or slightly greenish water along entire reach; moderate algal growth on stream substrates.	Greenish water along entire reach; overabundance of lush green macrophytes; abundant algal growth, especially during warmer months.	Pea-green, gray, or brown water along entire reach; dense stands of macrophytes clog stream; severe algal blooms create thick algal mats in stream.
10	**7**	**3**	**1**

BARRIERS TO FISH MOVEMENT

No barriers	Seasonal water withdrawals inhibit movement within the reach	Drop structures, culverts, dams, or diversions (<1 foot drop) within the reach	Drop structures, culverts, dams or diversions (>1 foot drop) within 3 miles of the reach	Drop structures, culverts, dams, or diversions (>1 foot drop) within the reach
10	**8**	**5**	**3**	**1**

INSTREAM FISH COVER

>7 cover types available	6 to 7 cover types available	4 to 5 cover types available	2 to 3 cover types available	None to 1 cover type available
10	**8**	**5**	**3**	**1**

Cover types: Logs/large woody debris, deep pools, overhanging vegetation, boulders/cobble, riffles, undercut banks, thick root mats, dense macrophye beds, isolated/backwater pools

other: _____

POOLS

Deep and shallow pools abundant; greater than 30% of the pool bottom is obscure due to depth, or the pools are least 5 feet deep	Pools present, but not abundant; from 10 to 30% of the pool bottom is obscure due to depth, or the pools are at least 3 feet deep	Pools present, but shallow; from 5 to 10% of the pool bottom is obscure due to depth, or the pools are less than 3 feet deep	Pools absent, or the entire bottom is discernible
10	**7**	**3**	**1**

APPENDIX B

INSECT/INVERTEBRATE HABITAT

At least 5 types of habitat available. Habitat is at a stage to allow full insect colonization (Woody debris and logs not freshly fallen)	3 to 4 types of habitat. Some potential habitat exists, such as overhanging trees, which will provide habitat, but have not yet entered the stream	1 to 2 types of habitat. The substrate is often disturbed, covered or removed by high stream velocities and scour or by sediment deposition	None to 1 type of habitat
10	**7**	**3**	**1**

Cover types: Fine woody debris, submerged logs, leaf packs, undercut banks, cobble, boulders, coarse gravel,

other: _____

CANOPY COVER (IF APPLICABLE)
WARMWATER FISHERY

25 to 90% of water surface shaded; mixture of conditions	>90% shaded; full canopy; same shading condition throughout the reach		<25% water surface shaded in reach
10	**7**		**1**

REACH NUMBER:	GENERAL LOCATION IN WATERSHED:	CHANNEL CONDITION:	HYDROLOGIC ALTERATION:	RIPARIAN ZONE:	BANK STABILITY:	WATER APPEARANCE:	NUTRIENT ENRICHMENT:	BARRIERS TO FISH MOVEMENT:	INSTREAM FISH COVER:	POOLS:	INVERTEBRATE HABITAT:	CANOPY COVER:	MANURE PRESENCE:	RIFFLE EMBEDDEDNESS:	OVERALL SCORE (TOTAL DIVIDED BY NUMBER SCORED)	RANK	SUSPECTED CAUSES OF OBSERVED PROBLEMS	RECOMMENDATIONS
BCMa	Bayers Creek at Sherk Road	5	4	10	3	1	4	10	5	7	6	10	n/a	n/a	5.9	Poor	Entrenched channel with limited access to floodplain; bare banks & exposed tree roots present; bank slumping indicates vegetation roots are too shallow; bank failure increases sediment load and turbidity impacting water quality & fish habitat	Do not grade banks too steep (dredging) so vegetation can become established and stabilize bank; plant deeper rooted vegetation; flooding conditions need to have access to floodplain to alleviate the erosive force of the water
BCTb	Bayers Creek at Sodom Road	5	4	3	7	n/a	7	10	3	3	1	1	n/a	n/a	4.4	Poor	Entrenched channel with limited access to floodplain; poor riparian buffer impacting habitat and canopy; some culverts partially blocked by debris	Do not grade banks too steep (dredging) so vegetation can become established and stabilize bank; increase size, variety, and diversity of native plant species in buffer; continue to monitor culverts so that they're clear of debris
GBMa	Grassy Brook at Montrose Road	8	7	8	5	5	3	10	7	8	7	n/a	n/a	n/a	6.8	Fair	Steep banks and bank erosion present in some areas; turbid water and algae identified during a site visit in 2007; ATV trails impact habitat and bank stability; bank erosion affecting 2 pedestrian bridges	Prevent/limit ATV trails adjacent to the stream to control bank erosion and stop additional sediment from entering the stream; replace pedestrian bridges due to safety issues; continue to monitor water quality in this watershed
GBMb	Grassy Brook at Crowland Avenue	8	8	6	7	7	6	10	6	7	7	10	n/a	n/a	7.5	Good	Poor riparian buffer in some areas; the presence of algae was noted during a site visit in 2007	Increase size, variety, and diversity of native plant species in buffer zone; continue to monitor water quality in this watershed
GBMc	Grassy Brook at Darby Road	8	8	5	7	n/a	n/a	10	4	3	4	1	n/a	n/a	5.5	Poor	Poor riparian buffer impacting habitat and canopy; at least 3 crossings present with no culvert	Increase size, variety, and diversity of native plant species in buffer; limit the number of crossings by installing a proper crossing
GBTa	Grassy Brook at Matthews Road	7	8	7	7	7	5	10	5	7	7	10	n/a	n/a	7.2	Fair	There is a location where there is no riparian buffer present and the adjacent land is well groomed which impacts cover and habitat	Create a riparian buffer using native plant species to create a more diverse ecological habitat
GBTb-headwater	Darby Road	5	7	1	3	n/a	n/a	10	1	1	1	1	n/a	n/a	3.3	Poor	Stream flows through agricultural field; no riparian buffer or channel canopy; no pools present; at least 3 crossings present with no culvert	Establish a riparian buffer along the length of the stream to increase cover and habitat; limit the number of crossings by installing a proper crossing

REACH NUMBER:	GENERAL LOCATION IN WATERSHED:	CHANNEL CONDITION:	HYDROLOGIC ALTERATION:	RIPARIAN ZONE:	BANK STABILITY:	WATER APPEARANCE:	NUTRIENT ENRICHMENT:	BARRIERS TO FISH MOVEMENT:	INSTREAM FISH COVER:	POOLS:	INVERTEBRATE HABITAT:	CANOPY COVER:	MANURE PRESENCE:	RIFFLE EMBEDDEDNESS:	OVERALL SCORE (TOTAL DIVIDED BY NUMBER SCORED)	RANK	SUSPECTED CAUSES OF OBSERVED PROBLEMS	RECOMMENDATIONS
HDMa	Hunters Drain at Sodom Road	8	7	8	5	7	5	10	7	7	7	10	n/a	9	7.5	Good	Bank erosion present in the form of bare banks and fallen vegetation (exposed roots and fallen/leaning vegetation can indicate channel widening); the presence of algae was noted during a site visit in 2007	Monitor bank erosion; continue to monitor water quality in this watershed
HDMb	Hunters Drain at Ort Road	7	7	4	7	n/a	n/a	10	3	1	2	10	n/a	n/a	5.7	Poor	Little variety and diversity of native plant species in buffer zone; a lack of fish cover, habitat types and deep pools; ATV trails within and across the stream	Increase variety and diversity of native plant species to create a more diverse ecological habitat, prevent/limit ATV trails to stop erosion and additional sediment from entering the stream
LCMa/ LCMb	Lyons Creek at McCredie Road	8	8	5	9	7	7	10	7	8	7	n/a	n/a	n/a	7.6	Good	Poor riparian buffer in some areas; vegetative debris being dumped adjacent to the stream	Increase variety & diversity of native plant species to create a more diverse ecological habitat where needed; due to the impact on water quality stop vegetative debris from being dumped adjacent to the stream
LCTb2	Lyons Creek at Carl Road	4	6	7	5	n/a	n/a	10	3	3	5	10	n/a	n/a	5.9	Poor	Entrenched channel with limited access to floodplain; fairly high width to depth ratio indicating sedimentation may be occurring; Trees growing within the channel and a number of debris jams indicate that the channel may be widening	Increase variety and diversity of native plant species to create a more diverse ecological habitat; flooding conditions need to have access to floodplain to alleviate the erosive force of the water
LCTb2-2	Lyons Creek at Crowland Road	8	8	5	7	6	5	10	4	3	6	10	n/a	n/a	6.5	Fair	Poor riparian buffer in some areas; fish cover and habitat are also poor; lack of deep pools; the presence of algae was noted during a site visit in 2007	Increase variety and diversity of native plant species to create a more diverse ecological habitat; continue to monitor water quality in this watershed
LCTc	Lyons Creek at McCredie Road	5	7	5	5	4	7	10	5	7	5	1	n/a	n/a	5.5	Poor	Bank slumping present; few to no trees present in upper portion of field site; the presence of algae and turbid water was noted during a site visit in 2007	Increase variety and diversity of native plant species to create a more diverse ecological habitat; deep rooted vegetation will help to stabilize the bank; continue to monitor water quality in this watershed

REACH NUMBER:	GENERAL LOCATION IN WATERSHED:	CHANNEL CONDITION:	HYDROLOGIC ALTERATION:	RIPARIAN ZONE:	BANK STABILITY:	WATER APPEARANCE:	NUTRIENT ENRICHMENT:	BARRIERS TO FISH MOVEMENT:	INSTREAM FISH COVER:	POOLS:	INVERTEBRATE HABITAT:	CANOPY COVER:	MANURE PRESENCE:	RIFFLE EMBEDDEDNESS:	OVERALL SCORE (TOTAL DIVIDED BY NUMBER SCORED)	RANK	SUSPECTED CAUSES OF OBSERVED PROBLEMS	RECOMMENDATIONS
LCTe	Lyons Creek at Schisler Road	4	3	6	7	7	7	10	3	7	3	1	n/a	n/a	5.3	Poor	Entrenched channel with limited access to floodplain; fairly high width to depth ratio indicating sedimentation may be occurring; bank erosion & rills present; poor cover & habitat types	Increase variety & diversity of native plant species to create a more diverse ecological habitat and limit the amount of sediment entering the channel; rill prevention measures should be implemented; flooding conditions need to have access to floodplain
LCTe-2	Lyons Creek at Old Schisler Road	7	10	1	8	8	7	10	1	1	1	10	n/a	n/a	5.8	Poor	Open field adjacent to stream (mowed to edge); lack of deep pools; fish cover and habitat types considered poor; landowner has concerns about property flooding	Increase variety and diversity of native plant species to create a more diverse ecological habitat; continually monitor culverts so that they're clear of debris and they should be properly sized
LCTf	Lyons Creek at Pearson Road	7	7	5	1	7	7	10	8	7	10	10	n/a	7	7.2	Fair	Bank erosion present (exposed roots & fallen vegetation, bare soil, and slumped soil); exposed roots and debris jams indicate that widening may be occurring; sediment deposition present	Increase variety and diversity of native plant species to create a more diverse ecological habitat; vegetation will control the amount of bank erosion and limit the amount of sediment entering the channel
LCTf – headwater	Lyons Creek at Buchener Road	10	8	10	10	n/a	n/a	10	5	5	7	10	n/a	n/a	8.3	Good	This is a headwater stream and therefore lacks a defined channel	No recommendations
LCTg	Lyons Creek at Doans Ridge/Lyons Creek Road	5	5	5	5	6	3	10	8	8	7	10	n/a	n/a	6.5	Fair	Entrenched channel with limited access to floodplain; bank erosion (exposed roots & fallen vegetation, bare banks); exposed roots & debris jams indicate that widening may be occurring; lack of buffer in some areas; high streambed slope; algae & duckweed	Increase variety and diversity of native plant species to create a more diverse ecological habitat; flooding conditions need to have access to floodplain to alleviate the erosive force of the water; continue to monitor water quality in this watershed
NRNineMa	Niagara River 9 at Niagara River Parkway	3	2	5	1	6	7	10	3	1	7	10	n/a	n/a	5.0	Poor	Entrenched channel with no access to floodplain; evidence of downcutting; little to no near bank vegetation; small buffer width on left bank; bank slumping present; vegetative debris being thrown over the bank & numerous debris jams present	Increase variety & diversity of native plant species in the buffer zone; flooding conditions need to have access to floodplain to alleviate erosive force of the water; due to impact on water quality need to stop throwing vegetative debris over the bank

REACH NUMBER:	GENERAL LOCATION IN WATERSHED:	CHANNEL CONDITION:	HYDROLOGIC ALTERATION:	RIPARIAN ZONE:	BANK STABILITY:	WATER APPEARANCE:	NUTRIENT ENRICHMENT:	BARRIERS TO FISH MOVEMENT:	INSTREAM FISH COVER:	POOLS:	INVERTEBRATE HABITAT:	CANOPY COVER:	MANURE PRESENCE:	RIFFLE EMBEDDEDNESS:	OVERALL SCORE (TOTAL DIVIDED BY NUMBER SCORED)	RANK	SUSPECTED CAUSES OF OBSERVED PROBLEMS	RECOMMENDATIONS
NRThirteen Ma	Niagara River 13 at Niagara River Parkway	6	10	1	1	n/a	n/a	10	1	1	1	1	n/a	n/a	3.6	Poor	Bare sediment exposed along bed & bank (stream flows through agricultural field); fairly high width to depth ratio indicates sedimentation may be occurring; 3 crossings present (no culvert); lack of buffer, canopy & deep pools results in poor habitat	Increase variety & diversity of native plant species to create a more diverse ecological habitat; vegetation will control the amount of bank erosion & limit the amount of sediment entering the channel; crossings should be limited by creating a proper one
NRTwelve Ma	Niagara River 12 at Willoughby Drive/ Somerville Road	6	10	8	7	n/a	n/a	10	3	1	7	10	n/a	n/a	6.9	Fair	Fairly high width to depth ratio indicating sedimentation may be occurring; bare soil exposed in near bank zone; trees growing within the channel & the presence of debris jams may indicate widening; no deep pools present	Increase the variety and diversity of native plant vegetation in near bank zone; vegetation will control the amount of bank erosion and limit the amount of sediment entering the channel
TCMa/ TCMb/ TCTa	Tee Creek at Montrose Road/Yokom Road	3	5	8	4	3	3	10	4	4	6	1	n/a	n/a	4.6	Poor	Entrenched channel with limited access to floodplain; banks are bare in some areas; the downstream was re-aligned by a landowner; presence of algae, oil sheen, and odour from disturbed sediment was noted during a site visit in 2007	Increase the variety & diversity of native plant vegetation in near bank zone; do not grade banks too steep (dredging) so vegetation can become established & stabilize banks (also need access to floodplain); continue to monitor water quality in watershed
TCMb	Tee Creek at Koabel Road	5	5	5	5	3	5	10	3	7	3	1	n/a	n/a	4.7	Poor	Entrenched channel with limited access to floodplain; banks are bare in some areas; sediment deposition occurring downstream of Koabel Road bridge; algae, duckweed, and turbid water identified during site visits in 2006 and 2007	Increase the variety & diversity of native plant vegetation in near bank zone; do not grade banks too steep (dredging) so vegetation can become established & stabilize bank (also need access to floodplain); continue to monitor water quality in watershed
TCMc	Tee Creek at Schaubel Road	5	3	5	7	n/a	n/a	10	5	3	5	1	n/a	n/a	4.8	Poor	Entrenched channel with limited access to floodplain; buffer vegetation is mostly herbaceous; few pools present	Increase the variety and diversity of native plant vegetation in near bank zone; do not grade banks too steep (dredging) so vegetation can become established and stabilize bank (also need access to floodplain)
TCMd	Tee Creek at White Road	6	10	8	7	7	7	10	4	3	7	10	n/a	n/a	7.2	Fair	Wetland area; trees in middle of channel which may indicate widening; blocked culvert may be contributing to widening; duckweed identified during site visit in 2007	Unblock culvert so that water can flow freely through it

REACH NUMBER:	GENERAL LOCATION IN WATERSHED:	CHANNEL CONDITION:	HYDROLOGIC ALTERATION:	RIPARIAN ZONE:	BANK STABILITY:	WATER APPEARANCE:	NUTRIENT ENRICHMENT:	BARRIERS TO FISH MOVEMENT:	INSTREAM FISH COVER:	POOLS:	INVERTEBRATE HABITAT:	CANOPY COVER:	MANURE PRESENCE:	RIFFLE EMBEDDEDNESS:	OVERALL SCORE (TOTAL DIVIDED BY NUMBER SCORED)	RANK	SUSPECTED CAUSES OF OBSERVED PROBLEMS	RECOMMENDATIONS
TCMd-2	Tee Creek at Forkes Road	6	7	8	5	7	7	10	6	7	7	10	n/a	n/a	7.3	Fair	Little to no near bank vegetation; debris jams, trees growing within the channel & at the toe of the bank indicate channel widening may be occurring	Increase variety and diversity of native plant species to create a more diverse ecological habitat
TCTa	Tee Creek at Crowland Avenue/ Misener Road	7	8	8	6	n/a	n/a	10	5	3	7	10	n/a	n/a	7.1	Fair	Channel is not strongly defined; width to depth ratio fairly high indicating sedimentation may be occurring; few pools present; 3 crossings at this site with no culvert; small buffer zone adjacent to residential properties	Increase buffer zone adjacent to houses and create more pools to increase habitat and cover along the stream bed; limit the number of crossings by installing a proper crossing
TCTa-2	Tee Creek at Montrose Road	6	10	4	8	n/a	n/a	10	3	3	5	1	n/a	n/a	5.6	Poor	Channel is not strongly defined; poor riparian buffer due to adjacent agricultural field and also a lack of trees; 1 crossing with no culvert present	Increase variety and diversity of native plant species to create a more diverse ecological habitat; limit the number of crossings by installing a proper crossing
TCTb	Tee Creek at Ridge Road	6	7	5	3	n/a	5	10	5	6	8	1	n/a	n/a	5.6	Poor	Poor riparian buffer due to adjacent agricultural field and also a lack of trees; bank erosion present (undercut banks, bare soil, slumping); large stones seem to be used as bank protection; landowners have mentioned problems with drainage	Increase variety & diversity of native plant species to create a more diverse ecological habitat; severe bank erosion occurring at channel bends should be properly stabilized; continually monitor culverts so that they're clear of debris & sized properly
TCTbA	Tee Creek at McKenney Road	5	5	5	7	1	1	10	3	4	5	1	n/a	n/a	4.3	Poor	Entrenched channel with limited access to floodplain; stationary water & sediment deposition present in upstream section; slumping present in upstream section; poor riparian buffer; algae, turbidity, and an odour from disturbed sediment identified in 2007	Increase the variety & diversity of native plant vegetation in buffer zone; vegetation will control the amount of bank erosion & limit the amount of sediment entering the channel; channel needs access to floodplain; continue to monitor water quality
TCTbA-2	Tee Creek at Netherby Road/Morris Road	6	8	8	7	5	3	10	5	5	6	10	n/a	n/a	6.6	Fair	Poor riparian buffer present; sediment deposition occurring; algae and an odour from disturbed sediment identified during a site visit in 2007	Increase the variety & diversity of native plant vegetation in buffer zone; vegetation will limit the amount of sediment entering the channel and provide cover & habitat; continue to monitor water quality in this watershed

REACH NUMBER:	GENERAL LOCATION IN WATERSHED:	CHANNEL CONDITION:	HYDROLOGIC ALTERATION:	RIPARIAN ZONE:	BANK STABILITY:	WATER APPEARANCE:	NUTRIENT ENRICHMENT:	BARRIERS TO FISH MOVEMENT:	INSTREAM FISH COVER:	POOLS:	INVERTEBRATE HABITAT:	CANOPY COVER:	MANURE PRESENCE:	RIFFLE EMBEDDEDNESS:	OVERALL SCORE (TOTAL DIVIDED BY NUMBER SCORED)	RANK	SUSPECTED CAUSES OF OBSERVED PROBLEMS	RECOMMENDATIONS
TCTbA-3	Tee Creek at Misener Road	6	7	5	4	n/a	5	10	5	5	7	10	n/a	n/a	6.4	Fair	Poor riparian buffer due to size and adjacent agricultural field; bank erosion present; failed culvert below driveway; 1 crossing with no culvert	Increase the variety & diversity of native plant vegetation in buffer zone; vegetation will limit the amount of sediment entering the channel and provide cover & habitat; erosion at channel bends should be properly stabilized; replace failed culvert
UCMa	Usshers Creek at Niagara River Parkway	7	5	8	8	8	7	10	5	7	7	10	n/a	n/a	7.5	Good	Poor riparian buffer in certain areas; duckweed identified during a site visit in 2006	Increase the amount of woody vegetation in the near bank zone; increase the size of the riparian buffer in certain locations to prevent erosion and provide cover and habitat
UCMc	Usshers Creek at Marshall Road	6	7	3	8	5	5	10	3	7	3	1	n/a	n/a	5.3	Poor	Entrenched channel with limited access to floodplain; fairly high width to depth ratio indicating sedimentation may be occurring; few trees in buffer zone; algae, duckweed, and a sheen identified during a site visit in 2007	Do not grade banks too steep (dredging) so vegetation can become established and stabilize bank (channel needs access to floodplain); vegetation will increase habitat and cover; continue to monitor water quality in this watershed
UCMc-2	Usshers Creek at Ort Road	4	4	7	3	3	7	10	5	8	7	10	n/a	n/a	6.2	Fair	Entrenched channel with limited access to floodplain; areas with high width to depth ratio indication sedimentation may be occurring; a slight sheen, duckweed, and algae identified during site visit 2007	Do not grade banks too steep (dredging) so vegetation can become established and stabilize bank (channel needs access to floodplain); vegetation will increase habitat and cover; continue to monitor water quality in this watershed
UCMd	Usshers Creek at Bossert Road	5	3	10	5	8	7	10	8	7	7	10	n/a	n/a	7.3	Fair	A section of channel is entrenched with limited access to floodplain, numerous debris jams present here indicating widening; the majority is a flat area with wetland type vegetation	Do not grade banks too steep (dredging) so vegetation can become established and stabilize bank (channel needs access to floodplain); increase the amount of wetland vegetation to provide habitat
UCTb	Usshers Creek at Sodom Road	4	6	8	5	8	5	10	3	3	5	10	n/a	n/a	6.1	Fair	Entrenched channel with limited access to floodplain; fairly high width to depth ratio & the presence of deep sediment deposits indicate that sedimentation is occurring; numerous debris jams indicate widening may be occurring; algae identified 2007	Do not grade banks too steep (dredging) so vegetation can become established and stabilize bank (channel needs access to floodplain); vegetation will provide cover and habitat; continue to monitor water quality in this watershed
UCTb-2	Usshers Creek at Sodom Road	4	3	7	7	n/a	5	10	7	5	7	7	n/a	n/a	6.2	Fair	Entrenched channel with no access to floodplain; high width to depth ratio in areas indicating sedimentation may be occurring; bank erosion present (exposed roots, bare soil, slumped soil); algae identified during site visit in 2007	Do not grade banks too steep (dredging) so vegetation can become established and stabilize bank (channel needs access to floodplain); vegetation will provide cover and habitat; continue to monitor water quality in this watershed

SOUTH NIAGARA FALLS WATERSHED REACH LOCATION

APPENDIX C

The following is a list of potential best management practices for the South Niagara Falls watershed. For further information on Niagara Region's and NPCA's policies regarding stormwater management, please refer to *Stormwater Management, Erosion, and Sediment Policies and Criteria: Draft Report March 2007.*

BEST MANAGEMENT PRACTICES MENU

MANAGEMENT ALTERNATIVE	DESCRIPTION
STORMWATER BEST MANAGEMENT PRACTICES	
RETROFIT EXISTING STORMWATER BASINS	Modify older basins that were designed to control only the 100-year storm into multi-functional stormwater wetlands or conventional wet ponds.
RETROFIT EXISTING DETENTION DEVICES	Modify to incorporate forebays. Sediment forebays allow polluted sediments to settle out before water is discharged into the detention pond, thereby increasing treatment time and capacity.
RETROFIT INFILTRATION DEVICES	Where soil permeability and depth to groundwater are sufficient, infiltration measures such as permeable pavement and infiltration trenches should be considered for introduction.
INFILTRATION TRENCH OR DRY WELL	Design new developments to include an infiltration trench, which receives runoff in a shallow excavated trench that has been backfilled with stone to form a below-grade reservoir. Water can then slowly infiltrate into the soil.
OFF-LINE INFILTRATION BASIN	In new development areas design drainage corridors to include an infiltration basin which is not part of the main channel to capture water and allow it to slowly infiltrate into the soil.
EXTENDED DETENTION DRY BASIN	Design new developments to include stormwater basins that capture water and detain it for 24-40 hours before releasing it.
CATCH BASINS	Catch basins hold sediment as it enters the stormwater pipe system, but once it becomes full of sediment, it can no longer catch sediment. Therefore, basins should be cleaned twice annually.
PERVIOUS CATCH BASINS	These are normal catch basins with a large sump connected to an exfiltration storage area. The storage area may be located either directly below the catch basin floor through a series of holes or beside the catch basin where low flows discharge through the wall of the catch basin into the exfiltration storage area.
WET POND	In new development areas. include wet ponds that use a permanent storage pool to capture or transform dissolved pollutants, thereby holding water and releasing it slowly back to the environment. Wet ponds also reduce peak flows and assist in sedimentation control.
DRY PONDS	Dry ponds only contain water during runoff events and for the length of time it takes for draw down. Dry ponds also provide storage, reduce peak flows, as well as assist in sedimentation control and pollutant removal.
SAND FILTERS	Sand filters can be used for smaller developments and urban areas with limited open space. This system uses sand in an underground catchment to filter stormwater.
GREEN PARKING LOTS	Install new bioretention areas, infiltration areas, underground vaults, or other practices to detain and clean parking lot storm water before discharging. Encourage businesses to share parking space, require that vegetated spaces in parking lots be used to treat stormwater, encourage mass transit, encourage permeable spillover parking.
POROUS PAVING FOR LOW TRAFFIC ROADWAYS AND PATHWAYS	Parking areas, fire lanes, and bicycle paths that consists of open-graded asphalt on a crushed stone base are capable of absorbing water, reducing the amount of runoff entering the storm sewers.

APPENDIX C

BEST MANAGEMENT PRACTICES MENU

MANAGEMENT ALTERNATIVE	DESCRIPTION
STORMWATER BEST MANAGEMENT PRACTICES	
"DAYLIGHTING" STORM SEWERS	Eliminate a storm sewer or culvert and replace it with an open, vegetated channel.
VEGETATED SWALES VS. CURB AND GUTTER	Where density, topography, soils, and slope permit, vegetated open channels should be used in the street right-of-way to convey and treat stormwater runoff instead of curb and gutter systems.
VEGETATED SWALE	Compared to storm sewers, overland flow offers longer contact time with the soil and allows settling of pollutants, nutrient uptake by vegetation and complete infiltration of smaller events.
ROAD AND HIGHWAY RUNOFF IMPROVEMENTS	Construct stormwater wetlands, pond systems, grassed swales, natural vegetation in highway rights-of-way open space.
RURAL/URBAN BEST MANAGEMENT PRACTICES	
CONSERVATION TILLAGE/AGRICULTURAL FILTER STRIPS/BUFFER AND FILTER STRIPS	Alter agricultural practices to encourage naturally vegetated buffers/filters around streams and rivers. Discourage landowners adjacent to watercourse from mowing to streambank.
LAWN DEBRIS MANAGEMENT	Grass trimmings and leaf litter can be controlled by composting or by community curb side collection programs. Compost can be converted to mulch, which when applied in lieu of fertilizer, can reduce nutrient excess into watercourses.
PROTECT RECEIVING WATERS FROM BANK EROSION	Stabilize existing steep slopes with bioengineering methods, and preserve and plant trees along streams to reduce bank erosion.
STREAM CHANNEL RESTORATION/STABILIZATION	Construct pipe outlets and bank stabilization measures to prevent streambank erosion due to excessive discharge velocities (usually bioengineered).
CONSTRUCTED WETLAND	Build wetlands to capture pollutants from runoff draining urban and agricultural areas. Wetlands differ from basins in that they are shallower, and are planted with wetland plants to filter the water.
RAIN BARRELS	Rain barrels can be used to catch rooftop runoff for later use (e.g. watering gardens and lawns)
DOWNSPOUT DISCONNECTION	Disconnecting downspouts from storm drains or directing them away from paved surfaces that lead directly to the stormwater system allows water to infiltrate into unpaved soils. An education and incentive program should also be created for this alternative.
NATIVE LANDSCAPING AND/OR TREE PLANTING	This measure includes planting street trees, and planting trees and plants in parking lot medians or in other landscapes. They can be designed so water flows into these areas before flowing into the stormwater system. Native plants do not need fertilizers, irrigation, or mowing, which can reduce phosphorus and possibly runoff.
ENCOURAGE DIVERSE NON-TURF VEGETATION AT STORMWATER BASIN EDGES	Educate landowners to allow long grasses and wetland plants to flourish in stormwater basins to filter the waste of, and discourage large populations of, waterfowl.

APPENDIX C

BEST MANAGEMENT PRACTICES MENU

MANAGEMENT ALTERNATIVE	DESCRIPTION
PLANNING AND DEVELOPMENT	
ESTABLISH BETTER ENFORCEMENT, FINES TO ENSURE COMPLIANCE	May include hiring more staff to inspect and enforce regulations.
IMPROVE SEPTIC SYSTEM MAINTENANCE	Require septic system inspection and compliance at point-of-sale; encourage regular maintenance through incentive and/or education programs. Identify any currently failing systems so they can be fixed.
NEW/REVISED ZONING BY-LAWS	If necessary, a zoning by-law should be created, or revised, to meet water quality/quantity needs so that planning decisions based on that by-law are defensible.
CONDUCT ZONING BY-LAW REVIEW	Establish a committee to conduct a formal review of zoning by-laws from a planning perspective for open space and natural features protection/restoration.
ADOPT STORMWATER POLICIES FOR NEW DEVELOPMENTS	This policy tool can be used to control and treat stormwater discharges whereas stormwater management must be addressed before building permits are issued.
ENCOURAGE AND/OR REGULATE LANDUSE PLANNING AND MANAGEMENT	Develop policies limiting pavement, preserving open space, defining locations for more on-site storm water management facilities, and zoning/sizing criteria for on-site facilities.
INTEGRATE NATURAL FEATURES INTO THE PLANNING PROCESS	Through overlay zoning and other methods, valuable natural features should be taken into account when zoning and making planning decisions where such policies are not present. Coordination with municipalities in this area is necessary to preserve systems of open space, and reduce fragmentation of the natural complex of woodlands, prairies and other natural water filtering systems.
ENCOURAGE OPEN SPACE SITE DESIGN	Reduction in lot size to preserve common open space of woodlands and wetlands; shared driveways, chipped paths, swales, reduction in road widths, and so forth.
NEW/REVISED MASTER PLANS	If substantial changes are made to implement stormwater quantity and quality measures, the master plan should be revisited so that it upholds the changes in natural features inventories, zoning priorities and so forth to ensure that stormwater measures are not in conflict with the master plan.
DOWNZONING	Changes an established zone to a lower density level or less intense use. Can be used on strips of land adjacent to waterways to provide a buffer between industrial sites and the streambank or on a whole area surrounding a water body to reverse or prevent pollution.
ENCOURAGE AND/OR REGULATE LAND USE PLANNING AND MANAGEMENT	Develop policies limiting pavement, preserving open space, defining locations for more on-site storm water management facilities, and zoning/sizing criteria for on-site facilities.
PUBLIC EDUCATION AND PARTICIPATION	
STORM DRAIN STENCILLING PROGRAM – TROUT UNLIMITED "YELLOW FISH" PROGRAM	Residents are frequently unaware that materials dumped down storm drains may be discharged to a local water body. Stencilling can create awareness and prevention.
CITIZEN MONITORING (ADOPT-A-STREAM PROGRAM)	Citizen groups can collect valuable information on basic parameters – they can monitor and identify problems, collect surface water samples, and measure turbidity.

APPENDIX C

BEST MANAGEMENT PRACTICES MENU

MANAGEMENT ALTERNATIVE	DESCRIPTION
PUBLIC EDUCATION AND PARTICIPATION	
PROMOTION OF NPCAs WATER QUALITY IMPROVEMENT PROGRAM AND FUNDING OPPORTUNITIES FOR LANDOWNERS	This program guides restoration activities in the watershed, educates land-owners on how to do restoration and/or manage their land, organizes volunteers, and encourages stewardship.
PROMOTE INCENTIVE PROGRAMS FOR PRESERVATION OF FARMLAND, WOODED AREAS AND OPEN SPACE	Work with agencies, organizations and individuals to promote incentive programs such as Conservation Land Tax Incentive Program, Managed Forest Tax Incentive Program and Farm Property Tax Class Tax Rate.
REDUCE EXCESS FERTILIZER NUTRIENTS APPLIED TO LAWNS	Change excessive homeowner and golf course lawn fertilizer application habits by educating homeowners and managers about proper soil testing and lawn care practices.
REDUCE/APPLY ONLY APPROPRIATE LEVEL OF FERTILIZER TO FARM FIELDS	Educate farmers and/or offer incentives to have soils tested for the appropriate application of fertilizers.
DEVELOP AN EDUCATION PROGRAM TO ENCOURAGE PROPER SEPTIC SYSTEM MAINTENANCE	Proper maintenance of septic systems is essential in preventing septic failure, which pollutes natural water systems. Landowners must refrain from inappropriate plantings and uses on the septic field, and periodically arrange for the removal of solids from the system.
UTILIZE PARKS AND PUBLIC LAND FOR HANDS-ON EDUCATIONAL PROJECTS	Public places, especially along a watercourse/wetland, provide opportunities for public involvement and education. Projects could include streambank stabilization, native planting, invasive plant removal, logjam removal, wetland creation and so forth.
USE RECREATIONAL AREAS AS DEMONSTRATION/EDUCATION OPPORTUNITIES	In park areas, develop educational signage (watershed awareness, natural vegetation and so forth) and/or create a demonstration/interpretive area to illustrate natural landscaping, detention basin landscaping, and wetlands to teach about best management practices.
WATERSHED SIGNS/PROJECT SIGNS	Signs can be used to mark watershed boundaries, identify critical areas, promote specific behaviours in specific places, identify co-operators in a project, explain a project and its BMPs, and provide interpretive natural resources information.
NEWSPAPER ARTICLES	Newspaper articles provide detail about local success stories, photos of citizen activities, and feature stories which provide information about problems and solutions. They can also be used to announce meetings or public involvement opportunities.
NEWSLETTERS	Newsletters are a good way to provide key messages and contribute a series of watershed management articles. They can also be used to announce meeting times and dates, update information on actions already taken, and list issues to be discussed at upcoming meetings.
MEETINGS/OPEN HOUSES	Public gatherings, club meetings, special conferences, and workshops can be used to explain a program and receive input, share information, plan actions, and evaluate progress.
EVENTS	Watershed displays should be set up at every opportunity: fairs, local Earth Day events, conferences, and school events.
AWARDS	Recognize good work and gain a variety of advocates for your program though conservation awards for young people, public service awards, and participation and sponsorship awards.

APPENDIX C

BEST MANAGEMENT PRACTICES MENU

MANAGEMENT ALTERNATIVE	DESCRIPTION
PUBLIC EDUCATION AND PARTICIPATION	
USE A WEBSITE TO HOST INFORMATION	Develop a 15-16-18 Mile Creeks Watershed website to keep agencies, organizations, and others updated about restoration programs.
TRAINING/WORKSHOPS/ PRESENTATIONS	Many times, people do not change their habits and behaviours because they do not know what to do instead (composting, native landscaping, no-phosphorus lawn care, and so forth).
INVOLVE SCHOOLS	Make presentations to classes or conduct field trips. Find out what schools are already doing and see how water quality education can fit into the curriculum.
FORM A COMMITTEE/TASK FORCE OF CITIZENS	Create a committee to work on specific aspects of the watershed program; try to include representatives from all interest groups.

APPENDIX D

Restoration guidelines for riparian, wetland and forest habitat as recommended by Environment Canada (2005) in its *'How Much Habitat is Enough?'* document. This framework was used as a guideline in the South Niagara Falls Restoration Strategy.

SOUTH NIAGARA FALLS RIPARIAN HABITAT GUIDELINES

RIPARIAN HABITAT GUIDELINES	
PARAMETER	GUIDELINE
PERCENT OF STREAM NATURALLY VEGETATED	75 percent of stream length should be naturally vegetated.
AMOUNT OF NATURAL VEGETATION ADJACENT TO STREAMS	Streams should have a minimum 30 metre wide naturally vegetated adjacent-lands area on both sides; Greater depending on site-specific conditions.
TOTAL SUSPENDED SEDIMENTS	Where and when possible, suspended sediment concentrations should be below 25 milligrams/litre or be consistent with Canadian Council of Ministers of the Environment (1999) guidelines.
PERCENT OF AN URBANIZING WATERSHED THAT IS IMPERVIOUS	Less than 10 percent imperviousness in an urbanizing watershed should maintain stream water quality and quantity, and preserve aquatic species' density and biodiversity. An upper limit of 30 percent represents the threshold for degraded systems.
FISH COMMUNITIES	Watershed guidelines for fish communities can be established based on knowledge of underlying characteristics of a watershed (e.g., drainage area, surficial geology, flow regime), historic and current fish communities, and factors (and their relative magnitudes) that currently impact the system.

APPENDIX D

SOUTH NIAGARA FALLS WETLAND HABITAT GUIDELINES

WETLAND HABITAT GUIDELINES	
PARAMETER	GUIDELINE
PERCENT WETLANDS IN WATERSHEDS AND SUBWATERSHEDS	Greater than 10 percent of each major watershed in wetland habitat; greater than 6 percent of each subwatershed in wetland habitat; or restore to original percentage of wetlands in the watershed.
AMOUNT OF NATURAL VEGETATION ADJACENT TO THE WETLAND	For key wetland functions and attributes, the identification and maintenance of the Critical Function Zone and its protection, along with an appropriate Protection Zone is the primary concern. Where this is not derived from site-specific characteristics, the following are minimum guidelines: Bog – the total catchment area Marsh – 100 metres Fen – 100 metres or as determined by hydrogeological study Swamp – 100 metres
WETLAND TYPE	The only 2 wetland types suitable for widespread rehabilitation are marshes and swamps.
WETLAND LOCATION	Wetlands can provide benefits anywhere in the watershed, but particular wetland functions can be achieved by rehabilitating in key locations, such as headwater areas for groundwater discharge and recharge, flood plains for flood attenuation, and coastal wetlands for fish production. Special attention should be paid to historic wetland locations or site and soil conditions.
WETLAND SIZE	Wetland of a variety of sizes, types, and hydroperiods should be maintained across a landscape. Swamps and marches of sufficient size to support habitat heterogeneity are particularly important.
WETLAND SHAPE	As with upland forests, in order to maximize habitat opportunities for edge-tolerant species, and where the surrounding matrix is not natural habitat, swamps should be regularly shaped with minimum edge and maximum interior habitat.

APPENDIX D

SOUTH NIAGARA FALLS FOREST HABITAT GUIDELINES

FOREST HABITAT GUIDELINES	
PARAMETER	GUIDELINE
PERCENT FOREST COVER	At least 30 percent of the watershed should be in forest cover.
SIZE OF LARGEST FOREST PATCH	A watershed or other land unit should have at least one 200 hectare forest patch that is a minimum 500 metres in width.
PERCENT OF WATERSHED THAT IS FOREST COVER 100 METRES AND 200 METRES FROM FOREST EDGE	The proportion of the watershed that is forest cover 100 metres or further from the forest edge should be greater than 10 percent. The proportion of the watershed that is forest cover 200 metres further from the forest edge should be greater than 5 percent.
FOREST SHAPE	To be of maximum use to species such as forest-breeding birds that are intolerant to edge habitat, forest patches should be circular or square in shape.
PROXIMITY TO OTHER FORESTED PATCHES	To be of maximum use to species such as forest-breeding birds, forest patches should be within 2 to 1 kilometre of one another or other supporting habitat features.
FRAGMENTED LANDSCAPES AND THE ROLE OF CORRIDORS	Connectivity width will vary depending on the objectives of the project and the attributes of the nodes that will be connected. Corridors designed to facilitate species movement should be a minimum of 50 metres to 100 metres in width. Corridors designed to accommodate breeding habitat for specialist species need to be designed to meet the habitat requirements of those target species.
FOREST QUALITY – SPECIES COMPOSITION AND AGE STRUCTURE	Watershed forest cover should be representative of the full diversity of forest types found at that latitude.

APPENDIX E

SPECIES REFERENCE LIST

SCIENTIFIC NAME	COMMON NAME
Justicia americana	American Water-willow
Peltandra virginica	Arrow-arum
Haliaeetus leucocephalus	Bald eagle
Nycticorax nycticorax)	Black-crowned Night-heron
Nyssa sylvatica	Black Gum
Emys blandingii	Blandings Turtle
Juglans cinerea	Butternut
Cephalanthus occidentalis	Buttonbush
Dendroica cerulea	Cerulean Warbler
Cornus florida	Flowering Dogwood
Esox americanus vermiculatus	Grass Pickerel
Moxostoma valenciennesi	Greater Redhorse
Polygonum arifolium	Halberd-leaved Tear-thumb
Carex hirsutella	Hirsute Sedge
Erimyzon sucetta	Lake Chubsucker
Saururus cernuus	Lizards Tail
Triadenum virginicum	Marsh St. John's wort
Carya tomentosa	Mockernut hickory
Asimina triloba	Pawpaw
Carya glabra	Pignut Hickory
Quercus palustris	Pin Oak
Smilax rotundifolia	Round-leaved Greenbrier
Mimulus alatus	Sharp-wing Monkeyflower
Carya laciniosa	Shellbark Hickory
Quercus shumardii	Shumard Oak
Agrimonia parviflora	Small-flower Groovebur
Cuscuta polygonorum	Smartweed Dodder
Bryoandersonia illecebra	Spoon-leaved Moss
Eupatorium purpureum	Sweet Joe-pye-weed
Carex seorsa	Weak Stellate Sedge
Panicum villosissimum	Whitehair Witchgrass
Aster divaricatus	White Wood Aster
Icteria virens	Yellow-breasted Chat

RESTORATION SUITABILITY CRITERIA: RIPARIAN HABITAT

HABITAT: RIPARIAN	RATIONALE	METHODOLOGY	REFERENCE
CRITERIA: PROXIMITY TO WATERCOURSE/WATERBODY *(edgedr)* 3 ≤ 30m 2 > 30m & < 50m 1 ≥ 50m	Areas within closest proximity to watercourses or waterbodies will be most suitable to restoration. These areas contribute to both riparian buffer and floodplain. Restoration in these areas will improve hydrological, habitat and water quality functions.	Generate straight line distance surface from watercourses and waterbodies. Reclassify surface values where lowest distances have highest suitability values, reflecting riparian and floodplain location.	Niagara River AOC RAP Riparian Habitat Guidelines
CRITERIA: LAND USE TYPE *(lurwood)* 3 Woodland, Wetland, Scrub, Low Intensity Agriculture 2 Recreational, Residential, High Intensity Agriculture 1 Industrial, Built Up Urban	In terms of potential conflict, existing land use type is scaled in terms of suitability to restoration. Areas classified as scrub, low intensity agriculture, or natural are much more suitable to restoration than areas classified as industrial or built-up urban.	Generate Land Use surface on Land Use Type value. Reclassify Land Use values where low conflict land use types have higher suitability values than high conflict land use types.	Niagara Peninsula Conservation Authority
CRITERIA: SLOPE *(slopedr)* 3 ≥ 10 degrees 2 < 10 degrees 1 0 degrees	Considers the presence of vegetation in terms of hydrological and mechanical contribution to bank stability and erosion control. As slope increases, restoration suitability increases.	Generate slope surface from DEM. Reclassify surface where higher slope values have higher suitability values.	Niagara Peninsula Conservation Authority
CRITERIA: FISH HABITAT CLASSIFICATION OF CATCHMENT *(catchfhr)* 3 Critical 2 Important 1 Marginal	Catchments which drain to watercourses classified as Fish Habitat are considered more suitable, as restoration projects will contribute to food, shelter, temperature moderation and oxygen production.	Generate surface from catchment polygons on fish habitat classification value. Reclassify values according to restoration suitability.	Niagara Peninsula Conservation Authority
CRITERIA: STREAM ORDER OF CATCHMENT *(catchsor)* 3 intermittent flow (1st & 2nd order) 2 intermittent / permanent flow (3rd order) 1 permanent flow (> 3rd order)	Catchments which drain to watercourses in headwater streams are considered more suitable for restoration than those that drain to higher ordered streams in terms of water quality improvement.	Generate surface from catchment polygons on stream order value. Reclassify values according to restoration suitability.	Niagara River AOC RAP Riparian Habitat Guidelines
CRITERIA: FOREST COVER *(coverwor)* 3 woodland not present 2 planting site 1 woodland present	It is more suitable to restore habitat where vegetation does not presently exist, or where infilling may be necessary from a previous restoration project.	Generate surface from natural vegetation polygons based on vegetation type. Reclassify cells lacking forest cover as highest suitability values.	Niagara River AOC RAP Riparian Habitat Guidelines

RESTORATION SUITABILITY CRITERIA: RIPARIAN HABITAT

HABITAT: RIPARIAN	RATIONALE	METHODOLOGY	REFERENCE
CRITERIA: STREAMBANK EROSION RATES *(Wetness Index)* (ripwir) 3 High (10-21) 2 Mid (5-10) 1 Low (0-5)	Riparian areas identified as having high erosion rates resulting from upslope contributing area and slope gradient analysis are most suitable to restoration with bioengineering.	Generate wetness index surface from topographic analysis. Reclassify surface where highest erosion rates have highest suitability values.	Niagara Peninsula Conservation Authority
CRITERIA: PROTECTED AREA *(careasdr)* 3 within conservation area boundary 2 ≤ 30m from conservation area boundary 1 > 30m from conservation area boundary	Areas within C.A. boundaries are protected from development pressure and destruction. Areas in close proximity to these boundaries are good areas to restore in terms of establishing connectivity.	Generate straight line distance surface from Conservation Area boundary polygons. Reclassify surface values according to restoration suitability.	Niagara Peninsula Conservation Authority

RESTORATION SUITABILITY CRITERIA: WETLAND HABITAT

HABITAT: WETLAND	RATIONALE	METHODOLOGY	REFERENCE
CRITERIA: PROXIMITY TO EXISTING SIGNIFICANT PATCH (SIZE) *(wecoredr)* 3 ≤ 50m 2 > 50m & < 100m 1 ≥ 100m	Areas within closest proximity to existing wetland patches of highest Natural Heritage Score (core size) will be most suitable to restoration of increased interior habitat.	Select existing patches with highest size significance value. Generate distance surface from selected patches. Reclassify surface values where lowest distances have highest suitability values.	Niagara River AOC RAP Wetland Extent Guidelines
CRITERIA: PROXIMITY TO SIGNIFICANT EXISTING PATCH *(wenndr)* 3 ≤ 50m 2 > 50m & < 100m 1 ≥ 100m	Areas within closest proximity to existing wetland patches of highest Natural Heritage score (nearest neighbor) will be most suitable to restoration.	Select existing patches with highest size significance value. Generate distance surface from selected patches. Reclassify surface values where lowest distances have highest suitability values.	Niagara River AOC RAP Wetland Extent Guidelines
CRITERIA: PROXIMITY TO WATERCOURSE / WATERBODY *(edgedr)* 3 ≤ 30m 2 > 30m & < 50m 1 ≥ 50m	Areas within closest proximity to watercourses or waterbodies will be most suitable to restoration. These areas contribute to both riparian buffer and floodplain. Restoration in these areas will improve hydrological, habitat and water quality functions.	Generate straight line distance surface from watercourses and waterbodies. Reclassify surface values where lowest distances have highest suitability values, reflecting riparian and floodplain location.	Niagara River AOC RAP Wetland Extent Guidelines
CRITERIA: SOIL DRAINAGE *(sdrainr)* 3 Alluvial Soil 2 Very Poorly and Poorly Drained 1 Imperfectly Drained	The drainage class of the underlying soil determines the amount of water the soil can receive and store before runoff. The more poorly drained the underlying soil, the more suitable the area to wetland restoration.	Generate surface from OMAF soil polygons based on drainage class. Reclassify surface according to suitability values.	North Carolina Coastal Region Evaluation of Wetland Significance
CRITERIA: LAND USE TYPE *(lurwood)* 3 Woodland, Wetland, Scrub, Low Intensity Agriculture 2 Recreational, Residential, High Intensity Agriculture 1 Industrial, Built Up Urban	In terms of potential conflict, existing land use type is scaled in terms of suitability to restoration. Areas classified as scrub, low intensity agriculture, or natural area are much more suitable to restoration than areas classified as industrial or built-up urban.	Generate Land Use surface on Land Use Type value. Reclassify Land Use values where low conflict land use types have higher suitability values than high conflict land use types.	Niagara Peninsula Conservation Authority
CRITERIA: FISH HABITAT CLASSIFICATION OF CATCHMENT *(catchfr)* 3 Critical 2 Important 1 Marginal	Catchments which drain to watercourses classified as Fish Habitat are considered more suitable, as restoration projects will contribute to food, shelter, temperature moderation and oxygen production.	Generate surface from catchment polygons on fish habitat classification value. Reclassify values according to restoration suitability.	Niagara Peninsula Conservation Authority

RESTORATION SUITABILITY CRITERIA: WETLAND HABITAT

HABITAT: WETLAND	RATIONALE	METHODOLOGY	REFERENCE
CRITERIA: STREAM ORDER OF CATCHMENT *(catchsor)* 3 intermittent flow (1st & 2nd order) 2 intermittent / permanent flow (3rd order) 1 permanent flow (> 3rd order)	Catchments which drain to watercourses in headwater streams are considered more suitable for restoration than those that drain to higher ordered streams in terms of water quality improvement.	Generate surface from catchment polygons on stream order value. Reclassify values according to restoration suitability.	Niagara River AOC RAP Wetland Extent Guidelines
CRITERIA: WETNESS INDEX (TOPOGRAPHIC POSITION/SLOPE) *(wetindr)* 3 high (10-21) 2 mid (5-10) 1 low (0-5)	The wetness index equation predicts zones of water saturation where steady-state conditions and uniform soil properties are assumed. It is a function of upslope contributing area and slope gradient. Areas of highest W.I. values are most suitable to wetland restoration.	Generate wetness index surface from slope gradient and flow accumulation. Reclassify surface where highest Wetness Index values have highest suitability values.	Niagara Peninsula Conservation Authority
CRITERIA: FOREST COVER *(coverwer)* 3 Forest cover present 2 Planting site present 1 Forest cover present	Where forest cover is already present, restoration is more suitable, particularly in terms of the establishment of swamp habitat.	Generate surface from woodland polygons. Reclassify values according to suitability value.	Niagara Peninsula Conservation Authority
CRITERIA: PROTECTED AREA *(careasdr)* 3 within conservation area boundary 2 ≤ 30m from conservation area boundary 1 > 30m from conservation area boundary	Areas within C.A. boundaries are protected from development pressure and destruction. Areas in close proximity to these boundaries are more suitable to restore in terms of establishing connectivity.	Generate straight line distance surface from Conservation Area boundary polygons. Reclassify surface values according to restoration suitability.	Niagara Peninsula Conservation Authority

RESTORATION SUITABILITY CRITERIA: UPLAND HABITAT

HABITAT: UPLAND FOREST	RATIONALE	METHODOLOGY	REFERENCE
CRITERIA: PROXIMITY TO SIGNIFICANT PATCH (CoreSize) *(wocoredr)* 3 ≤ 50m 2 > 50m & < 100m 1 ≥ 100m	Areas within closest proximity to existing forest patches of highest of Natural Heritage Score (core size) will be most suitable to restoration increased interior habitat.	Select existing patches with highest size significance value. Generate distance surface from selected patches. Reclassify surface values where lowest distances have highest suitability values.	Niagara River AOC RAP Evaluation of Upland Habitat
CRITERIA: PROXIMITY TO SIGNIFICANT PATCH (Connectivity) *(wonndr)* 3 ≤ 50m 2 > 50m & < 100m 1 ≥ 100m	Areas within closest proximity to existing forest patches of highest Natural Heritage score (nearest neighbor) will be most suitable to restoration of wildlife corridors.	Select existing patches with highest proximity significance value. Generate distance surface from selected patches. Reclassify surface values where lowest distances have highest suitability values.	Niagara River AOC RAP Evaluation of Upland Habitat
CRITERIA: PROXIMITY TO WATERCOURSE / WATERBODY *(edgedr)* 3 ≤ 30m 2 > 30m & < 50m 1 ≥ 50m	Areas within closest proximity to watercourses or waterbodies will be most suitable to restoration. These areas contribute to both riparian buffer and floodplain. Restoration in these areas will improve hydrological, habitat and water quality functions.	Generate straight line distance surface from watercourses and waterbodies. Reclassify surface values where lowest distances have highest suitability values, reflecting riparian and floodplain location.	Niagara River AOC RAP Riparian Habitat Guidelines
CRITERIA: LAND USE TYPE *(lurwood)* 3 Woodland, Wetland, Scrub, Low Intensity Agriculture 2 Recreational, Residential, High Intensity Agriculture 1 Industrial, Built Up Urban	In terms of potential conflict, existing land use type is scaled in terms of suitability to restoration. Areas classified as scrub, low intensity agriculture, or natural area are much more suitable to restoration than areas classified as industrial or built-up urban.	Generate surface from 1992 Landsat 7 Landuse Classification on Land Use Type value. Reclassify Land Use values where low conflict land use types have higher suitability values than high conflict land use types.	Niagara Peninsula Conservation Authority

RESTORATION SUITABILITY CRITERIA: UPLAND HABITAT

HABITAT: UPLAND FOREST	RATIONALE	METHODOLOGY	REFERENCE
CRITERIA:FISH HABITAT CLASSIFICATION OF CATCHMENT *(catchfhr)* 3 Critical 2 Important 1 Marginal	Catchments which drain to watercourses classified as Fish Habitat are considered more suitable, as restoration projects will contribute to food, shelter, temperature moderation and oxygen production.	Generate surface from catchment polygons on fish habitat classification value. Reclassify values according to restoration suitability.	Niagara Peninsula Conservation Authority
CRITERIA:STREAM ORDER OF CATCHMENT *(catchsor)* 3 intermittent flow (1st & 2nd order) 2 intermittent / permanent flow (3rd order) 1 permanent flow (> 3rd order)	Catchments which drain to watercourses in headwater streams are considered more suitable for restoration than those that drain to higher ordered streams in terms of water quality improvement.	Generate surface from catchment polygons on stream order value. Reclassify values according to restoration suitability.	Niagara River AOC RAP Evaluation of Upland Habitat
CRITERIA:0-240M WETLAND BUFFER HABITAT THRESHOLDS *(sigwetdr)* 3 < 50m 2 50m - 120m 1 120m - 240m	Areas within these buffer distances contribute to a range of habitat functions when vegetated. Vegetation within closest proximity to the wetland provides the greatest benefit to that wetland. These areas are thus considered most suitable to restoration.	Generate straight line distance surface from wetlands. Reclassify surface values where habitat threshold distances have highest suitability value.	Niagara River AOC RAP Wetland Extent Guidelines
CRITERIA:PROTECTED AREA *(careasdr)* 3 within conservation area boundary 2 ≤ 30m from conservation area boundary 1 > 30m from conservation area boundary	Areas within C.A. boundaries are protected from development pressure and destruction. Areas in close proximity to these boundaries are good areas to restore in terms of establishing connectivity.	Generate straight line distance surface from Conservation Area boundary polygons. Reclassify surface values according to restoration suitability.	Niagara Peninsula Conservation Authority
CRITERIA:SLOPE *(slopedr)* 3 ≥ 10 degrees 2 < 10 degrees 1 0 degrees	Considers the presence of forest cover in terms of hydrological and mechanical contribution to slope stability and erosion control. As slope increases, restoration suitability increases.	Generate slope surface from DEM. Reclassify surface where higher slope values have higher suitability values.	North Carolina Coastal Region Evaluation of Wetland Significance
CRITERIA:FOREST COVER *(coverwor)* 3 woodland not present 2 planting site 1 woodland present	The amount of forest cover must be increased in order to meet habitat targets. It is obviously more suitable to restore forest habitat where it does not presently exist, or where infilling may be necessary from a previous restoration site.	Generate surface from natural vegetation polygons based on vegetation type. Reclassify areas lacking forest cover as highest suitability values.	Niagara River AOC RAP Evaluation of Upland Habitat

RIPARIAN

PAIRWISE IMPORTANCE								
	WATER	LANDUSE	SLOPE	FISH HC	STREAM O	COVER	WET INDEX	C.A.'S
WATER	1.00	5.00	5.00	2.00	1.00	2.00	0.20	9.00
LANDUSE	0.20	1.00	7.00	2.00	2.00	4.00	0.33	9.00
SLOPE	0.20	0.14	1.00	0.20	0.14	0.50	0.20	5.00
FISH HC	0.50	0.50	5.00	1.00	0.33	3.00	0.20	9.00
STREAM O	1.00	0.50	7.00	3.00	1.00	4.00	0.25	9.00
COVER	0.50	0.25	2.00	0.33	0.25	1.00	0.14	9.00
WET INDEX	5.00	3.00	5.00	5.00	4.00	7.00	1.00	9.00
C.A.'S	0.11	0.11	0.20	0.11	0.11	0.11	0.11	1.00
SUM	**8.51**	**10.50**	**32.20**	**13.64**	**8.84**	**21.61**	**2.44**	**60.00**

BACKGROUND INFORMATION

IMPORTANCE LEVEL	RATING
Equally Important	1.00
Equally To Moderately More Important	2.00
Moderately More Important	3.00
Moderately To Strongly More Important	4.00
Strongly More Important	5.00
Strongly To Very Strongly More Important	6.00
Very Strongly More Important	7.00
Very Strongly To Extremely More Important	8.00
Extremely More Important	9.00

1 - 1 = 1	2 - 1 = 4	3 - 1 = 7	4 - 1 = 9
1 - 2 = X	2 - 2 = 1	3 - 2 = 4	4 - 2 = 7
1 - 3 = X	2 - 3 = X	3 - 3 = 1	4 - 3 = 4
1 - 4 = X	2 - 4 = X	3 - 4 = X	4 - 4 = 1

****TO USE THIS INFO IN SUITABILITY ANALYSIS:

1. Using raster calculator, add together each surface * relative weight
2. Divide sum by total of relative weights
   ie. (S1*W1 + S2*W2 + S3*W3 + ...) / (W1 + W2 + W3 + ...)
3. Compare result to manual weighting result

RIPARIAN

NORMALIZED VALUES										
	WATER	LANDUSE	SLOPE	FISH HC	STREAM O	COVER	WET INDEX	C.A.'S	SUM	WEIGHT
WATER	0.12	0.48	0.16	0.15	0.11	0.09	0.08	0.15	**1.33**	**11.30**
LANDUSE	0.02	0.10	0.22	0.15	0.23	0.19	0.14	0.15	**1.18**	**10.01**
SLOPE	0.02	0.01	0.03	0.01	0.02	0.02	0.08	0.08	**0.29**	**2.44**
FISH HC	0.06	0.05	0.16	0.07	0.04	0.14	0.08	0.15	**0.74**	**6.30**
STREAM O	0.12	0.05	0.22	0.22	0.11	0.19	0.10	0.15	**1.15**	**9.78**
COVER	0.06	0.02	0.06	0.02	0.03	0.05	0.06	0.15	**0.45**	**3.83**
WET INDEX	0.59	0.29	0.16	0.37	0.45	0.32	0.41	0.15	**2.73**	**23.16**
C.A.'S	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.02	**0.12**	**1.00**
SUM	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**		**67.82**

BACKGROUND INFORMATION

IMPORTANCE LEVEL	RATING
Equally Important	1.00
Equally To Moderately More Important	2.00
Moderately More Important	3.00
Moderately To Strongly More Important	4.00
Strongly More Important	5.00
Strongly To Very Strongly More Important	6.00
Very Strongly More Important	7.00
Very Strongly To Extremely More Important	8.00
Extremely More Important	9.00

1 - 1 = 1	2 - 1 = 4	3 - 1 = 7	4 - 1 = 9
1 - 2 = X	2 - 2 = 1	3 - 2 = 4	4 - 2 = 7
1 - 3 = X	2 - 3 = X	3 - 3 = 1	4 - 3 = 4
1 - 4 = X	2 - 4 = X	3 - 4 = X	4 - 4 = 1

*Min. Value

****TO USE THIS INFO IN SUITABILITY ANALYSIS:

1. Using raster calculator, add together each surface * relative weight
2. Divide sum by total of relative weights
   ie. (S1*W1 + S2*W2 + S3*W3 + ...) / (W1 + W2 + W3 + ...)
3. Compare result to manual weighting result

WETLANDS

PAIRWISE IMPORTANCE										
	PROX (NN)	PROX (CS)	WATER	SOIL	LAND USE	FISH HC	STREAM O	WET INDEX	COVER	C.A.'S
PROX (NN)	1.00	7.00	0.33	0.11	0.14	0.33	0.14	0.11	5.00	7.00
PROX (CS)	0.14	1.00	0.25	0.14	0.14	1.00	0.20	0.11	1.00	7.00
WATER	3.00	4.00	1.00	0.50	0.50	5.00	3.00	0.14	7.00	7.00
SOIL	9.00	7.00	2.00	1.00	3.00	6.00	5.00	2.00	7.00	9.00
LAND USE	7.00	7.00	2.00	0.33	1.00	7.00	5.00	1.00	7.00	7.00
FISH HC	3.00	1.00	0.20	0.17	0.14	1.00	0.33	0.14	5.00	5.00
STREAM O	7.00	5.00	0.33	0.20	0.20	3.00	1.00	0.20	7.00	7.00
WET INDEX	9.00	9.00	7.00	0.50	1.00	7.00	5.00	1.00	9.00	9.00
COVER	0.20	1.00	0.14	0.14	0.14	0.20	0.14	0.11	1.00	3.00
C.A.'S	0.14	0.14	0.14	0.11	0.14	0.20	0.14	0.11	0.33	1.00
SUM	**39.49**	**42.14**	**13.40**	**3.21**	**6.41**	**30.73**	**19.96**	**4.93**	**49.33**	**62.00**

BACKGROUND INFORMATION

IMPORTANCE LEVEL	RATING
Equally Important	1.00
Equally To Moderately More Important	2.00
Moderately More Important	3.00
Moderately To Strongly More Important	4.00
Strongly More Important	5.00
Strongly To Very Strongly More Important	6.00
Very Strongly More Important	7.00
Very Strongly To Extremely More Important	8.00
Extremely More Important	9.00

1 - 1 = 1	2 - 1 = 4	3 - 1 = 7	4 - 1 = 9
1 - 2 = X	2 - 2 = 1	3 - 2 = 4	4 - 2 = 7
1 - 3 = X	2 - 3 = X	3 - 3 = 1	4 - 3 = 4
1 - 4 = X	2 - 4 = X	3 - 4 = X	4 - 4 = 1

****TO USE THIS INFO IN SUITABILITY ANALYSIS:

1. Using raster calculator, add together each surface * relative weight
2. Divide sum by total of relative weights
   ie. (S1*W1 + S2*W2 + S3*W3 + ...) / (W1 + W2 + W3 + ...)
3. Compare result to manual weighting result

WETLANDS

NORMALIZED VALUES												
	PROX (NN)	PROX (CS)	WATER	SOIL	LAND USE	FISH HC	STREAM O	WET INDEX	COVER	C.A.'S	SUM	WEIGHT
PROX (NN)	0.03	0.17	0.02	0.03	0.02	0.01	0.01	0.02	0.10	0.11	**0.53**	**3.95**
PROX (CS)	0.00	0.02	0.02	0.04	0.02	0.03	0.01	0.02	0.02	0.11	**0.31**	**2.33**
WATER	0.08	0.09	0.07	0.16	0.08	0.16	0.15	0.03	0.14	0.11	**1.08**	**8.05**
SOIL	0.23	0.17	0.15	0.31	0.47	0.20	0.25	0.41	0.14	0.15	**2.46**	**18.41**
LANDUSE	0.18	0.17	0.15	0.10	0.16	0.23	0.25	0.20	0.14	0.11	**1.69**	**12.63**
FISH HC	0.08	0.02	0.01	0.05	0.02	0.03	0.02	0.03	0.10	0.08	**0.45**	**3.36**
STREAM O	0.18	0.12	0.02	0.06	0.03	0.10	0.05	0.04	0.14	0.11	**0.86**	**6.41**
WET INDEX	0.23	0.21	0.52	0.16	0.16	0.23	0.25	0.20	0.18	0.15	**2.28**	**17.09**
COVER	0.01	0.02	0.01	0.04	0.02	0.01	0.01	0.02	0.02	0.05	**0.21**	**1.58**
C.A.'S	0.00	0.00	0.01	0.03	0.02	0.01	0.01	0.02	0.01	0.02	**0.13**	**1.00**
SUM	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**		**74.82**

BACKGROUND INFORMATION

IMPORTANCE LEVEL	RATING
Equally Important	1.00
Equally To Moderately More Important	2.00
Moderately More Important	3.00
Moderately To Strongly More Important	4.00
Strongly More Important	5.00
Strongly To Very Strongly More Important	6.00
Very Strongly More Important	7.00
Very Strongly To Extremely More Important	8.00
Extremely More Important	9.00

1 - 1 = 1	2 - 1 = 4	3 - 1 = 7	4 - 1 = 9
1 - 2 = X	2 - 2 = 1	3 - 2 = 4	4 - 2 = 7
1 - 3 = X	2 - 3 = X	3 - 3 = 1	4 - 3 = 4
1 - 4 = X	2 - 4 = X	3 - 4 = X	4 - 4 = 1

* Min. Value

****TO USE THIS INFO IN SUITABILITY ANALYSIS:

1. Using raster calculator, add together each surface * relative weight
2. Divide sum by total of relative weights
   ie. (S1*W1 + S2*W2 + S3*W3 + ...) / (W1 + W2 + W3 + ...)
3. Compare result to manual weighting result

WOODLANDS

PAIRWISE IMPORTANCE										
	PROX(NN)	PROX(CS)	WATER	LANDUSE	FISHHC	STREAMO	HABTHRESH	C.A.'S	SLOPE	COVER
PROX(NN)	1.00	5.00	3.00	0.14	7.00	2.00	0.14	9.00	7.00	1.00
PROX(CS)	0.20	1.00	0.25	0.13	1.00	0.14	0.14	9.00	3.00	1.00
WATER	0.33	4.00	1.00	0.20	4.00	1.00	1.00	9.00	7.00	1.00
LANDUSE	7.00	8.00	5.00	1.00	7.00	6.00	4.00	9.00	7.00	1.00
FISH HC	0.14	1.00	0.25	0.14	1.00	0.50	0.14	7.00	3.00	1.00
STREAM O	0.50	7.00	1.00	0.17	2.00	1.00	0.33	9.00	7.00	1.00
HABTHRESH	7.00	7.00	1.00	0.25	7.00	3.00	1.00	9.00	7.00	1.00
C.A.'S	0.11	0.11	0.11	0.11	0.14	0.11	0.11	1.00	0.20	0.20
SLOPE	0.14	0.33	0.14	0.14	0.33	0.14	0.14	5.00	1.00	1.00
COVER	1.00	1.00	1.00	1.00	1.00	1.00	1.00	5.00	1.00	1.00
SUM	**17.43**	**34.44**	**12.75**	**3.28**	**30.48**	**14.90**	**8.02**	**72.00**	**43.20**	**9.20**

BACKGROUND INFORMATION

IMPORTANCE LEVEL	RATING
Equally Important	1.00
Equally To Moderately More Important	2.00
Moderately More Important	3.00
Moderately To Strongly More Important	4.00
Strongly More Important	5.00
Strongly To Very Strongly More Important	6.00
Very Strongly More Important	7.00
Very Strongly To Extremely More Important	8.00
Extremely More Important	9.00

1 - 1 = 1	2 - 1 = 4	3 - 1 = 7	4 - 1 = 9
1 - 2 = X	2 - 2 = 1	3 - 2 = 4	4 - 2 = 7
1 - 3 = X	2 - 3 = X	3 - 3 = 1	4 - 3 = 4
1 - 4 = X	2 - 4 = X	3 - 4 = X	4 - 4 = 1

****TO USE THIS INFO IN SUITABILITY ANALYSIS:

1. Using raster calculator, add together each surface * relative weight
2. Divide sum by total of relative weights
   ie. (S1*W1 + S2*W2 + S3*W3 + ...) / (W1 + W2 + W3 + ...)
3. Compare result to manual weighting result

WOODLANDS

NORMALIZED VALUES												
	PROX(NN)	PROX(CS)	WATER	LANDUSE	FISHHC	STREAMO	HABTHRESH	C.A.'S	SLOPE	COVER	SUM	WEIGHT
PROX (NN)	0.06	0.15	0.24	0.04	0.23	0.13	0.02	0.13	0.16	0.11	**1.26**	**10.63**
PROX (CS)	0.01	0.03	0.02	0.04	0.03	0.01	0.02	0.13	0.07	0.11	0.46	**3.90**
WATER	0.02	0.12	0.08	0.06	0.13	0.07	0.12	0.13	0.16	0.11	**0.99**	**8.39**
LANDUSE	0.40	0.23	0.39	0.30	0.23	0.40	0.50	0.13	0.16	0.11	**2.86**	**24.13**
FISH HC	0.01	0.03	0.02	0.04	0.03	0.03	0.02	0.10	0.07	0.11	**0.46**	**3.88**
STREAM O	0.03	0.20	0.08	0.05	0.07	0.07	0.04	0.13	0.16	0.11	**0.93**	**7.86**
HAB THRESH	0.40	0.20	0.08	0.08	0.23	0.20	0.12	0.13	0.16	0.11	**1.71**	**14.45**
C.A.'S	0.01	0.00	0.01	0.03	0.00	0.01	0.01	0.01	0.00	0.02	**0.12**	**1.00**
SLOPE	0.01	0.01	0.01	0.04	0.01	0.01	0.02	0.07	0.02	0.11	**0.31**	**2.64**
COVER	0.06	0.03	0.08	0.30	0.03	0.07	0.12	0.07	0.02	0.11	**0.90**	**7.56**
SUM	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**		**84.43**

BACKGROUND INFORMATION

IMPORTANCE LEVEL	RATING
Equally Important	1.00
Equally To Moderately More Important	2.00
Moderately More Important	3.00
Moderately To Strongly More Important	4.00
Strongly More Important	5.00
Strongly To Very Strongly More Important	6.00
Very Strongly More Important	7.00
Very Strongly To Extremely More Important	8.00
Extremely More Important	9.00

1 - 1 = 1	2 - 1 = 4	3 - 1 = 7	4 - 1 = 9
1 - 2 = X	2 - 2 = 1	3 - 2 = 4	4 - 2 = 7
1 - 3 = X	2 - 3 = X	3 - 3 = 1	4 - 3 = 4
1 - 4 = X	2 - 4 = X	3 - 4 = X	4 - 4 = 1

* Min Value

****TO USE THIS INFO IN SUITABILITY ANALYSIS:

1. Using raster calculator, add together each surface * relative weight
2. Divide sum by total of relative weights
   ie. (S1*W1 + S2*W2 + S3*W3 + ...) / (W1 + W2 + W3 + ...)
3. Compare result to manual weighting result

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